CARDSFlow

Release 0.0.

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USAGE AND INSTALLATION

Contents:

CHAPTER

ONE

INSTALLATION

1.1 Prerequisites

The CARDSflow repo has been tested on Ubuntu 16.04 with ROS kinetic and Ubunutu 18.04 with ROS melodic. It may work on different platforms with different ROS versions. Make sure you install the following packages:

```
sudo apt install ros-$ROS_DISTRO-desktop-full libeigen3-dev libxml2-dev coinor-
↪libipopt-dev \
qtbase5-dev qtdeclarative5-dev qtmultimedia5-dev qml-module-qtquick2 \
qml-module-qtquick-window2 qml-module-qtmultimedia qml-module-qtquick-dialogs \
qml-module-qtquick-controls qml-module-qt-labs-folderlistmodel qml-module-qt-labs-
↪settings \
ros-$ROS_DISTRO-moveit-msgs doxygen swig mscgen ros-$ROS_DISTRO-grid-map \
ros-$ROS_DISTRO-controller-interface ros-$ROS_DISTRO-controller-manager ros-$ROS_
↪DISTRO-aruco-detect \
ros-$ROS_DISTRO-effort-controllers libxml++2.6-dev ros-$ROS_DISTRO-robot-localization␣
↪libalglib-dev \
ros-$ROS_DISTRO-tf ros-$ROS_DISTRO-interactive-markers ros-$ROS_DISTRO-tf-conversions␣
↪\
ros-$ROS_DISTRO-robot-state-publisher
```

1.2 JSON

Install the newest json (version 3.6.1 at this time):

```
git clone https://github.com/nlohmann/json
cd json && mkdir build && cd build
cmake ..
make -j8
sudo make install
```

1.3 Get The Code

Clone the code to your catkin workspace:

```
cd path/to/your/catkin_ws/src
git clone --recursive https://github.com/CARDSflow/CARDSflow
```

1.4 Build From Source

First we need to build iDynTree (for more details on this step, visit the iDynTree website):

```
cd path/to/CARDSflow/iDyntree
mkdir build && cd build
cmake ..
make -j9
sudo make install
```

Next we need to build and install qpoases:

```
cd qpOASES/
mkdir build && cd build
cmake ../
sudo make -j9 install
```

Now you can build CARDSflow simply by building your catkin workspace:

```
cd path/to/your/catkin_ws
catkin_make
source devel/setup.bash
```

1.5 RaspberryPi 3B+ installation

Download the image using the following command:

```
wget -nv http://bot.roboy.org:8081/~roboy/CARDSflow_raspberry_pi3B+.md5sum
wget -nv http://bot.roboy.org:8081/~roboy/CARDSflow_raspberry_pi3B+.img
```

Use at least a 16GB SDcard and flash the image using the following command. NOTE: make sure you are using the correct sd-card device (/dev/sdX), otherwise you might wipe your whole system!!!

```
sudo dd if=CARDSflow_raspberry_pi3B+.img of=/dev/sdX bs=1M status=progress
```

Insert the sd-card into the raspi and power it. The image provides Ubuntu 16.03 MATE with ROS kinetic installed. In the home folder you can find the roboy_arcade_maschine workspace which contains a build version of CARDSflow.

CHAPTER

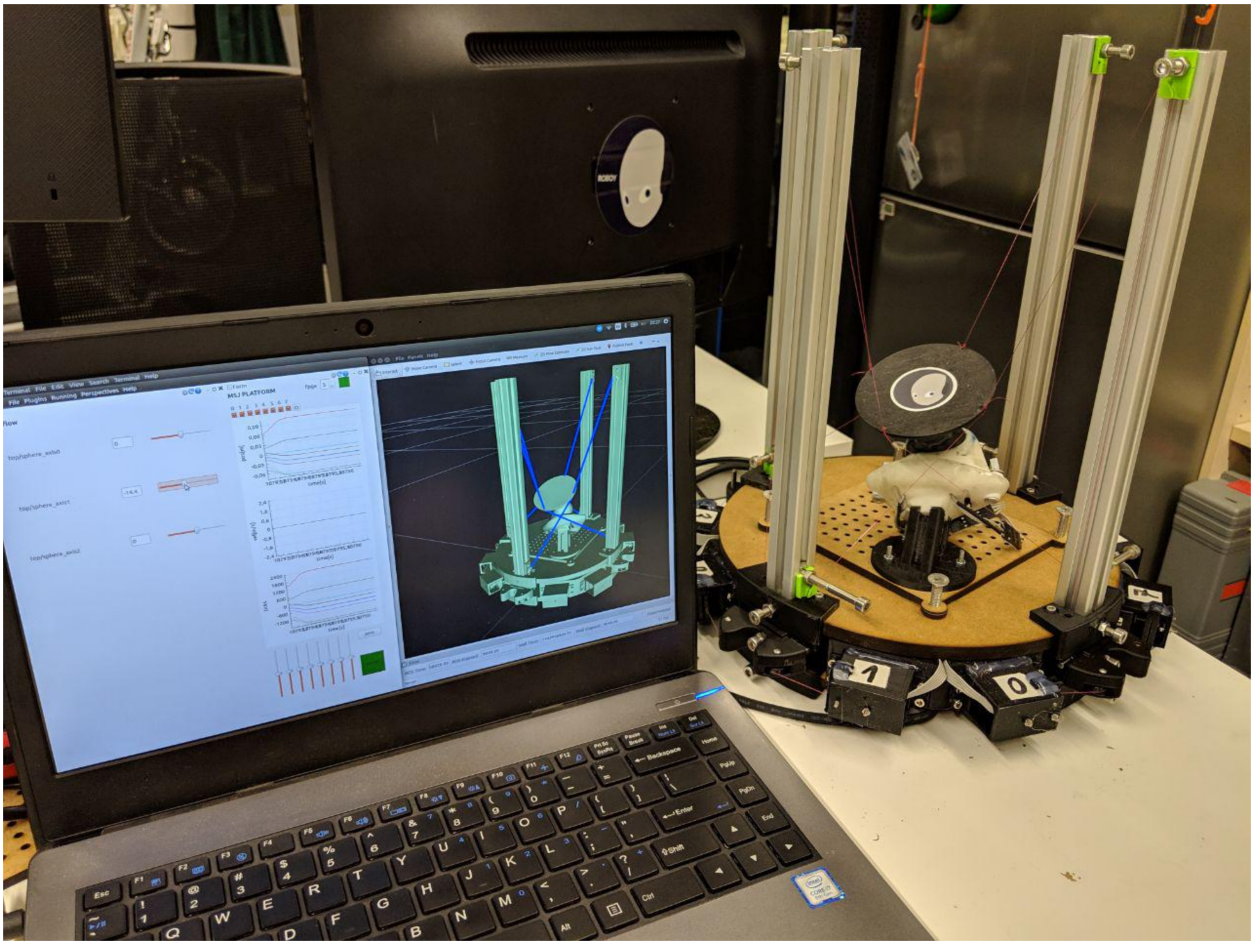
TWO

GETTING STARTED

2.1 Booting up the robot

In the kindyn package a couple of example robots can be found. You can run them with the provided robot.launch file:

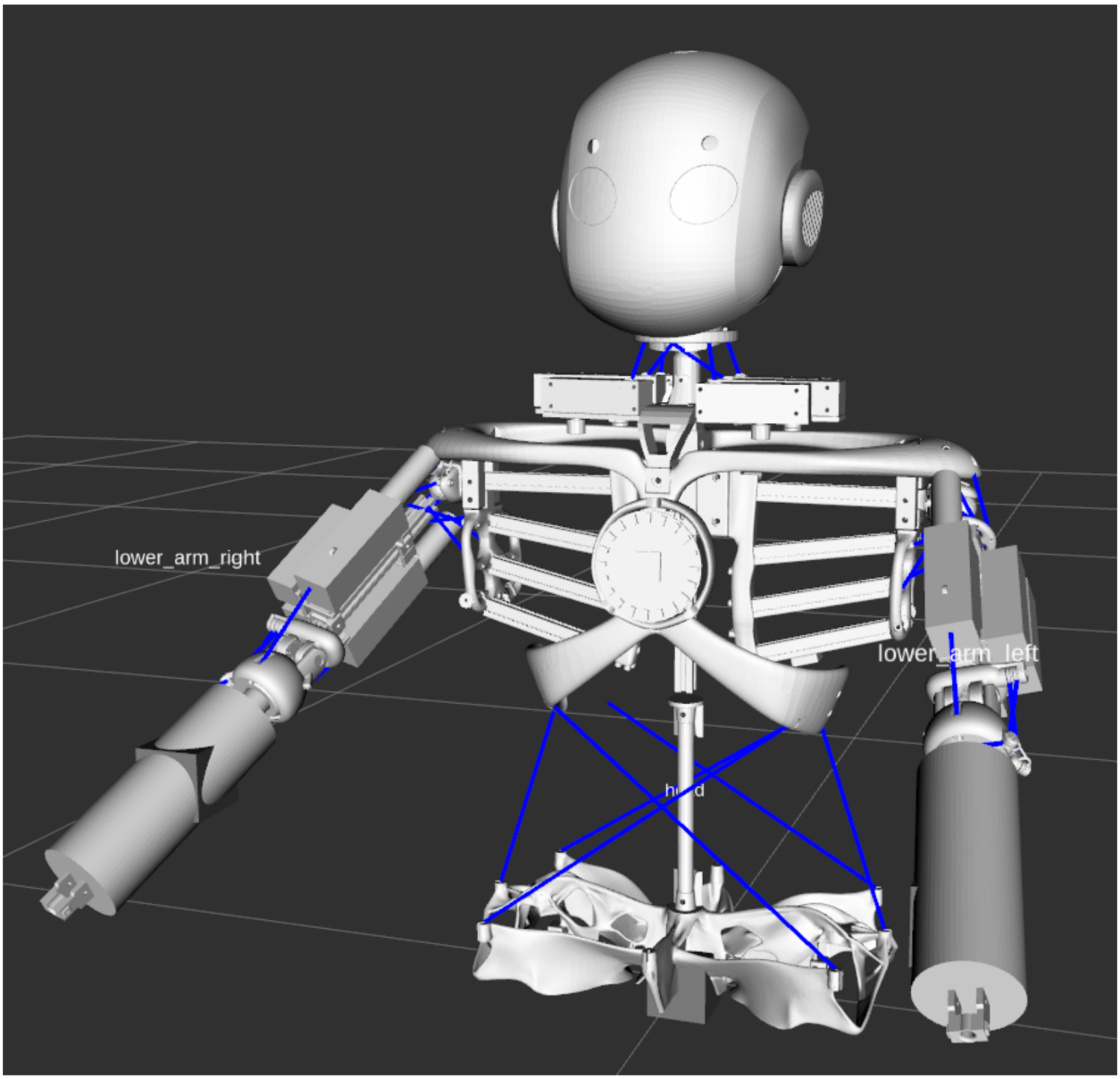
2.1.1 msj_platform



A robot that was build for training one of the 3-DoF shoulders of Roboy 2.0. It uses 8 cables to control the 3-DoFs. You can run it with the following command:

```
roslaunch kindyn robot.launch robot_name:=msj_platform start_controllers:='sphere_
↪axis0 sphere_axis1 sphere_axis2'
```

2.1.2 roboy_upper_body



Roboy 2.0 upper body with the 3-DoF head and his two 5-DoF arms. Use the following command to launch it:

```
roslaunch kindyn robot.launch robot_name:=roboy_upper_body start_controllers:='spine_
↪v0_axis0 spine_v0_axis1
spine_v0_axis2 spine_v1_axis0 spine_v1_axis1 spine_v1_axis2 spine_v2_axis0 spine_v2_
↪axis1 spine_v2_axis2
sphere_head_axis0 sphere_head_axis1 sphere_head_axis2 sphere_left_axis0 sphere_left_
↪axis1
```

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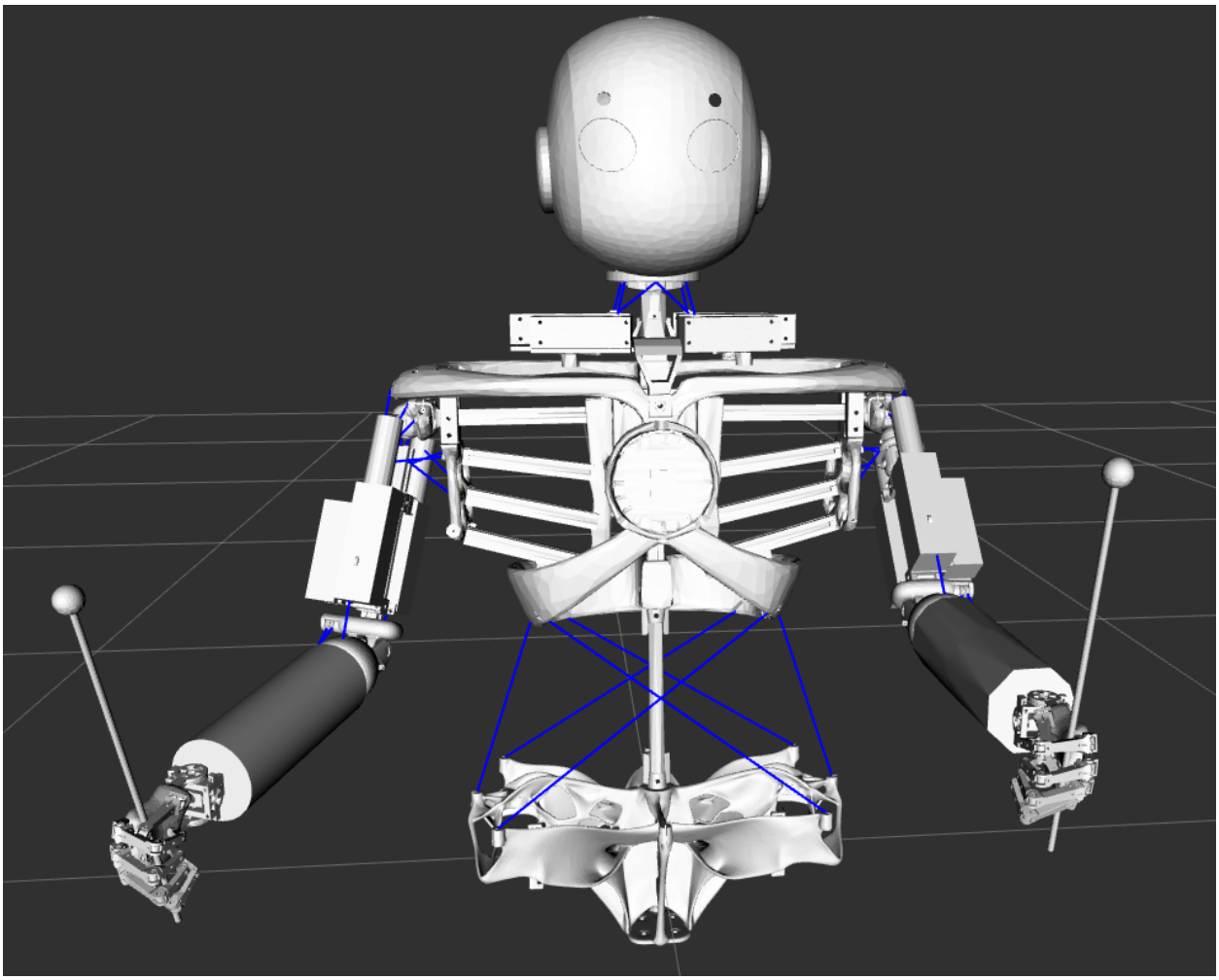
```
sphere_left_axis2 elbow_left_rot0 elbow_left_rot1 sphere_right_axis0 sphere_right_
↪axis1 sphere_right_axis2
elbow_right_rot0 elbow_right_rot1'
```

2.1.3 roboy_xylophone



Roboy 2.0 upper body with the 3-DoF head and his two 7-DoF arms holding xylophone playing sticks. Use the following command to launch it:

```
roslaunch kindyn robot.launch robot_name:=roboy_xylophone start_controllers:='sphere_
↪head_axis0 sphere_head_axis1
sphere_head_axis2 sphere_left_axis0 sphere_left_axis1 sphere_left_axis2 elbow_left_
↪rot0 elbow_left_rot1
sphere_right_axis0 sphere_right_axis1 sphere_right_axis2 elbow_right_rot0 elbow_right_
↪rot1 left_wrist_0
left_wrist_1 right_wrist_0 right_wrist_1 hip_joint left_stick_tip_joint right_stick_
↪tip_joint'
```

2.1.4 roboy_arcade_maschine

A retro arcad maschine in the Roboy lab that has a 3-DoF Roboy head mounted on the top. Launch it with:

```
roslaunch kindyn robot.launch robot_name:=roboy_arcade_maschine start_controllers:=
↪'sphere_axis0 sphere_axis1 sphere_axis2'
```

2.1.5 test_robot

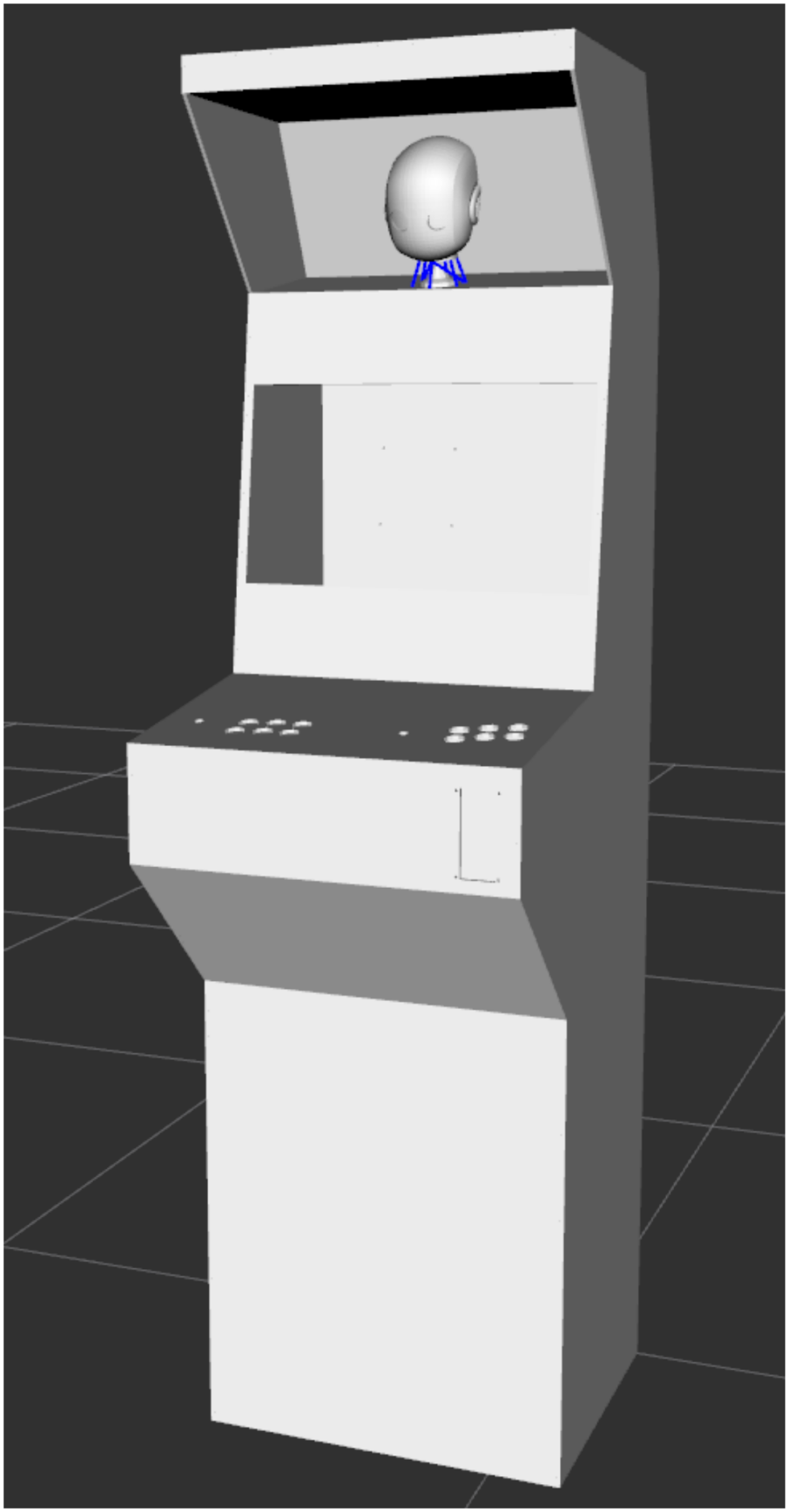
A robot with 6-DoF, 3 prismatic and 3 rotational, with 20 cables. You can launch it with the following command

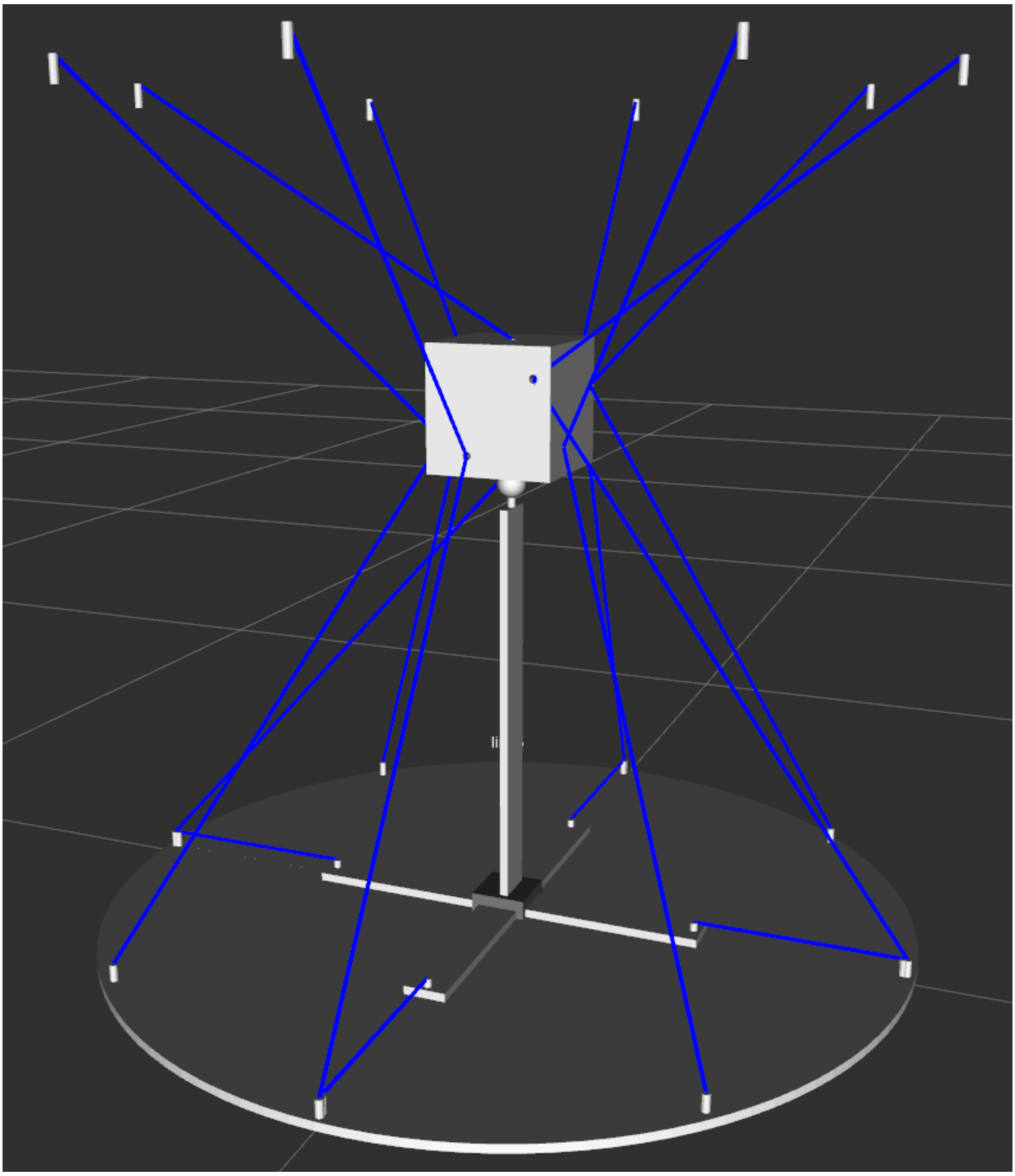
```
roslaunch kindyn robot.launch robot_name:=test_robot start_controllers:='joint0␣
↪joint1 joint2 sphere_axis0 sphere_axis1 sphere_axis2'
```

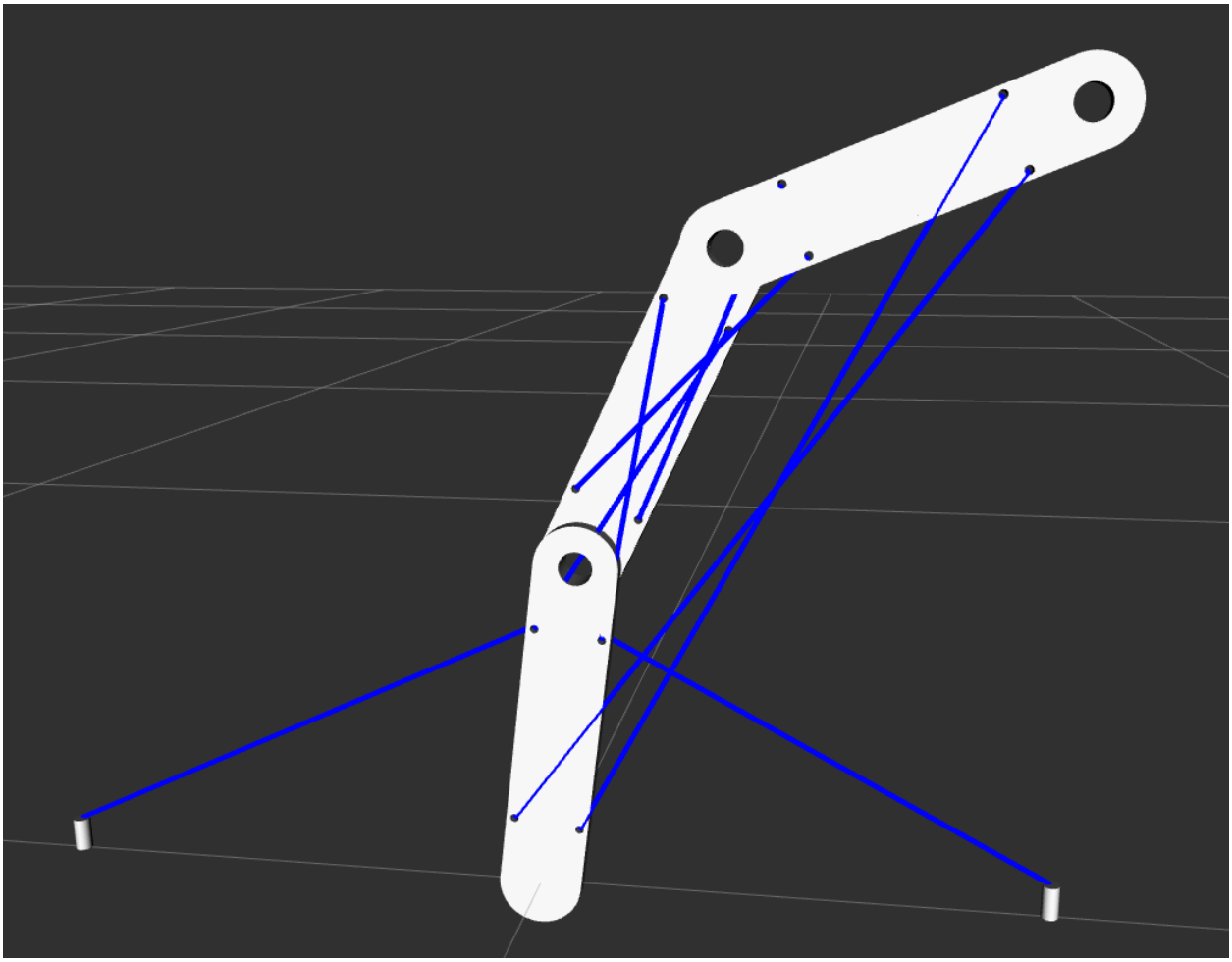
2.1.6 yatr

Yet another test robot, 3-DoF, 8 cables. You can launch it with the following command

```
roslaunch kindyn robot.launch robot_name:=yatr start_controllers:='joint0 joint1␣
↪joint2'
```







CHAPTER

THREE

WORKING WITH CASPR

CARDSflow supports visualization of robots in CASPR (*The Cable-robot Analysis and Simulation Platform for Research*), an open-source software platform developed in MATLAB for the analysis of arbitrary cable-robot models.

You need to install custom message support for matlab MATLABROS

3.1 Setting up CASPR

1. Follow the installation guide in CASPR
2. After having CASPR installed in MATLAB, note the IPs of your platforms running CARDSflow and CASPR
3. Set up the CARDSflow interface in CASPR by: *(replace <cardsflow_ip>, <caspr_ip> with the corresponding IPs)*

```
CARDSFlow_configuration.SetROSConfig('<cardsflow_ip>', '<caspr_ip>');
```

4. Build custom ROS messages in roboy_communication for MATLAB by following instructions here

3.2 Simple Visualization

3.2.1 Launching CARDSflow

1. Launch a simple visualizer in CARDSflow by:

```
roslaunch cardsflow_rviz simple_visualization.launch
```

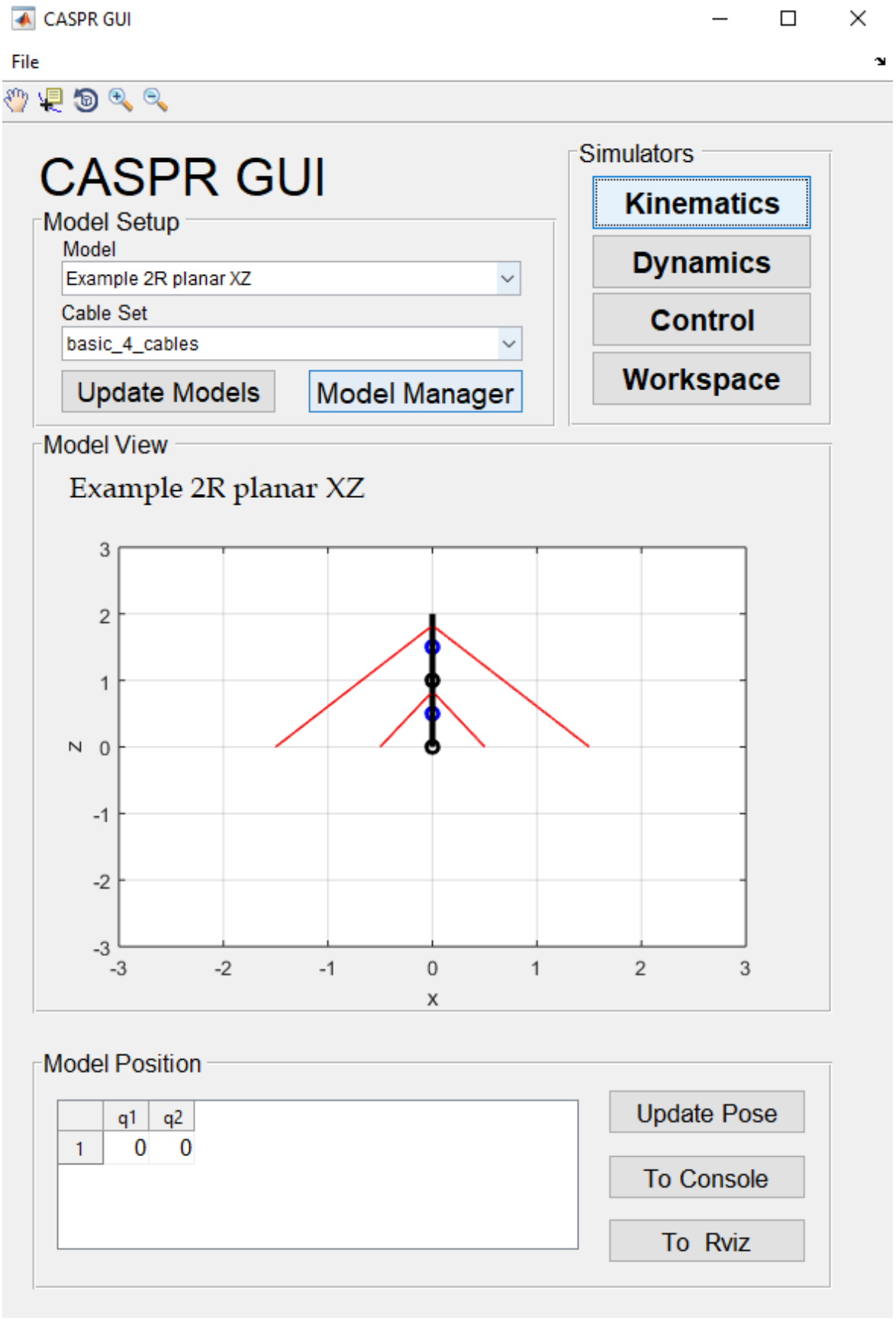
2. Add the CARDSflow panel in RViz
3. At the Displays Sidebar set Globals Options > Fixed Frame to “world”
4. At the Displays Sidebar add the display types “rviz > Marker” and “rviz > TF”
5. File > Save Config

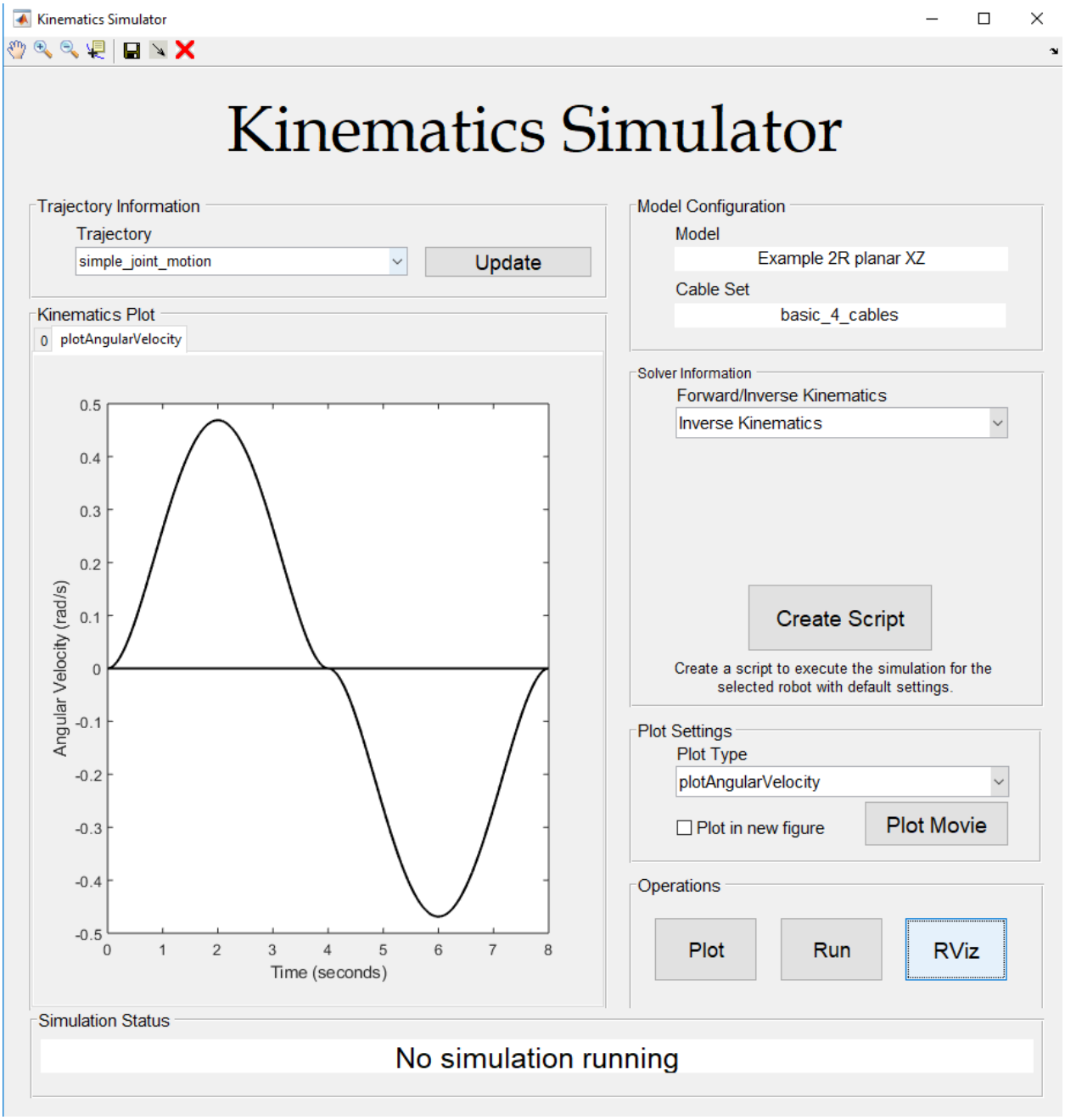
3.2.2 CASPR Simulations

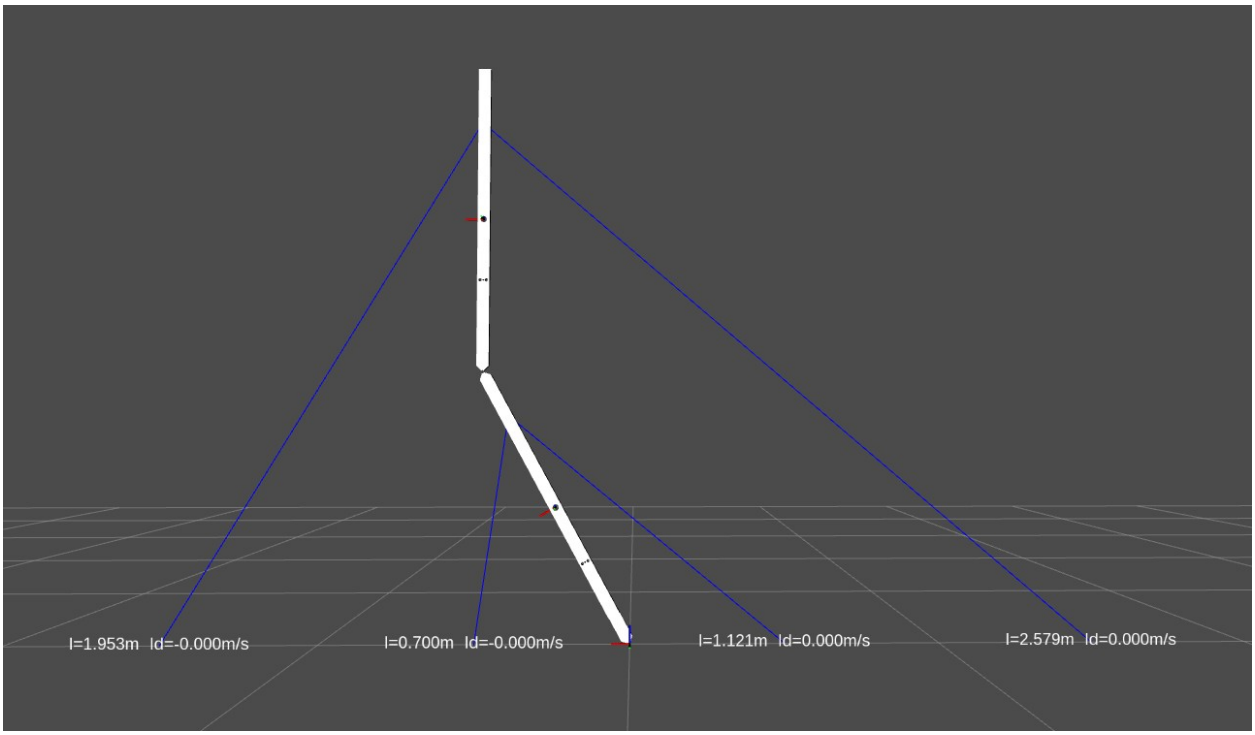
1. Launch the GUI in CASPR by:

```
CASPR_GUI
```

2. Select `Example 2R planar XZ` from the `Model` pull down menu
3. Press the `To Rviz` button on the GUI and verify that the robot is visualized in RViz
4. Press the `Kinematics` button in `Simulators`
5. Run an inverse kinematics simulation by pressing the `Run` button
6. Press the `RViz` button to visualize the trajectory


CASPR GUI
File
CASPR GUI
Simulators
Kinematics
Dynamics
Control
Workspace
Model Setup
Model
Example 2R planar XZ
Cable Set
basic_4_cables
Update Models
Model Manager
Model View
Example 2R planar XZ
3
2
1
0
-1
-2
-3
Z
-3
-2
-1
0
1
2
3
X
Model Position
q1
q2
1
0
0
Update Pose
To Console
To Rviz


Kinematics Simulator
Kinematics Simulator
Trajectory Information
Trajectory
simple_joint_motion
Update
Kinematics Plot
0 plotAngularVelocity
Angular Velocity (rad/s)
Time (seconds)
Model Configuration
Model
Example 2R planar XZ
Cable Set
basic_4_cables
Solver Information
Forward/Inverse Kinematics
Inverse Kinematics
Create Script
Create a script to execute the simulation for the selected robot with default settings.
Plot Settings
Plot Type
plotAngularVelocity
Plot in new figure
Plot Movie
Operations
Plot
Run
RViz
Simulation Status
No simulation running


l=1.953m ld=-0.000m/s
l=0.700m ld=-0.000m/s
l=1.121m ld=0.000m/s
l=2.579m ld=0.000m/s

CHAPTER

FOUR

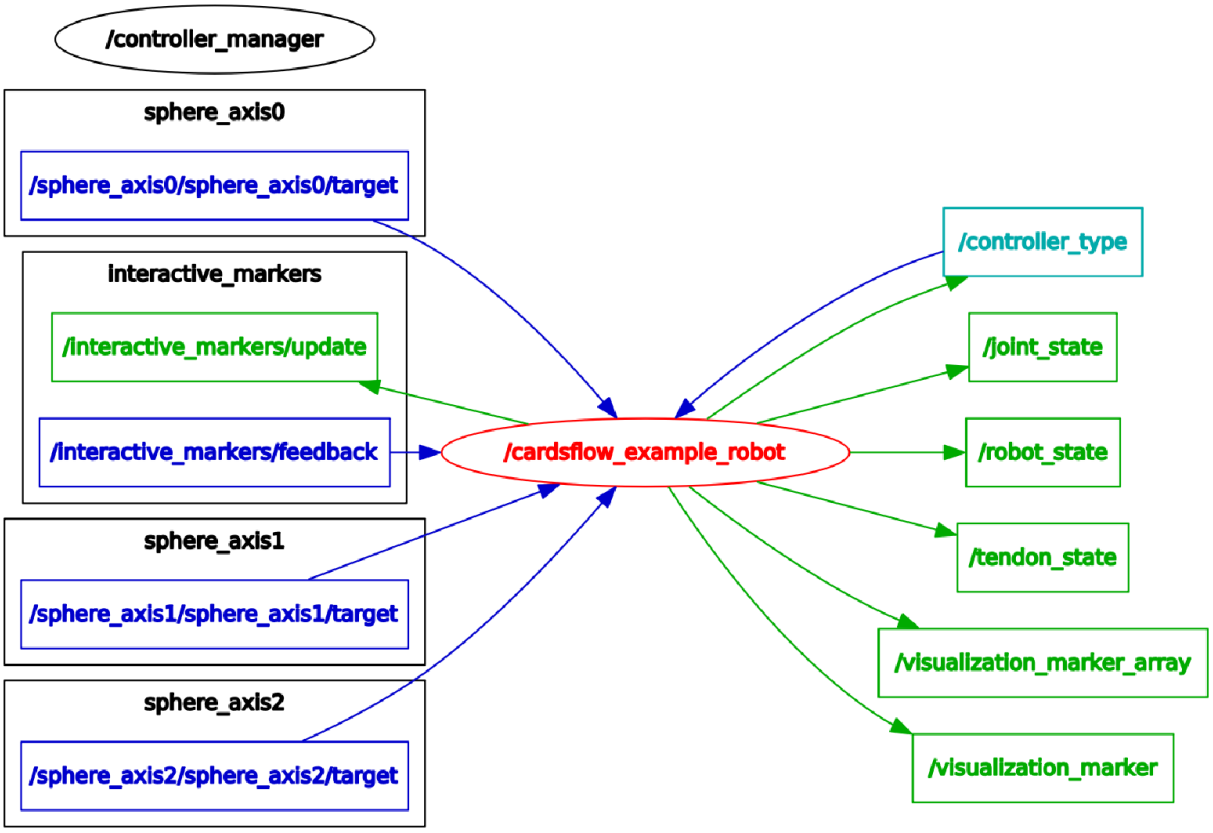
CONTEXT

CHAPTER

FIVE

TECHNICAL INTERFACES

The following rqt_graph shows an overview of the ROS message infrastructure for one of the example robots, the msj_platform.



Two ROS nodes are active, the cardsflow_example_robot and the controller_manager. The cardsflow_example_robot is our msj_platform doing all the kinematic calculations. The joint, robot and tendon states are published on the respective topics in green. On the left there are three joint target topics available in blue. The controller_manager spawned three joint controller and the respective controllers subscribe to these topics as their target setpoints. The controller_type topic is advertised by our msj_platform and the controllers publish their type on that topic once they are spawned by the controller_manager. The last topic is the interactive_marker topic which the msj_platform subscribes to. When a user drags the interactive markers in rviz, the inverse kinematics service is called and the robot will try to move to the requested position.

CHAPTER

SIX

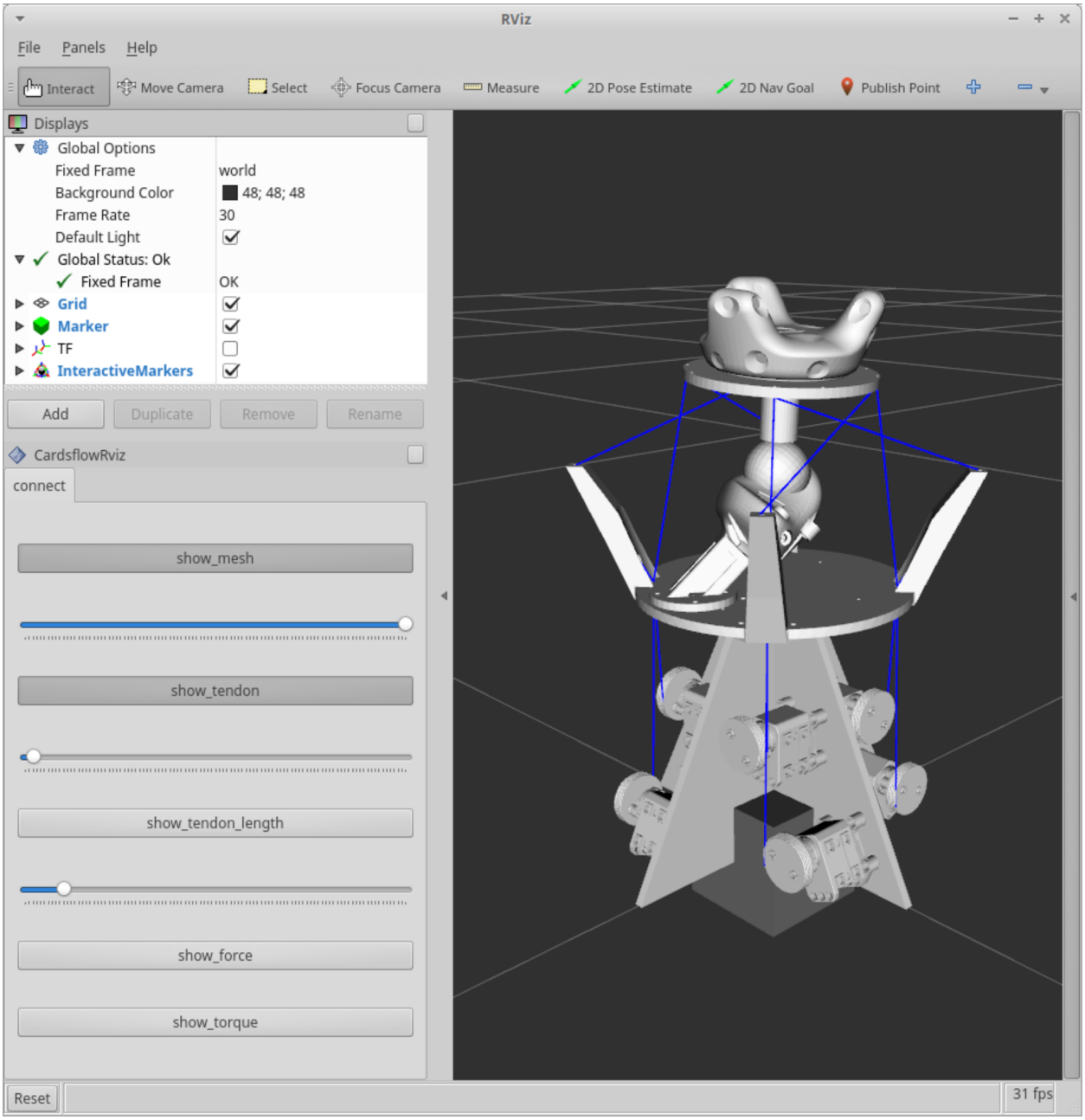
USER INTERFACES

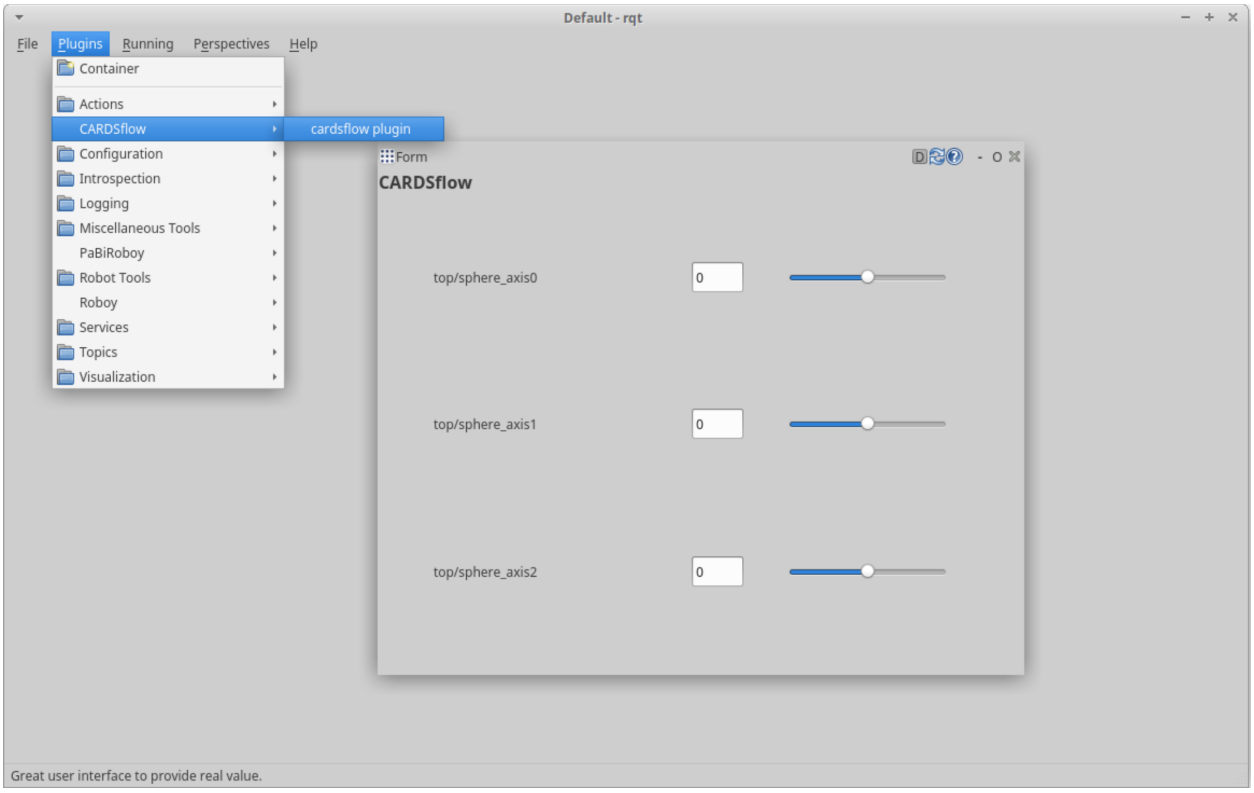
There are two user interfaces available to the user, a rviz plugin and a rqt plugin. The following figure shows the rviz plugin.

NOTE: In order for the mesh and tendons to be visible add the following pluins to rviz: 1) Marker 2) TF 3) InteractiveMarkers (you need to change the topic when you add the plugin) 4) you need to change the fixed frame in rviz from map to world

The buttons of the rviz plugin trigger visualization, while the slider change their appearance.

The rqt plugin can be seen in the figure below. The sliders can be used to change the setpoints for the endeffector joints.


RViz
File
Panels
Help
Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Nav Goal
Publish Point
Displays
Global Options
Fixed Frame
world
Background Color
48; 48; 48
Frame Rate
30
Default Light
Global Status: Ok
Fixed Frame
OK
Grid
Marker
TF
InteractiveMarkers
Add
Duplicate
Remove
Rename
CardsflowRviz
connect
show_mesh
show_tendon
show_tendon_length
show_force
show_torque
Reset
31 fps


Default - rqt
File
Plugins
Running
Perspectives
Help
Container
Actions
CARDSflow
Configuration
Introspection
Logging
Miscellaneous Tools
PaBiRoboy
Robot Tools
Roboy
Services
Topics
Visualization
cardsflow plugin
Form
CARDSflow
top/sphere_axis0
0
top/sphere_axis1
0
top/sphere_axis2
0
Great user interface to provide real value.

CHAPTER

SEVEN

API

struct Cable

Public Members

string **name**

vector<*ViaPointPtr*> **viaPoints**
name of the cable

class CableLengthController : **public** controller_interface::Controller<*hardware_interface*::*CardsflowCommandInterface*

Public Functions

CableLengthController()
Constructor.

bool **init**(*hardware_interface*::*CardsflowCommandInterface* **hw*, ros::NodeHandle &*n*)
Initializes the controller.

Will be call by controller_manager when loading this controller

Return success

Parameters

- `hw`: pointer to the hardware interface
- `n`: the nodehandle

void **update**(**const** ros::Time &*time*, **const** ros::Duration &*period*)
Called regularily by controller manager.

The length change of the cables wrt to a PD controller on the joint target position is calculated.

Parameters

- `time`: current time
- `period`: period since last control

void **starting**(**const** ros::Time &*time*)
Called by controller manager when the controller is about to be started.

Parameters

- `time`: current time

void **stopping**(**const** ros::Time &*time*)
Called by controller manager when the controller is about to be stopped.

Parameters

- `time`: current time

void **JointPositionCommand**(**const** std_msgs::Float32ConstPtr &*msg*)
Joint position command callback for this joint.

Parameters

- `msg`: joint position target in radians

bool **setControllerParameters**(roboy_control_msgs::SetControllerParameters::Request &*req*, roboy_control_msgs::SetControllerParameters::Response &*res*)
Controller Parameters service.

Return success

Parameters

- `req`: requested gains
- `res`: success

Private Members

double **Kp** = 100

double **Kd** = 0

double **p_error_last** = 0
PD gains.

ros::NodeHandle **nh**
last error

ros::Publisher **controller_state**
ROS nodehandle.

ros::ServiceServer **controller_parameter_srv**
publisher for controller state

boost::shared_ptr<ros::AsyncSpinner> **spinner**
service for controller parameters

hardware_interface::*CardsflowHandle* **joint**
ROS async spinner.

ros::Subscriber **joint_command**
cardsflow joint handle for access to joint/cable model state

string **joint_name**
joint command subscriber

int **joint_index**
name of the controlled joint

ros::Time **last_update**
index of the controlled joint in the robot model

class CableLengthVelocityController : **public** controller_interface::Controller<*hardware_interface*::*CardsflowComma*

Public Functions

CableLengthVelocityController()
Constructor.

bool **init**(*hardware_interface*::*CardsflowCommandInterface* **hw*, ros::NodeHandle &*n*)
Initializes the controller.

Will be call by controller_manager when loading this controller

Return success

Parameters

- `hw`: pointer to the hardware interface
- `n`: the nodehandle

void **update**(**const** ros::Time &*time*, **const** ros::Duration &*period*)
Called regularily by controller manager.

The length change of the cables wrt to a PD controller on the joint target position is calculated.

Parameters

- `time`: current time
- `period`: period since last control

void **starting**(**const** ros::Time &*time*)
Called by controller manager when the controller is about to be started.

Parameters

- `time`: current time

void **stopping**(**const** ros::Time &*time*)
Called by controller manager when the controller is about to be stopped.

Parameters

- `time`: current time

void **JointVelocityCommand**(**const** std_msgs::Float32ConstPtr &*msg*)
Joint position command callback for this joint.

Parameters

- `msg`: joint position target in radians

bool **setControllerParameters**(roboy_control_msgs::SetControllerParameters::Request &*req*, roboy_control_msgs::SetControllerParameters::Response &*res*)
Controller Parameters service.

Return success

Parameters

- `req`: requested gains
- `res`: success

Private Members

double **Kp** = 0.1

double **Kd** = 0

double **p_error_last** = 0
PD gains.

ros::NodeHandle **nh**
last error

ros::Publisher **controller_state**
ROS nodehandle.

ros::ServiceServer **controller_parameter_srv**
publisher for controller state

boost::shared_ptr<ros::AsyncSpinner> **spinner**
service for controller parameters

hardware_interface::*CardsflowHandle* **joint**
ROS async spinner.

ros::Subscriber **joint_command**
cardsflow joint handle for access to joint/cable model state

string **joint_name**
joint command subscriber

int **joint_index**
name of the controlled joint

ros::Time **last_update**
index of the controlled joint in the robot model

class CardsflowCommandInterface : **public** HardwareResourceManager<*CardsflowHandle*, ClaimResources>

class CardsflowHandle : **public** *hardware_interface*::*CardsflowStateHandle*

Public Functions

CardsflowHandle()

CardsflowHandle(**const** *CardsflowStateHandle* *&js*, double **joint_position_cmd*, double **joint_velocity_cmd*, double **joint_torque_cmd*, VectorXd **motor_cmd*)

Parameters

- `js`: joint state handle
- `joint_position_cmd`: joint position command
- `joint_velocity_cmd`: joint velocity command
- `joint_torque_cmd`: joint torque command
- `motor_cmd`: cable command

- `js`: This joint's state handle
- `cmd`: A pointer to the storage for this joint's output command

void **setMotorCommand**(VectorXd *command*)
Cable length command.

Parameters

- `command`:

double **getJointPositionCommand**() **const**
Returns the joint position command.

Return joint position command

double **getJointVelocityCommand**() **const**
Returns the joint velocity command.

Return joint velocity command

double **getJointTorqueCommand**() **const**
Returns the joint torque command.

Return joint torque command

void **setJointPositionCommand**(double *cmd*)
Sets the joint position command.

Parameters

- `cmd`: joint position command

void **setJointVelocityCommand**(double *cmd*)
Sets the joint velocity command.

Parameters

- `cmd`: joint velocity command

void **setJointTorqueCommand**(double *cmd*)
Sets the joint torque command.

Parameters

- `cmd`: joint torque command

Private Members

double ***joint_position_cmd_**

double ***joint_velocity_cmd_**

double ***joint_torque_cmd_**

VectorXd *__motor_cmd_
joint position/velocity/torque command

class **CardsflowRviz** : **public** Panel, **public** *rviz_visualization*

Public Functions

CardsflowRviz(QWidget *parent = 0)

~CardsflowRviz()

void **load**(**const** rviz::Config &*config*)
Load all configuration data for this panel from the given Config object.

Parameters

- `config`: rviz config file

void **save**(rviz::Config *config*) **const**
Save all configuration data from this panel to the given Config object.

It is important here that you call *save()* on the parent class so the class id and panel name get saved.

Parameters

- `config`: rviz config file

Public Slots

void **show_mesh**()
Toggles mesh visualization.

void **show_collision**()
Toggles collision visualization.

void **show_target**()
Toggles target visualization.

void **show_tendon**()
Toggles tendon visualization.

void **show_tendon_length**()
Toggles tendon length visualization.

void **show_force**()
Toggles force visualization.

void **show_torque**()
Toggles torque visualization.

void **visualizePose**()
Visualization of Pose.

void **visualizeCollision**()
Visualization of Collision Shapes.

void **visualizePoseTarget**()
Visualization of Pose Target.

void **visualizeTendon**()
Visualization of *Tendon*.

void **visualizeTendonTarget**()
Visualization of *Tendon* Target.

void **visualizeTorque**()
Visualization of Torque.

void **visualizeTorqueTarget**()
Visualization of Torque Target.

Signals

void **visualizePoseSignal**()

void **visualizeCollisionSignal**()

void **visualizeTargetSignal**()

void **visualizePoseTargetSignal**()

void **visualizeTendonSignal**()

void **visualizeTendonTargetSignal**()

void **visualizeTorqueSignal**()

void **visualizeTorqueTargetSignal**()

Private Functions

void **RobotState**(**const** geometry_msgs::PoseStampedConstPtr &*msg*)
Callback to robot state messages.

Parameters

- msg:

void **RobotStateTarget**(**const** geometry_msgs::PoseStampedConstPtr &*msg*)
Callback to robot state target messages.

Parameters

- msg:

void **TendonState**(**const** roboy_simulation_msgs::TendonConstPtr &*msg*)
Callback for *Tendon* state messages.

Parameters

- msg:

void **TendonStateTarget**(**const** roboy_simulation_msgs::TendonConstPtr &*msg*)
Callback for *Tendon* state target messages.

Parameters

- msg:

void **JointState**(**const** roboy_simulation_msgs::JointStateConstPtr &*msg*)
Callback for Joint state messages.

Parameters

- msg:

void **JointStateTarget**(**const** roboy_simulation_msgs::JointStateConstPtr &*msg*)
Callback for Joint state target messages.

Parameters

- msg:

Private Members

ros::NodeHandlePtr **nh**

boost::shared_ptr<ros::AsyncSpinner> **spinner**

ros::Subscriber **robot_state**

ros::Subscriber **tendon_state**

ros::Subscriber **joint_state**

ros::Subscriber **robot_state_target**

ros::Subscriber **tendon_state_target**

ros::Subscriber **joint_state_target**

tf::TransformListener **tf_listener**

tf::TransformBroadcaster **tf_broadcaster**

map<string, geometry_msgs::Pose> **pose**

map<string, geometry_msgs::Pose> **pose_target**

map<string, *Tendon*> **tendon**

map<string, *Tendon*> **tendon_target**

map<string, geometry_msgs::Vector3> **joint_origin**

map<string, geometry_msgs::Vector3> **joint_origin_target**

map<string, geometry_msgs::Vector3> **joint_axis**

map<string, geometry_msgs::Vector3> **joint_axis_target**

map<string, double> **torque**

map<string, double> **torque_target**

bool **visualize_pose** = true

bool **visualize_collisions** = true

bool **visualize_targets** = true

bool **visualize_tendon** = true

bool **visualize_tendon_length** = true

bool **visualize_force** = false

bool **visualize_torque** = false

bool **visualize_tendon_target** = true

bool **visualize_tendon_length_target** = true

bool **visualize_force_target** = false

bool **visualize_torque_target** = false

QPushButton ***show_mesh_button**

QPushButton ***show_collision_button**

QPushButton ***show_target_button**

QPushButton ***show_tendon_button**

QPushButton ***show_force_button**

QPushButton ***show_torque_button**

QPushButton ***show_tendon_length_button**

QSlider ***mesh_transparency**

QSlider ***cable_thickness**

QSlider ***tendon_length_text_size**

string **model_name**

class CardsflowStateHandle

Subclassed by *hardware_interface::CardsflowHandle*

Public Functions

CardsflowStateHandle()

CardsflowStateHandle(**const** *std*::string &*name*, int *joint_index*, **const** double **pos*, **const** double **vel*, **const** double **acc*, **const** MatrixXd **L*, **const** MatrixXd **M*, **const** VectorXd **CG*)

Parameters

- `name`: The name of the joint
- `joint_index`: index of the joint in the robot model
- `pos`: joint position
- `vel`: joint velocity
- `acc`: joint acceleration
- `L`: pointer to the L matrix
- `M`: pointer to the mass matrix

- `CG`: pointer to the Coriolis+Gravity vector
- `name`: The name of the joint
- `joint_index`: index of the joint in the robot model
- `pos`: A pointer to the storage for this joint's position
- `vel`: A pointer to the storage for this joint's velocity

std::string **getName**() **const**
Returns the joint name.

Return joint name

int **getJointIndex**() **const**
Returns the joint index in the robot model.

Return joint index

double **getPosition**() **const**
Returns the currect joint position.

Return joint position

double **getVelocity**() **const**
Returns the currect joint velocity.

Return joint velocity

double **getAcceleration**() **const**
Returns the currect joint acceleration.

Return joint acceleration

MatrixXd **getL**() **const**
Returns the cable model L matrix.

Return L

MatrixXd **getM**() **const**
Returns the robot Mass matrix.

Return M

VectorXd **getCG**() **const**
Returns the robot Coriolis+Gravity vector.

Return CG

Private Members

std::string **name_**

int **joint_index_**
joint name

const double ***pos_**
joint index

const double ***vel_**
joint position

const double ***acc_**
joint velocity

const VectorXd ***CG_**
joint acceleration

const MatrixXd ***L_**
Coriolis+Gravity vector.

const MatrixXd ***M_**

class CardsflowStateInterface : **public** HardwareResourceManager<*CardsflowStateHandle*>

struct COLOR

Public Functions

COLOR(float *r*, float *g*, float *b*, float *a*)

void **randColor**()

Public Members

float **r**

float **g**

float **b**

float **a**

struct EigenRobotAcceleration

Public Functions

void **resize**(int *nrOfInternalDOFs*)

void **random**()

Public Members

Eigen::Matrix<double, 6, 1> **baseAcc**

Eigen::VectorXd **jointAcc**

struct EigenRobotState

A tutorial on how to use the KinDynComputations class with Eigen data structures.

CopyPolicy: Released under the terms of LGPL 2.0+ or later Struct containing the floating robot state using Eigen data structures.

Author Silvio Traversaro

Public Functions

void **resize**(int *nrOfInternalDOFs*)

void **random**()

Public Members

Eigen::Matrix4d **world_H_base**

Eigen::VectorXd **jointPos**

Eigen::Matrix<double, 6, 1> **baseVel**

Eigen::VectorXd **jointVel**

Eigen::Vector3d **gravity**

class ForcePositionController : **public** controller_interface::Controller<*hardware_interface*::*CardsflowCommandInterf*

Public Functions

ForcePositionController()

Constructor.

bool **init**(*hardware_interface*::*CardsflowCommandInterface* **hw*, ros::NodeHandle &*n*)

Initializes the controller.

Will be call by controller_manager when loading this controller

Return success

Parameters

- `hw`: pointer to the hardware interface
- `n`: the nodehandle

void **update**(**const** ros::Time &*time*, **const** ros::Duration &*period*)

Called regularily by controller manager.

The torque for a joint wrt to a PD controller on the joint target position is calculated.

Parameters

- `time`: current time
- `period`: period since last control

void **starting**(**const** ros::Time &*time*)

Called by controller manager when the controller is about to be started.

Parameters

- `time`: current time

void **stopping**(**const** ros::Time &*time*)
Called by controller manager when the controller is about to be stopped.

Parameters

- `time`: current time

void **JointPositionCommand**(**const** std_msgs::Float32ConstPtr &*msg*)
Joint position command callback for this joint.

Parameters

- `msg`: joint position target in radians

bool **setControllerParameters**(roboy_control_msgs::SetControllerParameters::Request &*req*, roboy_control_msgs::SetControllerParameters::Response &*res*)
Controller Parameters service.

Return success

Parameters

- `req`: requested gains
- `res`: success

Private Members

double **q_target** = 0

double **p_error_prev** = 0
joint position target

double **Kp** = 1

double **Kd** = 0

ros::NodeHandle **nh**
PD gains.

ros::Publisher **controller_state**
ROS nodehandle.

ros::ServiceServer **controller_parameter_srv**
publisher for controller state

boost::shared_ptr<ros::AsyncSpinner> **spinner**
service for controller parameters

hardware_interface::*CardsflowHandle* **joint**

ros::Subscriber **joint_command**
cardsflow joint handle for access to joint/cable model state

string **joint_name**
joint command subscriber

int **joint_index**
name of the controlled joint

template<typename **_Scalar**, int **NX** = Dynamic, int **NY** = Dynamic>
struct Functor

Public Types

enum [anonymous]
Values:

InputsAtCompileTime = NX

ValuesAtCompileTime = NY

typedef _Scalar **Scalar**

typedef *Eigen*::Matrix<*Scalar*, *InputsAtCompileTime*, 1> **InputType**

typedef *Eigen*::Matrix<*Scalar*, *ValuesAtCompileTime*, 1> **ValueType**

typedef *Eigen*::Matrix<*Scalar*, *ValuesAtCompileTime*, *InputsAtCompileTime*> **JacobianType**

Public Functions

Functor()

Functor(int *inputs*, int *values*)

int **inputs**() **const**

int **values**() **const**

Public Members

const int **m_inputs**

const int **m_values**

struct iDynTreeRobotAcceleration

Public Functions

void **resize**(int *nrOfInternalDOFs*)

Public Members

iDynTree::Vector6 **baseAcc**

iDynTree::VectorDynSize **jointAcc**

struct iDynTreeRobotState
the base link of each endeffector

Public Functions

void **resize**(int *nrOfInternalDOFs*)

Public Members

iDynTree::Transform **world_H_base**

iDynTree::VectorDynSize **jointPos**

iDynTree::Twist **baseVel**

iDynTree::VectorDynSize **jointVel**

iDynTree::Vector3 **gravity**

struct iDynTreeRobotState

Struct containing the floating robot state using iDynTree data structures.

For the semantics of this structures, see KinDynComputation::setRobotState method.

Public Functions

void **resize**(int *nrOfInternalDOFs*)

Public Members

iDynTree::Transform **world_H_base**

iDynTree::VectorDynSize **jointPos**

iDynTree::Twist **baseVel**

iDynTree::VectorDynSize **jointVel**

iDynTree::Vector3 **gravity**

struct iDynTreeRobotState

the base link of each endeffector

Public Functions

void **resize**(int *nrOfInternalDOFs*)

Public Members

iDynTree::Transform **world_H_base**

iDynTree::VectorDynSize **jointPos**

iDynTree::Twist **baseVel**

iDynTree::VectorDynSize **jointVel**

iDynTree::Vector3 **gravity**

class MeasureExecutionTime

Public Functions

MeasureExecutionTime(string *logfile_name*)

~MeasureExecutionTime()

void **start**()

double **stop**(**const** char **name*)

Private Members

time_point<*Clock*> **start_point**

time_point<*Clock*> **stop_point**

ofstream **log_file**

class MotorConfig

Public Functions

MotorConfig()

bool **readConfig**(**const** string &*filepath*)
Reads a yaml motor config file.

Return success

Parameters

- `filepath`: to config

bool **writeConfig**(**const** string &*filepath*)
Writes a yaml motor config file.

Return success

Parameters

- `filepath`:

bool **fileExists**(**const** string &*filepath*)
Checks if a file exists.

Return exists

Parameters

- `filepath`:

double **displacement2force**(double *displacement*, int *fpga*, int *motor*)
Transforms displacement to force using loaded coefficients.

Return force

Parameters

- `displacement`:
- `fpga`: for this fpga
- `motor`: motor id (as listed in read config)

double **force2displacement**(double *force*, int *fpga*, int *motor*)
Transforms force to displacement using loaded coefficients.

Return force

Parameters

- `displacement`:
- `fpga`: for this fpga
- `motor`: motor id (as listed in read config)

Public Members

vector<vector<vector<float>>> **coeffs_displacement2force**

vector<vector<vector<float>>> **coeffs_force2displacement**

class MsjPlatform : **public** *cardsflow*::*kindyn*::*Robot*, **public** *cardsflow*::*kindyn*::*Robot*

Public Functions

MsjPlatform(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **read**()
Updates the robot model and if we do not use gazebo for simulation, we integrate using the forwardKinematics function with a small step length.

void **write**()
Sends motor commands to the real robot.

bool **GymStepService**(roboy_simulation_msgs::GymStep::Request &*req*, roboy_simulation_msgs::GymStep::Response &*res*)

bool **GymResetService**(roboy_simulation_msgs::GymReset::Request &*req*, roboy_simulation_msgs::GymReset::Response &*res*)

MsjPlatform(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **read**()
Updates the robot model and if we do not use gazebo for simulation, we integrate using the forwardKinematics function with a small step length.

void **write**()
Sends motor commands to the real robot.

int **pnpoly**(vector<double> *limits_x*, vector<double> *limits_y*, double *testx*, double *testy*)

void **randomPose**()

Public Members

bool **external_robot_state**

ros::NodeHandlePtr **nh**
indicates if we get the robot state externally

ros::Publisher **motor_command**
ROS nodehandle.

ros::ServiceServer **gym_step**
motor command publisher

ros::ServiceServer **gym_reset**

double **l_offset**
motor command publisher

float **Kp** = 0.001

ros::Publisher **sphere_axis0**

ros::Publisher **sphere_axis1**

ros::Publisher **sphere_axis2**

vector<double> **limits**[3]

boost::shared_ptr<*std*::thread> **pose_thread**

class Rickshaw_pedaling : **public** *cardsflow*::*kindyn*::*Robot*

Public Functions

Rickshaw_pedaling(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **read**()
Updates the robot model and integrates the robot model using the forwardKinematics function with a small step length.

void **write**()
Sends motor commands to the real robot.

Public Members

ros::NodeHandlePtr **nh**

ros::Publisher **motor_command**
ROS nodehandle.

ros::ServiceClient **motor_config**
motor command publisher

ros::ServiceClient **sphere_left_axis0_params**

ros::ServiceClient **sphere_left_axis1_params**

ros::ServiceClient **sphere_left_axis2_params**

map<string, ros::ServiceClient> **motor_control_mode**

vector<string> **endeffectors** = {"spine_right"}

map<string, vector<string>> **endeffector_jointnames**

bool **external_robot_state**

map<string,vector<short unsigned int> > Rickshaw_pedaling::motors= { {"head
indicates if we get the robot state externally

map<string,vector<short unsigned int> > Rickshaw_pedaling::sim_motors= { {"

map<string,vector<double> > Rickshaw_pedaling::l_offset= { {"head",{0,0,0,0

class Rikshaw : **public** *cardsflow*::*kindyn*::*Robot*, **public** *cardsflow*::*kindyn*::*Robot*

Public Functions

Rikshaw(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **read**()
Updates the robot model and integrates the robot model using the forwardKinematics function with a small step length.

void **write**()
Sends motor commands to the real robot.

Rikshaw(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **MotorStatus**(**const** roboy_middleware_msgs::MotorStatus::ConstPtr &*msg*)

void **read** ( )
Updates the robot model and integrates the robot model using the forwardKinematics function with a small step length.

void **write** ( )
Sends motor commands to the real robot.

Public Members

ros::NodeHandlePtr **nh**

ros::Publisher **motor_command**
ROS nodehandle.

ros::ServiceClient **motor_config**
motor command publisher

ros::ServiceClient **sphere_left_axis0_params**

ros::ServiceClient **sphere_left_axis1_params**

ros::ServiceClient **sphere_left_axis2_params**

map<string, ros::ServiceClient> **motor_control_mode**

vector<string> **endeffectors** = {"spine_right"}

map<string, vector<string>> **endeffector_jointnames**

bool **external_robot_state**

map< string, vector< short unsigned int > > Rikshaw::motors= { {"head",{9,1
indicates if we get the robot state externally

map< string, vector< short unsigned int > > Rikshaw::sim_motors= { {"head",

map< string, vector< double > > Rikshaw::l_offset= { {"head",{0,0,0,0,0,0}}

ros::Publisher **joint_hip_left**
motor command publisher

ros::Publisher **joint_hip_right**

ros::Publisher **joint_knee_left**

ros::Publisher **joint_knee_right**

ros::Publisher **joint_foot_left**

ros::Publisher **joint_foot_right**

ros::Publisher **left_shoulder_axis0**

ros::Publisher **left_shoulder_axis1**

ros::Publisher **left_shoulder_axis2**

ros::Publisher **elbow_left_rot0**

ros::Publisher **elbow_left_rot1**

ros::Publisher **left_wrist_0**

ros::Publisher **left_wrist_1**

ros::Publisher **right_shoulder_axis0**

ros::Publisher **right_shoulder_axis1**

ros::Publisher **right_shoulder_axis2**

ros::Publisher **elbow_right_rot0**

ros::Publisher **elbow_right_rot1**

ros::Publisher **right_wrist_0**

ros::Publisher **right_wrist_1**

ros::Subscriber **motor_status**

map<string, ros::ServiceClient> **motor_config**

bool **status_received** = false
indicates if we get the robot state externally

std_msgs::Float32 **roll**

std_msgs::Float32 **pitch**

std_msgs::Float32 **yaw**

float **err_x** = 0

float **error_y** = 0

float **pitch_max** = 0.33

float **pitch_min** = -0.50

float **yaw_min** = -0.50

float **yaw_max** = 0

map<string,vector<double> > Rikshaw::encoder_offset= { {"head",{0,0,0,0,0,0

class Robot : **public** *rviz_visualization*
Subclassed by *Roboy2*, *RoboyIcecream*

Public Functions

Robot()
Constructor.

~Robot()
Destructor.

void **init**(string *urdf_file_path*, string *viapoints_file_path*, vector<string> *joint_names*)
initializes everything, call before use!

Parameters

- `urdf_file_path`: path to robot urdf
- `viapoints_file_path`: path to viapoints xml
- `joint_names`: a vector of joint_names to be considered from the model

void **update**()
Updates the model.

virtual void **read**()
This is the read function and should implement reading the state of your robot.

virtual void **write**()
This is the write function and should implement writing commands to your robot.

Public Members

iDynTree::KinDynComputations **kinDynComp**

iDynTree::KinDynComputations **kinDynCompTarget**

size_t **number_of_dofs** = 0
the full robot model

vector<string> **endeffectors**
number of degrees of freedom of the whole robot

map<string, size_t> **endeffector_index**
names of the endeffectors

vector<size_t> **endeffector_number_of_dofs**

vector<size_t> **endeffector_dof_offset**

size_t **number_of_joints** = 0
number of degrees of freedom of each endeffector

size_t **number_of_cables** = 0
number of joints of the whole robot

size_t **number_of_links** = 0
number of cables, ie muscles of the whole robot

Matrix4d **world_H_base**
number of links of the whole robot

vector<Matrix4d> **world_to_link_transform**
floating base 6-DoF pose

vector<Matrix4d> **link_to_world_transform**

vector<Matrix4d> **frame_transform**

Eigen::Matrix<double, 6, 1> **baseVel**

Vector3d **gravity**
the velocity of the floating base

MatrixXd **M**
gravity vector (default: (0,0,-9.81)

VectorXd **CG**
The Mass matrix of the robot.

VectorXd **q**
The Coriolis+Gravity term of the robot.

VectorXd **qd**

VectorXd **qdd**

VectorXd **q_min**
joint positon, velocity, acceleration

VectorXd **q_max**

VectorXd **q_target**
joint limits

VectorXd **qd_target**

VectorXd **qdd_target**

VectorXd **q_target_prev**
joint positon, velocity, acceleration targets

VectorXd **qd_target_prev**

VectorXd **qdd_target_prev**

VectorXd **l_int**
joint positon, velocity, acceleration targets

VectorXd **l**

VectorXd **l_target**

vector<VectorXd> **Ld**
tendon length and length change

VectorXd **torques**

VectorXd **cable_forces**
joint torques

vector<VectorXd> **ld**
the cable forces in Newton

MatrixXd **L**
tendon length changes for each controller

MatrixXd **L_t**

MatrixXd **S**
L and -L^T.

MatrixXd **P**

MatrixXd **V**

MatrixXd **W**

vector<vector<pair<ViaPointPtr, ViaPointPtr>>> **segments**
matrices of cable model

bool **external_robot_state**
cable segments

bool **simulated** = false
indicates if we get the robot state externally

bool **initialized** = false
indicates if the robots is simulated or hardware is used

Protected Types

typedef boost::array<double, 2> **state_type**
odeint integration time

Protected Attributes

iDynTree::FreeFloatingGeneralizedTorques **bias**

iDynTree::MatrixDynSize **Mass**
Coriolis+Gravity term.

bool **torque_position_controller_active** = false
Mass matrix.

bool **force_position_controller_active** = false

bool **cable_length_controller_active** = false

VectorXd **qdd_torque_control**

VectorXd **qdd_force_control**

vector<Cable> **cables**

vector<VectorXd> **joint_axis**
all cables of the robot

vector<string> **link_names**
joint axis of each joint

vector<string> **joint_names**

map<string, int> **link_index**
link and joint names of the robot

map<string, int> **joint_index**

vector<ros::Publisher> **joint_command_pub**
link and joint indices of the robot

vector<int> **controller_type**

double **integration_time** = 0
currently active controller type

vector<*state_type*> **joint_state**
second order dynamics integration

vector<*state_type*> **motor_state**

bool **first_time_solving** = true
joint and cable states

int **nWSR** = 1000

VectorXd **f_min**
qp working sets

VectorXd **f_max**

int **qp_print_level** = PL_NONE

SQProblem **qp_solver**
qpoases print level

real_t ***H**
qpoases quadratic problem solver

real_t ***g**

real_t ***A**

real_t ***lb**

real_t ***ub**

real_t ***b**

real_t ***FOpt**

ros::Time **last_visualization**
quadratic problem variables

Eigen::IOFormat **fmt**
timestamp for visualization at reasonable intervals

hardware_interface::JointStateInterface **joint_state_interface**
formator for terminal printouts

hardware_interface::EffortJointInterface **joint_command_interface**
ros control joint state interface

hardware_interface::*CardsflowStateInterface* **cardsflow_state_interface**
ros control joint command interface

hardware_interface::*CardsflowCommandInterface* **cardsflow_command_interface**
cardsflow state interface

bool **first_update** = true
cardsflow command interface

Private Functions

void **MoveEndEffector**(**const** roboy_control_msgs::MoveEndEffectorGoalConstPtr &*goal*)
Move endeffector action server.

Parameters

- `goal`:

bool **parseViapoints**(**const** string &*viapoints_file_path*, vector<Cable> &*cables*)
parses the cardsflow xml file for viapoint definitions

Return success

Parameters

- `viapoints_file_path`: path to the cardsflow.xml file
- `cables`: will be filled with the parsed viapoints of the defined cables

bool **ForwardKinematicsService**(roboy_middleware_msgs::ForwardKinematics::Request &*req*, roboy_middleware_msgs::ForwardKinematics::Response &*res*)
Forward kinematic service for endeffectors.

Return success

Parameters

- `req`: endeffector, requested joint angles
- `res`: 3d resulting position of endeffector

bool **InverseKinematicsService**(roboy_middleware_msgs::InverseKinematics::Request &*req*, roboy_middleware_msgs::InverseKinematics::Response &*res*)

Inverse kinematic service for endeffectors.

Return success

Parameters

- `req`: endeffector and ik type
- `res`: joint configuration solution

bool **InverseKinematicsMultipleFramesService**(roboy_middleware_msgs::InverseKinematicsMultipleFrames::Re &*req*, roboy_middleware_msgs::InverseKinematicsMultipleFram &*res*)

void **InteractiveMarkerFeedback**(**const** *visualization_msgs*::InteractiveMarkerFeedbackConstPtr &*msg*)

Callback for Interactive Marker Feedback of endeffectors.

When the Interactive Marker is released in rviz, the IK routine is called and the solution directly applied to the robot q_target angles

Parameters

- `msg`: Interactive Marker Feedback message

void **JointState**(**const** sensor_msgs::JointStateConstPtr &*msg*)

Callback for the joint state of the robot.

This can come from gazebo, the real robot or else where.

Parameters

- `msg`: message containing joint_name/angle information

void **JointTarget**(**const** sensor_msgs::JointStateConstPtr &*msg*)

Callback for the joint target of the robot.

Parameters

- `msg`: message containing joint_name/angle information

void **FloatingBase**(**const** geometry_msgs::PoseConstPtr &*msg*)

Callback for the floating base world pose.

This can come from gazebo, the real robot or else where.

Parameters

- `msg`: message containing the 6 DoF pose of the floating base

VectorXd **resolve_function**(MatrixXd &*A_eq*, VectorXd &*b_eq*, VectorXd &*f_min*, VectorXd &*f_max*)

Private Members

Matrix3d ***link_to_link_transform**

ros::NodeHandlePtr **nh**

boost::shared_ptr<ros::AsyncSpinner> **spinner**
ROS node handle.

ros::Publisher **robot_state_pub**
async ROS spinner

ros::Publisher **tendon_state_pub**

ros::Publisher **joint_state_pub**

ros::Publisher **cardsflow_joint_states_pub**

ros::Publisher **robot_state_target_pub**
ROS robot pose and tendon publisher.

ros::Publisher **tendon_state_target_pub**

ros::Publisher **joint_state_target_pub**

ros::Subscriber **controller_type_sub**
target publisher

ros::Subscriber **joint_state_sub**

ros::Subscriber **joint_target_sub**

ros::Subscriber **floating_base_sub**

ros::Subscriber **interactive_marker_sub**

ros::ServiceServer **ik_srv**
ROS subscribers.

ros::ServiceServer **ik_two_frames_srv**

ros::ServiceServer **fk_srv**

map<string, boost::shared_ptr<actionlib::SimpleActionServer<roboy_control_msgs::MoveEndEffectorAction>>> **moveEndEff**

map<string, iDynTree::KinDynComputations> **ik_models**

map<string, iDynTree::InverseKinematics> **ik**
the robot models for each endeffector

map<string, string> **ik_base_link**
the ik for each endeffector

struct *cardsflow*::*vrpuppet*::*Robot*::*iDynTreeRobotState* **robotstate**

class Robot : **public** *cardsflow*::*kindyn*::*Robot*

Public Functions

Robot(string *urdf*, string *cardsflow_xml*)

void **read**()
This is the read function and should implement reading the state of your robot.

void **write**()
This is the write function and should implement writing commands to your robot.

Private Members

ros::NodeHandlePtr **nh**

bool **external_robot_state**

class Robot : **public** RobotHW, **public** *rviz_visualization*
Subclassed by *MsjPlatform*, *MsjPlatform*, *Rickshaw_pedaling*, *Rikshaw*, *Rikshaw*, *Robot*, *RoboyArcadeMaschine*, *RoboyHead*, *RoboyUpperBody*, *RoboyXylophone*, *ShoulderTestbed*, *TheClaw*, *VRpuppet*, *Yatr*

Public Functions

Robot()
Constructor.

~Robot()
Destructor.

void **init**(string *urdf_file_path*, string *viapoints_file_path*, vector<string> *joint_names*)
initializes everything, call before use!

Parameters

- `urdf_file_path`: path to robot urdf
- `viapoints_file_path`: path to viapoints xml
- `joint_names`: a vector of joint_names to be considered from the model

void **update**()
Updates the model.

virtual void **read**()
This is the read function and should implement reading the state of your robot.

virtual void **write**()
This is the write function and should implement writing commands to your robot.

void **forwardKinematics**(double *dt*)
Integrates the robot equation of motions using odeint.

Parameters

- `dt`: the integrations step length in seconds

Public Members

size_t **number_of_dofs** = 0

vector<string> **endeffectors**
number of degrees of freedom of the whole robot

map<string, size_t> **endeffector_index**
names of the endeffectors

vector<size_t> **endeffector_number_of_dofs**

vector<size_t> **endeffector_dof_offset**

size_t **number_of_joints** = 0
number of degrees of freedom of each endeffector

size_t **number_of_cables** = 0
number of joints of the whole robot

size_t **number_of_links** = 0
number of cables, ie muscles of the whole robot

Matrix4d **world_H_base**
number of links of the whole robot

vector<Matrix4d> **world_to_link_transform**
floating base 6-DoF pose

vector<Matrix4d> **link_to_world_transform**

vector<Matrix4d> **frame_transform**

Eigen::Matrix<double, 6, 1> **baseVel**

Vector3d **gravity**
the velocity of the floating base

MatrixXd **M**
gravity vector (default: (0,0,-9.81)

VectorXd **CG**
The Mass matrix of the robot.

VectorXd **q**
The Coriolis+Gravity term of the robot.

VectorXd **qd**

VectorXd **qdd**

VectorXd **q_min**
joint positon, velocity, acceleration

VectorXd **q_max**

VectorXd **q_target**
joint limits

VectorXd **qd_target**

VectorXd **qdd_target**

VectorXd **q_target_prev**
joint positon, velocity, acceleration targets

VectorXd **qd_target_prev**

VectorXd **qdd_target_prev**

VectorXd **l_int**
joint positon, velocity, acceleration targets

VectorXd **l**

VectorXd **l_target**

vector<VectorXd> **Ld**
tendon length and length change

VectorXd **torques**

VectorXd **cable_forces**
joint torques

vector<VectorXd> **ld**
the cable forces in Newton

MatrixXd **L**
tendon length changes for each controller

MatrixXd **L_t**

MatrixXd **S**
L and -L^T.

MatrixXd **P**

MatrixXd **V**

MatrixXd **W**

vector<vector<pair<*ViaPointPtr*, *ViaPointPtr*>>> **segments**
matrices of cable model

Protected Types

typedef boost::array<double, 2> **state_type**
odeint integration time

Protected Attributes

iDynTree::FreeFloatingGeneralizedTorques **bias**
cable segments

iDynTree::MatrixDynSize **Mass**
Coriolis+Gravity term.

bool **torque_position_controller_active** = false
Mass matrix.

bool **force_position_controller_active** = false

bool **cable_length_controller_active** = false

VectorXd **qdd_torque_control**

VectorXd **qdd_force_control**

vector<*Cable*> **cables**

vector<VectorXd> **joint_axis**
all cables of the robot

vector<string> **link_names**
joint axis of each joint

vector<string> **joint_names**

map<string, int> **link_index**
link and joint names of the robot

map<string, int> **joint_index**

vector<ros::Publisher> **joint_command_pub**
link and joint indices of the robot

vector<int> **controller_type**

double **integration_time** = 0
currently active controller type

vector<*state_type*> **joint_state**
second order dynamics integration

vector<*state_type*> **motor_state**

bool **first_time_solving** = true
joint and cable states

int **nWSR** = 1000

VectorXd **f_min**
qp working sets

VectorXd **f_max**

int **qp_print_level** = PL_NONE

SQProblem **qp_solver**
qpoases print level

real_t ***H**
qpoases quadratic problem solver

real_t ***g**

real_t ***A**

real_t ***lb**

real_t ***ub**

real_t ***b**

real_t ***FOpt**

ros::Time **last_visualization**
quadratic problem variables

Eigen::IOFormat **fmt**
timestamp for visualization at reasonable intervals

hardware_interface::JointStateInterface **joint_state_interface**
formator for terminal printouts

hardware_interface::EffortJointInterface **joint_command_interface**
ros control joint state interface

hardware_interface::*CardsflowStateInterface* **cardsflow_state_interface**
ros control joint command interface

hardware_interface::*CardsflowCommandInterface* **cardsflow_command_interface**
cardsflow state interface

bool **first_update** = true
cardsflow command interface

bool **external_robot_target** = false

Private Functions

void **MoveEndEffector**(**const** roboy_control_msgs::MoveEndEffectorGoalConstPtr &*goal*)
Move endeffector action server.

Parameters

- `goal`:

bool **parseViapoints**(**const** string &*viapoints_file_path*, vector<Cable> &*cables*)
parses the cardsflow xml file for viapoint definitions

Return success

Parameters

- `viapoints_file_path`: path to the cardsflow.xml file
- `cables`: will be filled with the parsed viapoints of the defined cables

bool **ForwardKinematicsService**(roboy_middleware_msgs::ForwardKinematics::Request &*req*, roboy_middleware_msgs::ForwardKinematics::Response &*res*)
Forward kinematic service for endeffectors.

Return success

Parameters

- `req`: endeffector, requested joint angles
- `res`: 3d resulting position of endeffector

bool **InverseKinematicsService**(roboy_middleware_msgs::InverseKinematics::Request &*req*, roboy_middleware_msgs::InverseKinematics::Response &*res*)
Inverse kinematic service for endeffectors.

Return success

Parameters

- `req`: endeffector and ik type
- `res`: joint configuration solution

bool **InverseKinematicsMultipleFramesService**(roboy_middleware_msgs::InverseKinematicsMultipleFrames::Re &*req*, roboy_middleware_msgs::InverseKinematicsMultipleFram &*res*)

void **InteractiveMarkerFeedback**(**const** *visualization_msgs*::InteractiveMarkerFeedbackConstPtr &*msg*)
Callback for Interactive Marker Feedback of endeffectors.

When the Interactive Marker is released in rviz, the IK routine is called and the solution directly applied to the robot q_target angles

Parameters

- `msg`: Interactive Marker Feedback message

void **JointState**(**const** sensor_msgs::JointStateConstPtr &*msg*)
Callback for the joint state of the robot.

This can come from gazebo, the real robot or else where.

Parameters

- msg: message containing joint_name/angle information

void **FloatingBase**(**const** geometry_msgs::PoseConstPtr &*msg*)
Callback for the floating base world pose.

This can come from gazebo, the real robot or else where.

Parameters

- msg: message containing the 6 DoF pose of the floating base

VectorXd **resolve_function**(MatrixXd &*A_eq*, VectorXd &*b_eq*, VectorXd &*f_min*, VectorXd &*f_max*)

void **update_V**()
Updates the V matrix of the cable model.

void **update_S**()
Updates the S matrix of the cable model.

void **update_P**()
Updates the P matrix of the cable model.

void **controllerType**(**const** roboy_simulation_msgs::ControllerTypeConstPtr &*msg*)
Callback for controller type change.

The controller type defines how the forwardKinematics function integrates the robot states

Parameters

- msg: message containing the joint_name/type pair

Private Members

Matrix3d ***link_to_link_transform**

ros::NodeHandlePtr **nh**

boost::shared_ptr<ros::AsyncSpinner> **spinner**
ROS node handle.

ros::Publisher **robot_state_pub**
async ROS spinner

ros::Publisher **tendon_state_pub**

ros::Publisher **joint_state_pub**

ros::Publisher **robot_state_target_pub**
ROS robot pose and tendon publisher.

ros::Publisher **tendon_state_target_pub**

ros::Publisher **joint_state_target_pub**

ros::Subscriber **controller_type_sub**
target publisher

ros::Subscriber **joint_state_sub**

ros::Subscriber **floating_base_sub**

ros::Subscriber **interactive_marker_sub**

ros::ServiceServer **ik_srv**
ROS subscribers.

ros::ServiceServer **ik_two_frames_srv**

ros::ServiceServer **fk_srv**

map<string, boost::shared_ptr<actionlib::SimpleActionServer<roboy_control_msgs::MoveEndEffectorAction>>> **moveEndEff**

iDynTree::KinDynComputations **kinDynComp**

iDynTree::KinDynComputations **kinDynCompTarget**

map<string, iDynTree::KinDynComputations> **ik_models**
the full robot model

map<string, iDynTree::InverseKinematics> **ik**
the robot models for each endeffector

map<string, string> **ik_base_link**
the ik for each endeffector

struct *cardsflow*::*kindyn*::*Robot*::*iDynTreeRobotState* **robotstate**

struct **RobotConfigurationEstimator** : **public** Functor<double>

Public Functions

RobotConfigurationEstimator(int *number_of_samples*, int *number_of_cables*, int *number_of_links*)

int **operator()**(**const** VectorXd &*x*, VectorXd &*fvec*) **const**
This is the function that is called in each iteration.

Return

Parameters

- `x`: the pose vector (3 rotational 3 translational parameters)
- `fvec`: the error function (the difference between the sensor positions)

Public Members

int **number_of_samples**

int **number_of_cables**

int **number_of_links**

Public Static Attributes

cardsflow::*kindyn*::*Robot* ***robot**

class **Roboy2** : **public** *cardsflow*::*vrpuppet*::*Robot*

Public Functions

Roboy2 (string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

bool **initPose** (std_srvs::Empty::Request &*req*, std_srvs::Empty::Response &*res*)

void **MotorStatus** (**const** roboy_middleware_msgs::MotorStatus::ConstPtr &*msg*)

void **read** ()
Updates the robot model.

void **write** ()
Sends motor commands to the real robot.

Public Members

ros::NodeHandlePtr **nh**

ros::Publisher **motor_command**
ROS nodehandle.

ros::Subscriber **motor_status_sub**
motor command publisher

ros::ServiceServer **init_pose**

ros::AsyncSpinner ***spinner**

map<string, ros::ServiceClient> **motor_control_mode**

map<string, ros::ServiceClient> **motor_config**

vector<string> **body_parts** = {"head"}

map<string, vector<string>> **endeffector_jointnames**

map<string, bool> **motor_status_received**

map<string, int> **init_mode**

map<string, int> **init_setpoint**

map<string, vector<int>> **real_motor_ids**

map<string, vector<int>> **sim_motor_ids**

map<string, vector<int>> **motor_type**

map<string, vector<double>> **l_offset**

map<string, vector<double>> **position**

map<string, vector<double>> **velocity**

map<string, vector<double>> **displacement**

map<string, int> **bodyPartIDs**

map<string, bool> **use_motor_config**

class RoboyArcadeMaschine : **public** *cardsflow*::*kindyn*::*Robot*

Public Functions

RoboyArcadeMaschine(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **read**()
Updates the robot model and integrates the robot model using the forwardKinematics function with a small step length.

void **write**()
Sends motor commands to the real robot.

Public Members

ros::NodeHandlePtr **nh**

ros::Publisher **motor_command**
ROS nodehandle.

bool **external_robot_state**
motor command publisher

class RoboyHead : **public** *cardsflow*::*kindyn*::*Robot*

Public Functions

RoboyHead(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **FaceCoordinates**(**const** geometry_msgs::Point::ConstPtr &*msg*)

void **MotorStatus**(**const** roboy_middleware_msgs::MotorStatus::ConstPtr &*msg*)

void **read**()
Updates the robot model and integrates the robot model using the forwardKinematics function with a small step length.

void **write**()
Sends motor commands to the real robot.

Public Members

ros::NodeHandlePtr **nh**

ros::Publisher **motor_command**
ROS nodehandle.

ros::Publisher **sphere_head_axis0**

ros::Publisher **sphere_head_axis1**

ros::Publisher **sphere_head_axis2**

ros::Subscriber **motor_status**
motor command publisher

ros::Subscriber **face_coordinates**

ros::ServiceClient **sphere_left_axis0_params**

ros::ServiceClient **sphere_left_axis1_params**

ros::ServiceClient **sphere_left_axis2_params**

map<string, ros::ServiceClient> **motor_control_mode**

map<string, ros::ServiceClient> **motor_config**

vector<string> **endeffectors** = {"shoulder_right"}

map<string, vector<string>> **endeffector_jointnames**

bool **external_robot_state**

bool **status_received** = false
indicates if we get the robot state externally

std_msgs::Float32 **roll**

std_msgs::Float32 **pitch**

std_msgs::Float32 **yaw**

float **err_x** = 0

float **error_y** = 0

float **pitch_max** = 0.33

float **pitch_min** = -0.50

float **yaw_min** = -0.50

float **yaw_max** = 0

map<string,vector<int> > RoboyHead::motors= { **{"shoulder_right",{9,10,11,12**

map<string,vector<int> > RoboyHead::sim_motors= { **{"shoulder_right",{0,1,2,**

map<string,vector<float> > RoboyHead::l_change= { **{"shoulder_right",{0,0,0,**

map<string,vector<double> > RoboyHead::l_offset= { **{"head",{0,0,0,0,0,0}},**

map<string,vector<double> > RoboyHead::encoder_offset= { **{"head",{0,0,0,0,0**

class RoboyIcecream : **public** *cardsflow*::*vrpuppet*::*Robot*

Public Functions

RoboyIcecream(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

bool **initPose**(std_srvs::Empty::Request &*req*, std_srvs::Empty::Response &*res*)

void **MotorStatus**(**const** roboy_middleware_msgs::MotorStatus::ConstPtr &*msg*)

void **read**()
Updates the robot model.

void **write**()
Sends motor commands to the real robot.

Public Members

ros::NodeHandlePtr **nh**

ros::Publisher **motor_command**
ROS nodehandle.

ros::Subscriber **motor_status_sub**
motor command publisher

ros::ServiceServer **init_pose**

ros::AsyncSpinner ***spinner**

map<string, ros::ServiceClient> **motor_control_mode**

map<string, ros::ServiceClient> **motor_config**

vector<string> **body_parts** = {"head", , }

map<string, vector<string>> **endeffector_jointnames**

map<string, bool> **motor_status_received**

map<string, int> **init_mode**

map<string, int> **init_setpoint**

map<string, vector<int>> **real_motor_ids**

map<string, vector<int>> **sim_motor_ids**

map<string, vector<int>> **motor_type**

map<string, vector<double>> **l_offset**

map<string, vector<double>> **position**

map<string, vector<double>> **velocity**

map<string, vector<double>> **displacement**

map<string, int> **bodyPartIDs**

map<string, bool> **use_motor_config**

class RoboyUpperBody : **public** *cardsflow*::*kindyn*::*Robot*

Public Functions

RoboyUpperBody(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **read**()
Updates the robot model and integrates the robot model using the forwardKinematics function with a small step length.

void **write**()
Sends motor commands to the real robot.

Public Members

ros::NodeHandlePtr **nh**

ros::Publisher **motor_command**
ROS nodehandle.

ros::ServiceClient **motor_config**
motor command publisher

ros::ServiceClient **sphere_left_axis0_params**

ros::ServiceClient **sphere_left_axis1_params**

ros::ServiceClient **sphere_left_axis2_params**

map<string, ros::ServiceClient> **motor_control_mode**

vector<string> **endeffectors** = {"spine_right"}

map<string, vector<string>> **endeffector_jointnames**

bool **external_robot_state**

map<string,vector<int> > RoboyUpperBody::motors= { **{"head",{9,10,11,12,13,1**
indicates if we get the robot state externally

map<string,vector<int> > RoboyUpperBody::sim_motors= { **{"head",{36,37,35,34**

map<string,vector<double> > RoboyUpperBody::l_offset= { **{"head",{0,0,0,0,0,**

class RoboyXylophone : **public** *cardsflow*::*kindyn*::*Robot*

Public Functions

RoboyXylophone (string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **read** ()
Updates the robot model and integrates the robot model using the forwardKinematics function with a small step length.

void **write** ()
Sends motor commands to the real robot.

Public Members

ros::NodeHandlePtr **nh**

ros::Publisher **motor_command**
ROS nodehandle.

bool **external_robot_state**
motor command publisher

vector<double> **l_offset**
indicates if we get the robot state externally

class rviz_visualization
Subclassed by *cardsflow::kindyn::Robot*, *cardsflow::vrpuppet::Robot*, *CardsflowRviz*

Public Functions

rviz_visualization ()

~rviz_visualization ()

void **initializeInteractiveMarkerServer** ()

Marker **makeBox** (InteractiveMarker &*msg*)

InteractiveMarkerControl &**makeBoxControl** (InteractiveMarker &*msg*)

void **make6DofMarker** (bool *fixed*, unsigned int *interaction_mode*, **const** tf::Vector3 &*position*, bool *show_6dof*, double *scale* = 1, **const** char **frame* = "world", **const** char **name* = "interactive_marker", **const** char **description* = "for interaction and shit")

Vector3d **convertGeometryToEigen** (**const** geometry_msgs::Vector3 &*vector_in*)

geometry_msgs::Vector3 **convertEigenToGeometry** (**const** Vector3d &*vector_in*)

void **PoseMsgToTF** (**const** geometry_msgs::Pose &*msg*, tf::Transform &*bt*)

void **publishMesh**(**const** char **package*, **const** char **relative_path*, **const** char **modelname*, Vector3d *&pos*, Quaterniond *&orientation*, double *scale*, **const** char **frame*, **const** char **ns*, int *message_id*, double *duration* = 0, *COLOR color* = *COLOR*(1, , ,))

Publishes a mesh visualization marker.

Parameters

- `package`: ros package in which this mesh is located
- `relative_path`: the relative path inside that ros packae
- `the`: mesh file name
- `pos`: at this position
- `orientation`: with this orientation
- `modelname`: name of the mesh.dae
- `frame`: in this frame
- `ns`: namespace
- `message_id`: unique id
- `duration`: in seconds
- `color`: of the mesh

void **publishMesh**(**const** char **package*, **const** char **relative_path*, **const** char **modelname*, geometry_msgs::Pose *&pose*, double *scale*, **const** char **frame*, **const** char **ns*, int *message_id*, double *duration* = 0, *COLOR color* = *COLOR*(1, , ,))

Publishes a mesh visualization marker.

Parameters

- `package`: ros package in which this mesh is located
- `relative_path`: the relative path inside that ros packae
- `the`: mesh file name
- `pose`: of mesh
- `modelname`: name of the mesh.dae
- `frame`: in this frame
- `ns`: namespace
- `message_id`: unique id
- `duration`: in seconds
- `color`: of the mesh

void **publishSphere**(Vector3d *&pos*, **const** char **frame*, **const** char **ns*, int *message_id*, *COLOR color*, float *radius* = 0.01, double *duration* = 0)

Publishes a sphere visualization marker.

Parameters

- `pos`: at this positon
- `frame`: in this frame

- `ns`: namespace
- `message_id`: a unique id
- `rgda`: rgb color (0-1) plus transparancy
- `duration`: for this duration in seconds (0=forever)

void **publishSphere**(geometry_msgs::Pose *&pose*, **const** char **frame*, **const** char **ns*, int *message_id*, *COLOR color*, float *radius* = 0.01, double *duration* = 0)

Publishes a sphere visualization marker.

Parameters

- `pose`: at this positon
- `frame`: in this frame
- `ns`: namespace
- `message_id`: a unique id
- `rgda`: rgb color (0-1) plus transparancy
- `duration`: for this duration in seconds (0=forever)

void **publishCube**(Vector3d *&pos*, Vector4d *&quat*, **const** char **frame*, **const** char **ns*, int *message_id*, *COLOR color*, float *radius* = 0.01, double *duration* = 0)

Publishes a cube visualization marker.

Parameters

- `pos`: at this positon
- `quat`: with this orientation
- `frame`: in this frame
- `ns`: namespace
- `message_id`: a unique id
- `rgda`: rgb color (0-1) plus transparancy
- `duration`: for this duration in seconds (0=forever)

void **publishCube**(geometry_msgs::Pose *&pose*, **const** char **frame*, **const** char **ns*, int *message_id*, *COLOR color*, float *radius* = 0.01, double *duration* = 0)

Publishes a cube visualization marker.

Parameters

- `pose`: with this pose
- `frame`: in this frame
- `ns`: namespace
- `message_id`: a unique id
- `rgda`: rgb color (0-1) plus transparancy
- `duration`: for this duration in seconds (0=forever)

void **publishCube**(Vector3d &*pos*, Quaternionf &*quat*, **const** char **frame*, **const** char **ns*, int *message_id*, *COLOR color*, float *dx* = 0.01, float *dy* = 0.01, float *dz* = 0.01, double *duration* = 0)

Publishes a cube visualization marker.

Parameters

- `pos`: position
- `quat`: quaternion
- `frame`: in this frame
- `ns`: namespace
- `message_id`: a unique id
- `rgda`: rgb color (0-1) plus transparancy
- `dx`: cube x dim
- `dy`: cube y dim
- `dz`: cube z dim
- `duration`: for this duration in seconds (0=forever)

void **publishCylinder**(Vector3d &*pos*, **const** char **frame*, **const** char **ns*, int *message_id*, *COLOR color*, float *radius* = 0.01, double *duration* = 0)

Publishes a cylinder visualization marker.

Parameters

- `pos`: at this positon
- `frame`: in this frame
- `ns`: namespace
- `message_id`: a unique id
- `rgda`: rgb color (0-1) plus transparancy
- `duration`: for this duration in seconds (0=forever)

void **publishRay**(Vector3d &*pos*, Vector3d &*dir*, **const** char **frame*, **const** char **ns*, int *message_id*, *COLOR color*, double *duration* = 0)

Publishes a ray visualization marker.

Parameters

- `pos`: at this positon
- `dir`: direction
- `frame`: in this frame
- `message_id`: a unique id
- `ns`: namespace
- `color`: rgb color (0-1) plus transparancy
- `duration`: for this duration in seconds (0=forever)

void **publishText**(Vector3d &*pos*, **const** char **text*, **const** char **frame*, **const** char **ns*, int *message_id*, *COLOR color*, double *duration*, float *height*)
Publishes a text message marker.

Parameters

- `pos`: at this positon
- `text`: with this text
- `frame`: in this frame
- `ns`: namespace
- `message_id`: a unique id
- `color`: rgb color (0-1) plus transparancy
- `duration`: for this duration in seconds (0=forever)
- `height`: height of the text

void **clearMarker**(int *id*)
Clears a marker with this id.

void **clearAll**()
Clears all markers in rviz.

bool **getTransform**(string *from*, string *to*, geometry_msgs::Pose &*transform*)
Gets a tf transform.

Return success

Parameters

- `from`: source frame
- `to`: target frame
- `transform`: will be filled with the transform

bool **getTransform**(string *from*, string *to*, Matrix4d &*transform*)
Gets a tf transform.

Return success

Parameters

- `from`: source frame
- `to`: target frame
- `transform`: will be filled with the transform

bool **getLighthouseTransform**(bool *lighthouse*, **const** char **to*, Matrix4d &*transform*)
Queries the tf listener for the specified transform.

Return true if available

Parameters

- `lighthouse`:

- `to`: another frame
- `transform`: the transform if available

bool **`getLighthouseTransform`**(**`const`** char **from*, bool *lighthouse*, Matrix4d &*transform*)
Queries the tf listener for the specified transform.

Return true if available

Parameters

- `lighthouse`:
- `from`: another frame
- `transform`: the transform if available

bool **`getTransform`**(**`const`** char **from*, **`const`** char **to*, tf::Transform &*transform*)
Queries the tf listener for the specified transform.

Return true if available

Parameters

- `to`: this frame
- `from`: another frame
- `transform`: the transform if available

bool **`publishTransform`**(string *from*, string *to*, geometry_msgs::Pose &*transform*)
Publishes a tf transform.

Return success

Parameters

- `from`: source frame
- `to`: target frame
- `transform`:

Public Members

ros::Publisher **`visualization_pub`**

ros::Publisher **`visualization_array_pub`**

bool **`publish_as_marker_array`** = false

int **`number_of_markers_to_publish_at_once`** = 100

Public Static Functions

void **`processFeedback`**(**`const`** *visualization_msgs*::InteractiveMarkerFeedbackConstPtr &*feedback*)

Private Members

ros::NodeHandlePtr **nh**

visualization_msgs::MarkerArray **marker_array**

tf::TransformListener **listener**

tf::TransformBroadcaster **broadcaster**

Private Static Attributes

boost::shared_ptr<interactive_markers::InteractiveMarkerServer> **interactive_marker_server**

interactive_markers::MenuHandler **menu_handler**

bool **first** = true

class ShoulderTestbed : **public** *cardsflow*::*kindyn*::*Robot*

Public Functions

ShoulderTestbed(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **read**()
Updates the robot model and if we do not use gazebo for simulation, we integrate using the forwardKinematics function with a small step length.

void **write**()
Sends motor commands to the real robot.

Public Members

ros::Time **last_update**

bool **external_robot_state**

ros::NodeHandlePtr **nh**
indicates if we get the robot state externally

ros::Publisher **motor_command**
ROS nodehandle.

double **l_offset**[**NUMBER_OF_MOTORS**]
motor command publisher

double **winch_radius**[8] = {0.007, , , , , , , }

float **Kp** = 0.001

struct Tendon

Public Members

float **force**

float **l**

float **ld**

vector<geometry_msgs::Vector3> **viaPoints**

class **TheClaw** : **public** *cardsflow*::*kindyn*::*Robot*

Public Functions

TheClaw(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **read**()
Updates the robot model and if we do not use gazebo for simulation, we integrate using the forwardKinematics function with a small step length.

int **meterPerSecondToServoSpeed**(double *meterPerSecond*)
Converts tendon length chages from the cable model to pwm commands of the real robot.

Return pwm

Parameters

- `meterPerSecond`: tendon length change

void **write**()
Sends motor commands to the real robot.

Public Members

bool **external_robot_state**

ros::NodeHandlePtr **nh**
indicates if we get the robot state externally

ros::Publisher **motor_command**
ROS nodehandle.

class **TorquePositionController** : **public** controller_interface::Controller<*hardware_interface*::EffortJointInterface>

Public Functions

TorquePositionController()
Constructor.

bool **init**(*hardware_interface*::EffortJointInterface **hw*, ros::NodeHandle *&n*)
Initializes the controller.

Will be call by controller_manager when loading this controller

Return success

Parameters

- `hw`: pointer to the hardware interface
- `n`: the nodehandle

void **update**(**const** ros::Time *&time*, **const** ros::Duration *&period*)
Called regularily by controller manager.

The torque for a joint wrt to a PD controller on the joint target position is calculated.

Parameters

- `time`: current time
- `period`: period since last control

void **starting**(**const** ros::Time *&time*)
Called by controller manager when the controller is about to be started.

Parameters

- `time`: current time

void **stopping**(**const** ros::Time *&time*)
Called by controller manager when the controller is about to be stopped.

Parameters

- `time`: current time

void **JointCommand**(**const** std_msgs::Float32ConstPtr *&msg*)
Joint position command callback for this joint.

Parameters

- `msg`: joint position target in radians

bool **setControllerParameters**(roboy_control_msgs::SetControllerParameters::Request *&req*, roboy_control_msgs::SetControllerParameters::Response *&res*)
Controller Parameters service.

Return success

Parameters

- `req`: requested gains
- `res`: success

Private Members

double **q_target** = 0

double **Kp** = 3000
joint position target

double **Kd** = 5

ros::NodeHandle **nh**
PD gains.

ros::Publisher **controller_state**
ROS nodehandle.

ros::ServiceServer **controller_parameter_srv**
publisher for controller state

boost::shared_ptr<ros::AsyncSpinner> **spinner**
service for controller parameters

hardware_interface::JointHandle **joint**

ros::Subscriber **joint_command**

string **joint_name**
joint command subscriber

class UDPSocket

Public Functions

UDPSocket(**const** char ***server_IP*, int *server_port*, **const** char ***client_IP*, int *client_port*, bool *exclusive* = true)
Creates a socket on the given server_IP and server_port and sets up the "connection" with the client.

Because it is UDP, there is no handshake, the socket just sends and listens to packages from the client_IP and client_port

Parameters

- `server_IP`: the server socket IP
- `server_port`: the server socket port
- `client_IP`: the client to send and receive UDP packets to/from
- `client_port`: the client port
- `exclusive`: receive exclusively packages from client

UDPSocket(**const** char ***client_IP*, int *client_port*, bool *exclusive* = true)
Tries to guess the users IP and sets up the socket on Port 8000 and "connects" to client_IP on client_port.

Parameters

- `client_IP`: the client to send and receive UDP packets to/from
- `client_port`: the client port
- `exclusive`: receive exclusively packages from client

UDPSocket(**const** char ***client_IP*, int *client_port*, int *server_port*, bool *exclusive* = true)

UDPSocket (int *port*, int *broadcastIP* = 0xffffffff, bool *broadcaster* = false)
Creates a broadcast socket on port.

Parameters

- `port`: on this port
- `broadcastIP`: use this broadcast IP
- `broadcaster`: if true this binds the port to the broadcast port

UDPSocket (int *port*, bool *broadcaster*)
Creates a broadcast socket on port.

Parameters

- `port`: on this port
- `broadcaster`: if true this binds the port to the broadcast port

~UDPSocket ()

uint32_t **receiveHostIP** (**const** char **key*, uint32_t &*IP*)
Receive ROS master IP.

Return status (0 invalid, 1 too short, 2 too long, 3 accepted)

Parameters

- `key`: only if this key is matched with the UDP message

bool **broadcastHostIP** (uint32_t *IP*)
Broadcast ROS master IP.

Return successfully broadcasted

Parameters

- `IP`: broadcast this IP

bool **broadcastHostIP** (char **key*, int *length*)
Broadcast ROS master IP of the machine this node was run on.

Return successfully broadcasted

Parameters

- `key`: the key to unlock
- `length`: the length inbytes of the key

bool **receiveSensorData** (uint32_t &*sensorID*, bool &*lighthouse*, bool &*axis*, uint16_t &*sweepDuration*)
Listens for UDP package containing lighthouse tracking data.

Return

Parameters

- `sensorID`: sensor id

- `lighthouse`: witch lighthouse
- `axis`:
- `sweepDuration`:

bool **`receiveSensorData`**(vector<uint32_t> &*sensorID*, vector<bool> &*lighthouse*, vector<bool> &*axis*, vector<uint32_t> &*sweepDuration*)

bool **`convertByte2Text`**(uint32_t *inet*, char **inet_str*)
Converts a byte internet address to a human readable address.

Return success

Parameters

- `inet`:
- `inet_str`:

bool **`convertText2Byte`**(char **inet_str*, uint32_t **inet*)
Converts a human readable address to abyte internet address.

Return success

Parameters

- `inet_str`:
- `inet`:

int **`receiveUDP`**()
receive from anyone

Return received number of bytes

int **`receiveUDPFromClient`**()
receive from client

Return received number of bytes

bool **`sendUDPToClient`**()
send to client

Return success

Public Members

pair<uint32_t, string> **`myIP`**

pair<uint32_t, string> **`myBroadcastIP`**

char **`buf`**[**`MAXBUFLENGTH`**]

`struct` sockaddr_in **`client_addr`**

ssize_t **`numbytes`**

Private Functions

bool **setTimeOut** (int *usecs*)
Sets the UDP package receive and send timeout.

Return success

Parameters

- `usecs`: time in microseconds

bool **whatsMyIP** (string &*IP*, string &*Broadcast_IP*, bool *preferEthernet* = true)
Tries to guess your IP.

Parameters

- `IP`: your IP
- `Broadcast_IP`: your broadcast IP
- `preferEthernet`: if True ethernet will be preferred over wifi
- `success`: (fails if I can't find a valid IP for wifi or ethernet adapter)

bool **broadcastUDP** ()
broadcast

Return success

Private Members

bool **initialized** = false

int **sockfd**

struct sockaddr_in **server_addr**

struct sockaddr_in **broadcast_addr**

socklen_t **client_addr_len**

socklen_t **server_addr_len**

socklen_t **broadcast_addr_len**

struct addrinfo ***servinfo**

bool **exclusive**

struct ViaPoint

Public Functions

ViaPoint (string *link_name*, Vector3d &*local_coordinates*, bool *fixed_to_world* = false)

Parameters

- `link_name`:
- `local_coordinates`:

- `fixed_to_world`:

Public Members

string **`link_name`**

int **`link_index`**
the name of the link the viapoint belongs to

bool **`fixed_to_world`**
the index of the link the viapoint belongs to wrt. the robot model

Vector3d **`local_coordinates`**
indicates if the viapoint if moving with the link or is fixed to the world

Vector3d **`global_coordinates`**
the local coordinates in the link frame

`class VRpuppet` : **`public`** *cardsflow*::*kindyn*::*Robot*

Public Functions

`VRpuppet`(string *urdf*, string *cardsflow_xml*)
Constructor.

Parameters

- `urdf`: path to urdf
- `cardsflow_xml`: path to cardsflow xml

void **`read`**()
Updates the robot model and integrates the robot model using the forwardKinematics function with a small step length.

void **`write`**()
Sends motor commands to the real robot.

Public Members

ros::NodeHandlePtr **`nh`**

ros::Publisher **`motor_command`**
ROS nodehandle.

ros::ServiceClient **`motor_config`**
motor command publisher

ros::ServiceClient **`sphere_left_axis0_params`**

ros::ServiceClient **`sphere_left_axis1_params`**

ros::ServiceClient **`sphere_left_axis2_params`**

map<string, ros::ServiceClient> **`motor_control_mode`**

vector<string> **`endeffectors`** = {"spine_right"}

map<string, vector<string>> **`endeffector_jointnames`**

bool **external_robot_state**

map<string,vector<short unsigned int> > VRpuppet::motors= { **{"head",{9,10,1**
indicates if we get the robot state externally

map<string,vector<short unsigned int> > VRpuppet::sim_motors= { **{"head",{36**

map<string,vector<double> > VRpuppet::l_offset= { **{"head",{0,0,0,0,0,0}},**

class Yatr : **public** *cardsflow*::*kindyn*::*Robot*

Public Functions

Yatr (string *urdf*, string *cardsflow_xml*)

void **read** ()
Updates the robot model and if we do not use gazebo for simulation, we integrate using the forwardKinematics function with a small step length.

void **write** ()
Sends motor commands to the real robot.

Public Members

bool **external_robot_state**

ros::NodeHandlePtr **nh**
indicates if we get the robot state externally

ros::Publisher **motor_command**
ROS nodehandle.

namespace capture_pedal_trajectory

Functions

getPositionLeftFoot ()
UTILITY FUNCTIONS ###.

getPositionRightFoot ()

setJointControllerParameters (*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)

jointStateCallback (*joint_data joint_data*)

getPedalPositions (*numSamples numSamples*)

plotPedalTrajectories ()

plotEverything (*numSamples numSamples*, *jointAngleDict jointAngleDict*)

inverse_kinematics_client (*endeffector endeffector*, *frame frame*, *x x*, *y y*, *z z*)

inverse_kinematics_multiple_frames_client (*endeffector endeffector*, *frames frames*, *x x*, *y y*, *z z*, *weights weights*)

main ()
MAIN ###.

Variables

string capture_pedal_trajectory.JSON_FILENAME = "captured_pedal_trajectory_22feb.json

float capture_pedal_trajectory.JOINT_ANGLE_TOLERANCE_FK = 0.05

int capture_pedal_trajectory.JOINT_KP = 10

int capture_pedal_trajectory.JOINT_KD = 0

float capture_pedal_trajectory.PEDAL_CENTER_OFFSET_X = 0.09223
MEASURED PARAMETERS ###.

float capture_pedal_trajectory.PEDAL_CENTER_OFFSET_Y = 0.00013

float capture_pedal_trajectory.PEDAL_CENTER_OFFSET_Z = 0.00426

int capture_pedal_trajectory.BIKE_OFFSET_X = 0

int capture_pedal_trajectory.BIKE_OFFSET_Y = 0

int capture_pedal_trajectory.BIKE_OFFSET_Z = 0

float capture_pedal_trajectory.PEDAL_RADIUS = 0.16924

float capture_pedal_trajectory.RIGHT_LEG_OFFSET_Y = 0.15796

float capture_pedal_trajectory.LEFT_LEG_OFFSET_Y = -0.18736

string capture_pedal_trajectory.ROS_JOINT_HIP_RIGHT = "joint_hip_right"
GLOBAL VARIABLES ###.

string capture_pedal_trajectory.ROS_JOINT_KNEE_RIGHT = "joint_knee_right"

string capture_pedal_trajectory.ROS_JOINT_ANKLE_RIGHT = "joint_foot_right"

string capture_pedal_trajectory.ROS_JOINT_HIP_LEFT = "joint_hip_left"

string capture_pedal_trajectory.ROS_JOINT_KNEE_LEFT = "joint_knee_left"

string capture_pedal_trajectory.ROS_JOINT_ANKLE_LEFT = "joint_foot_left"

string capture_pedal_trajectory.RIGHT_HIP_JOINT = "right_hip"

string capture_pedal_trajectory.RIGHT_KNEE_JOINT = "right_knee"

string capture_pedal_trajectory.RIGHT_ANKLE_JOINT = "right_ankle"

string capture_pedal_trajectory.LEFT_HIP_JOINT = "left_hip"

string capture_pedal_trajectory.LEFT_KNEE_JOINT = "left_knee"

string capture_pedal_trajectory.LEFT_ANKLE_JOINT = "left_ankle"

dictionary capture_pedal_trajectory._jointsStatusData= { RIGHT_HIP_JOINT: {

namespace capture_pedal_trajectory_left_leg_only

Functions

get_distance(*point1 point1*, *point2 point2*)
UTILITY FUNCTIONS ###.

Documentation for a function

Return the distance between two points where points are a list of two coordinates.

getPositionLeftFoot()

getPositionRightFoot()

setJointControllerParameters(*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)

jointStateCallback(*joint_data joint_data*)

getPedalPositions(*numSamples numSamples*)

plotPedalTrajectories()

plotEverything(*numSamples numSamples*, *jointAngleDict jointAngleDict*)

inverse_kinematics_client(*endeffector endeffector*, *frame frame*, *x x*, *y y*, *z z*)

inverse_kinematics_multiple_frames_client(*endeffector endeffector*, *frames frames*, *x x*, *y y*, *z z*, *weights weights*)

main_notnow()
MAIN ###.

main()

Variables

string capture_pedal_trajectory_left_leg_only.JSON_FILENAME = "captured_pedal_trajecto

string capture_pedal_trajectory_left_leg_only.TEMP_READFILE = "captured_pedal_trajecto

float capture_pedal_trajectory_left_leg_only.JOINT_ANGLE_TOLERANCE_FK = 0.002

int capture_pedal_trajectory_left_leg_only.JOINT_KP = 200

int capture_pedal_trajectory_left_leg_only.JOINT_KD = 0

float capture_pedal_trajectory_left_leg_only.POINT_REACHED_TOLERANCE = 0.02

capture_pedal_trajectory_left_leg_only.LEFT_HIP_JOINT_TEST_CONFIGURATIONS = np.linspa

capture_pedal_trajectory_left_leg_only.LEFT_KNEE_JOINT_TEST_CONFIGURATIONS = np.linsp

capture_pedal_trajectory_left_leg_only.LEFT_ANKLE_JOINT_TEST_CONFIGURATIONS = np.lins

float capture_pedal_trajectory_left_leg_only.LEFT_HIP_JOINT_LOWER_LIMIT = -1.9

int capture_pedal_trajectory_left_leg_only.LEFT_KNEE_JOINT_LOWER_LIMIT = 0

float capture_pedal_trajectory_left_leg_only.LEFT_ANKLE_JOINT_LOWER_LIMIT = -0.7

float capture_pedal_trajectory_left_leg_only.LEFT_HIP_JOINT_UPPER_LIMIT = 0.5

float capture_pedal_trajectory_left_leg_only.LEFT_KNEE_JOINT_UPPER_LIMIT = 2.0

float capture_pedal_trajectory_left_leg_only.LEFT_ANKLE_JOINT_UPPER_LIMIT = 0.7

float capture_pedal_trajectory_left_leg_only.PEDAL_CENTER_OFFSET_X = 0.09222872619138
MEASURED PARAMETERS ###.

float capture_pedal_trajectory_left_leg_only.PEDAL_CENTER_OFFSET_Y = 0.00013171801209

float capture_pedal_trajectory_left_leg_only.PEDAL_CENTER_OFFSET_Z = 0.004277283496541

int capture_pedal_trajectory_left_leg_only.BIKE_OFFSET_X = 0

int capture_pedal_trajectory_left_leg_only.BIKE_OFFSET_Y = 0

int capture_pedal_trajectory_left_leg_only.BIKE_OFFSET_Z = 0

float capture_pedal_trajectory_left_leg_only.PEDAL_RADIUS = 0.16924

float capture_pedal_trajectory_left_leg_only.RIGHT_LEG_OFFSET_Y = 0.1579606226770175

float capture_pedal_trajectory_left_leg_only.LEFT_LEG_OFFSET_Y = -0.1873561275007122

string capture_pedal_trajectory_left_leg_only.ROS_JOINT_HIP_RIGHT = "joint_hip_right"
GLOBAL VARIABLES ###.

string capture_pedal_trajectory_left_leg_only.ROS_JOINT_KNEE_RIGHT = "joint_knee_right

string capture_pedal_trajectory_left_leg_only.ROS_JOINT_ANKLE_RIGHT = "joint_foot_right

string capture_pedal_trajectory_left_leg_only.ROS_JOINT_HIP_LEFT = "joint_hip_left"

string capture_pedal_trajectory_left_leg_only.ROS_JOINT_KNEE_LEFT = "joint_knee_left"

string capture_pedal_trajectory_left_leg_only.ROS_JOINT_ANKLE_LEFT = "joint_foot_left

string capture_pedal_trajectory_left_leg_only.RIGHT_HIP_JOINT = "right_hip"

string capture_pedal_trajectory_left_leg_only.RIGHT_KNEE_JOINT = "right_knee"

string capture_pedal_trajectory_left_leg_only.RIGHT_ANKLE_JOINT = "right_ankle"

string capture_pedal_trajectory_left_leg_only.LEFT_HIP_JOINT = "left_hip"

string capture_pedal_trajectory_left_leg_only.LEFT_KNEE_JOINT = "left_knee"

string capture_pedal_trajectory_left_leg_only.LEFT_ANKLE_JOINT = "left_ankle"

dictionary capture_pedal_trajectory_left_leg_only._jointsStatusData= { RIGHT_HIP_J

namespace CARDSflow

Enums

enum ControllerType
Values:

cable_length_controller

torque_position_controller

force_position_controller

namespace cardsflow

namespace kindyn

Typedefs

typedef boost::shared_ptr<*ViaPoint*> ViaPointPtr

namespace vrpuppet

namespace compute_steering_path

Functions

computeSteeringAngles()
UTILITY FUNCTIONS ###.

computeHandTrajectories()

main()
MAIN ###.

Variables

int compute_steering_path.MAX_TURNING_ANGLE = math.pi / 6
FUNCTION PARAMETERS ###.

int compute_steering_path.NUM_STEERING_ANGLES = 61

int compute_steering_path.RIKSHAW_TURN_JOINT_X_OFFSET = 0

int compute_steering_path.RIKSHAW_TURN_JOINT_Y_OFFSET = 0

int compute_steering_path.RIKSHAW_TURN_JOINT_Z_OFFSET = 0

float compute_steering_path.HANDLEBAR_X_OFFSET = 0.728713

float compute_steering_path.HANDLEBAR_Z_OFFSET = 0.719269

float compute_steering_path.HAND_Y_OFFSET = 0.125

list compute_steering_path._steeringAngles = []
GLOBAL VARIABLES ###.

list compute_steering_path._rightHandTrajectory = []

list compute_steering_path._leftHandTrajectory = []

list compute_steering_path._centerHandlebarTrajectory = []

namespace Eigen

namespace EigenExtension

Functions

Matrix3f **SkewSymmetric**(Vector3f *v*)
Skew symmetric matrix for cross product computation.

Return skew symmetric matrix

Parameters

- v: 3d Vector

Matrix3d **SkewSymmetric2**(Vector3d *v*)
Skew symmetric matrix for cross product computation.

Return skew symmetric matrix

Parameters

- v: 3d Vector

Matrix<float, 2, 1> **GetLinearSplineCoefficients**(float *q_r_i*, float *q_r_ip1*, double *t*)

Matrix<float, 4, 1> **GetCubicSplineCoefficients**(float *q_r_i*, float *q_d_r_i*, float *q_r_ip1*, float *q_d_r_ip1*, double *t*)

Matrix<float, 6, 1> **GetQuinticSplineCoefficients**(float *q_r_i*, float *q_d_r_i*, float *q_dd_r_i*, float *q_r_ip1*, float *q_d_r_ip1*, float *q_dd_r_ip1*, double *t*)

void **LinearSplineInterpolate**(float *q_r, float *q_d_r, float *q_dd_r, Matrix<float, 2, 1> *a*, double *t*)

void **CubicSplineInterpolate**(float *q_r, float *q_d_r, float *q_dd_r, Matrix<float, 4, 1> *a*, double *t*)

void **QuinticSplineInterpolate**(float *q_r, float *q_d_r, float *q_dd_r, Matrix<float, 6, 1> *a*, double *t*)

Matrix3f **ComputeRotationMatrix**(AngleAxisf *a*)

Matrix3f **ComputeRotationMatrixDeriv**(AngleAxisf *a*, AngleAxisf *a_d*)

Matrix3f **ComputeRotationMatrixDoubleDeriv**(AngleAxisf *a*, AngleAxisf *a_d*, AngleAxisf *a_dd*)

MatrixXf **Pinv**(MatrixXf *A*)
Pseudo inverse matrix.

Return Pseudo inverse matrix

Parameters

- A:

MatrixXd **Pinv**(MatrixXd *A*)
Pseudo inverse matrix.

Return Pseudo inverse matrix

Parameters

- A:

namespace finals_simulation_pedaling

Functions

joint_state_callback(*joint_data joint_data*)
Documentation for a function.

This function collects the current status of the joint-angles and saves them in the global dictionary "joint_status_data".

import_joint_trajectory_record()
Documentation for a function.

Collects and saves all joint- and pedal-angles from the pre-captured trajectory from the (global variable).

get_joint_position(*jointName jointName*)
Documentation for a function.

Return current joint-angle of .

plot_measured_trajectories(*input_float input_float*)

get_joint_velocity (*jointName jointName*)
Documentation for a function.

Return current joint-velocity of .

get_position (*endeffector endeffector*, *frame frame*)
Documentation for a function.

Return the postion of the of the correspondent .

set_joint_controller_parameters (*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)
Documentation for a function.

Sets Kp of joint-controller to Sets Kd of joint-controller to

get_position_left_foot ()
Documentation for a function.

Return the position of the left foot of Roboy.

get_position_right_foot ()
Documentation for a function.

Return the position of the right foot of Roboy.

get_distance (*point1 point1*, *point2 point2*)
Documentation for a function.

Return the distance between two points where points are a list of two coordinates.

check_output_limits (*inputVal inputVal*)
Documentation for a function.

Checks if is inside possible range of joint-angle velocities. If not, returns max-velocity if too high or min-velocity if to low instead of .

compute_velocity (*joint_name joint_name*, *next_joint_angle next_joint_angle*, *current_joint_angle current_joint_angle*, *end_time end_time*)
Documentation for a function.

Returns ideal joint-velocity for according to and joint-angle-difference between and :

ideal_velocity = joint_angle_difference / (end_time - current_time)

check_pedal_angle_valid (*pedal_angle pedal_angle*)

get_joint_angle (*joint_name joint_name*, *pedal_angle pedal_angle*)
Documentation for a function.

Evaluate and return joint-angle of correspondent to using the interpolated function:

The functions can be used by calling "<function_name>(<pedal_angle>)" ==> returns <joint_angle>

interpolate_functions ()
Documentation for a function.

Initializing interpolated functions for joint-angles using pre-captured set points with pedal-angle as input and joint-angle as output:

The functions can be used by calling "<function_name>(<pedal_angle>)" ==> returns <joint_angle>

evaluate_current_pedal_angle (*current_point current_point*)
Documentation for a function.

Evaluating the current pedal-angle according to the current position of the left foot . Using trigonometric functions for the evaluation of the angle.

publish_velocity (*joint_name joint_name*, *next_joint_angle next_joint_angle*, *current_joint_angle current_joint_angle*, *end_time end_time*)

Documentation for a function.

For joint :

- Evaluate ideal velocity in rad/s according to joint-angle-difference and end-time of transition
- Multiply value with (global variable) to receive velocity in rad/s
- Multiply value with (global variable) to slow down simulation time.
- Multiply value with (global variable) of correspondent joint to erase joint-error
- Publish velocity to joint-controller and sleep until end-time of transition

update_velocity (*velocity_Twist velocity_Twist*)

Documentation for a function.

Updates the global variables , and TRAJECTORY_POINT_DURATION when a bike-velocity gets published to the topic "cmd_vel".

get_angle_difference (*angle_1 angle_1*, *angle_2 angle_2*)

Documentation for a function.

Returns the absolute difference of two angles within the interval [0;2pi]

control_pedaling ()

Documentation for a function.

Controls the whole pedaling-process.

Evaluates next pedal-angle according to current pedal-angle and (global variable). Uses to compute joint-velocities for every joint-angle for every transition between two. trajectory points.

Use Threads to simultaneously publish and control joint-angles.

Computes joint-angle-error and adjusts error-factors for every joint to optimize ideal joint-velocity for further transitions.

Simplified Pseudo-Code:

while bike_velocity = 0:

```
for joint in joints:

    publish(0)

sleep()
```

current_pedal_angle = get_current_pedal_angle(left_foot_position)

next_pedal_angle = current_pedal_angle + (2pi / number_circulation_points)

for joint in joints:

```
next_joint_angle = interpolation_function(next_pedal_angle)

Thread.publish_velocity(joint_name, current_joint_angle, next_joint_angle,␣
↪end_time)
```

for Thread in created_threads:

```
Thread.join
```

for joint in joints:

```
update_error_factor()
```

main()

Documentation for a function.

Initializes the Control-Node for Pedaling and starts Pedaling-Algorithm.

Variables

bool finals_simulation_pedaling.PRINT_DEBUG = True

int finals_simulation_pedaling.SIMULATION_FACTOR = 100

int finals_simulation_pedaling.NUMBER_CIRCULATION_POINTS = 15

string finals_simulation_pedaling.RECORDED_TRAJECTORY_FILENAME = "trajectory_pedaling

float finals_simulation_pedaling.JOINT_VELOCITY_FACTOR_SIMULATION = 0.008

int finals_simulation_pedaling.CONTROLLER_FREQUENCY = 100

float finals_simulation_pedaling.MIN_JOINT_VEL = -500.0

float finals_simulation_pedaling.MAX_JOINT_VEL = 500.0

int finals_simulation_pedaling.MIN_PEDAL_ANGLE = 0

float finals_simulation_pedaling.RADIUS_BACK_TIRE = 0.294398

float finals_simulation_pedaling.RADIUS_GEAR_CLUSTER = 0.06

float finals_simulation_pedaling.RADIUS_FRONT_CHAIN_RING = 0.075

float finals_simulation_pedaling.BIKE_VELOCITY = 0.0

float finals_simulation_pedaling.PEDAL_SINGLE_ROTATION_DURATION = 0.0

float finals_simulation_pedaling.TRAJECTORY_POINT_DURATION = 0.0

string finals_simulation_pedaling.ROS_JOINT_HIP_RIGHT = "joint_hip_right"

string finals_simulation_pedaling.ROS_JOINT_KNEE_RIGHT = "joint_knee_right"

string finals_simulation_pedaling.ROS_JOINT_ANKLE_RIGHT = "joint_foot_right"

string finals_simulation_pedaling.ROS_JOINT_HIP_LEFT = "joint_hip_left"

string finals_simulation_pedaling.ROS_JOINT_KNEE_LEFT = "joint_knee_left"

string finals_simulation_pedaling.ROS_JOINT_ANKLE_LEFT = "joint_foot_left"

string finals_simulation_pedaling.RIGHT_HIP_JOINT = "right_hip"

string finals_simulation_pedaling.RIGHT_KNEE_JOINT = "right_knee"

string finals_simulation_pedaling.RIGHT_ANKLE_JOINT = "right_ankle"

string finals_simulation_pedaling.LEFT_HIP_JOINT = "left_hip"

string finals_simulation_pedaling.LEFT_KNEE_JOINT = "left_knee"

string finals_simulation_pedaling.LEFT_ANKLE_JOINT = "left_ankle"

```
list finals_simulation_pedaling.x_pedal_record =  [ ]
list finals_simulation_pedaling.y_pedal_record =  [ ]
dictionary finals_simulation_pedaling.joint_trajectories_recorded=  {    "pedal_angle"
finals_simulation_pedaling.f_interpolated_hip_right =  None
finals_simulation_pedaling.f_interpolated_hip_left =  None
finals_simulation_pedaling.f_interpolated_knee_right =  None
finals_simulation_pedaling.f_interpolated_knee_left =  None
finals_simulation_pedaling.f_interpolated_ankle_right =  None
finals_simulation_pedaling.f_interpolated_ankle_left =  None
finals_simulation_pedaling.f_interpolated_pedal_angle =  None
float finals_simulation_pedaling.velocity_error_factor_hip =  1.0
float finals_simulation_pedaling.velocity_error_factor_knee =  1.0
float finals_simulation_pedaling.velocity_error_factor_ankle =  1.0
int finals_simulation_pedaling.velocity_error_counter =  0
finals_simulation_pedaling.ros_right_hip_publisher =  rospy.Publisher('/joint_hip_right
finals_simulation_pedaling.ros_right_knee_publisher =  rospy.Publisher('/joint_knee_ri
finals_simulation_pedaling.ros_right_ankle_publisher =  rospy.Publisher('/joint_foot_r
finals_simulation_pedaling.ros_left_hip_publisher =  rospy.Publisher('/joint_hip_left/
finals_simulation_pedaling.ros_left_knee_publisher =  rospy.Publisher('/joint_knee_left
finals_simulation_pedaling.ros_left_ankle_publisher =  rospy.Publisher('/joint_foot_le
float finals_simulation_pedaling.PEDAL_CENTER_OFFSET_X =  0.09222872619138603
float finals_simulation_pedaling.PEDAL_CENTER_OFFSET_Y =  0.00013171801209023543
float finals_simulation_pedaling.PEDAL_CENTER_OFFSET_Z =  0.0042772834965418725
list finals_simulation_pedaling._jointsList=  [ LEFT_HIP_JOINT, LEFT_KNEE_JOINT,
dictionary finals_simulation_pedaling._parametersRightHip=  {    "param_p": 1500.0,
dictionary finals_simulation_pedaling._parametersRightKnee=  {    "param_p": 2000.0,
dictionary finals_simulation_pedaling._parametersRightAnkle=  {    "param_p": 1000.0,
dictionary finals_simulation_pedaling._parametersLeftHip=  {    "param_p": 1500.0,
dictionary finals_simulation_pedaling._parametersLeftKnee=  {    "param_p": 2000.0,
dictionary finals_simulation_pedaling._parametersLeftAnkle=  {    "param_p": 1000.0,
dictionary finals_simulation_pedaling._jointsControlData=  {    RIGHT_HIP_JOINT: _para
dictionary finals_simulation_pedaling.joint_status_data=  {    RIGHT_HIP_JOINT: {
int finals_simulation_pedaling.number_imported_trajectory_points =  -1
int finals_simulation_pedaling.trajectoryStartingPoint =  0
list finals_simulation_pedaling.pedalTrajectoryRight =  [ ]
list finals_simulation_pedaling.pedalAngleTrajectoryLeft =  []
```

```
    list finals_simulation_pedaling.pedalTrajectoryLeft =  [ ]
    list finals_simulation_pedaling.hipTrajectoryRight =  [ ]
    list finals_simulation_pedaling.kneeTrajectoryRight =  [ ]
    list finals_simulation_pedaling.ankleTrajectoryRight =  [ ]
    list finals_simulation_pedaling.hipTrajectoryLeft =  [ ]
    list finals_simulation_pedaling.kneeTrajectoryLeft =  [ ]
    list finals_simulation_pedaling.ankleTrajectoryLeft =  [ ]
namespace hardware_interface
namespace interpolation
```

Functions

```
    importJointTrajectoryRecord()
```

Variables

```
    string interpolation.RECORDED_TRAJECTORY_FILENAME =  "capture_trajectory/captured_traj
    bool interpolation.PRINT_DEBUG =  False
    int interpolation.numTrajectoryPoints =  0
    int interpolation.trajectoryStartingPoint =  0
    list interpolation.pedalTrajectoryRight =  [ ]
    list interpolation.pedalAngleTrajectoryRight =  []
    list interpolation.pedalTrajectoryLeft =  [ ]
    list interpolation.hipTrajectoryRight =  [ ]
    list interpolation.kneeTrajectoryRight =  [ ]
    list interpolation.ankleTrajectoryRight =  [ ]
    list interpolation.hipTrajectoryLeft =  [ ]
    list interpolation.kneeTrajectoryLeft =  [ ]
    list interpolation.ankleTrajectoryLeft =  [ ]
    list interpolation.pedalTrajectory =  pedalTrajectoryRight
    list interpolation.hipTrajectory =  hipTrajectoryRight
    list interpolation.x =  []
    list interpolation.y =  []
    list interpolation.z =  []
    list interpolation.x_new =  []
    list interpolation.y_new =  []
    list interpolation.z_new =  []
    interpolation.a =  range(0, 341, 10)
```

```
    interpolation.f =  interpolate.interp1d(a, hipTrajectory, kind = "cubic")
    interpolation.f1 =  interpolate.interp2d(x, y, z, kind='cubic')
    interpolation.f2 =  interpolate.interp2d(x, y, z, kind='linear')
    list interpolation.interp1 =  []
    list interpolation.interp2 =  []
    list interpolation.interp3 =  []
    interpolation.a_new =  np.arange(0,340, 0.05)
    interpolation.some_value =  f(a_new)
    list interpolation.temp1 =  []
    list interpolation.temp2 =  []
    list interpolation.temp3 =  []
    int interpolation.mean_error1 =  0
    interpolation.max_error1 =  0
    int interpolation.mean_error2 =  0
    interpolation.max_error2 =  0
    int interpolation.mean_error3 =  0
    int interpolation.max_error3 =  0
    interpolation.current_error =  np.abs(temp1[i ] - z_new[i ])
namespace joint_angle_velocity_factor_test
```

Functions

jointStateCallback(*joint_data joint_data*)
UTILITY FUNCTIONS ###.

importJointTrajectoryRecord()

getJointPosition(*jointName jointName*)

getJointVelocity(*jointName jointName*)

getPosition(*endeffector endeffector*, *frame frame*)

getPositionLeftFoot()

getPositionRightFoot()

getDistance(*point1 point1*, *point2 point2*)

setPedalSingleRotationDuration(*new_duration_seconds new_duration_seconds*)

setTrajectoryPointDuration()

interpolateTrajectoryPoints(*value1 value1*, *value2 value2*, *startTime startTime*, *currTime currTime*, *endTime endTime*)
CONTROL FUNCTIONS ###.

checkOutputLimits(*inputVal inputVal*)

computeVelocitySetpoint(*jointName jointName*, *next_joint_angle next_joint_angle*, *current_joint_angle current_joint_angle*, *startTime startTime*, *currTime currTime*, *endTime endTime*)

get_joint_angle(*thisJointName thisJointName*, *trajectory_angle trajectory_angle*)

interpolate_functions()

evaluate_current_angle(*current_point current_point*)

publish_velocity(*thisJointName thisJointName*, *next_joint_angle next_joint_angle*, *current_joint_angle current_joint_angle*, *_startTime _startTime*, *_currTime _currTime*, *_endTime _endTime*)

FSM()

main()
MAIN ###.

Variables

bool joint_angle_velocity_factor_test.PRINT_DEBUG = False
MODULE PARAMETERS ###.

string joint_angle_velocity_factor_test.RECORDED_TRAJECTORY_FILENAME = "capture_traje

float joint_angle_velocity_factor_test.PEDAL_POSITION_ERROR_TOLERANCE = 0.02

float joint_angle_velocity_factor_test.JOINT_TRAJECTORY_ERROR_TOLERANCE = 0.02

int joint_angle_velocity_factor_test.PEDAL_SINGLE_ROTATION_DURATION = 20

int joint_angle_velocity_factor_test.NUMBER_CIRCULATION_POINTS = 72

int joint_angle_velocity_factor_test.TRAJECTORY_POINT_DURATION = 10

int joint_angle_velocity_factor_test.CONTROLLER_FREQUENCY = 100

int joint_angle_velocity_factor_test.MIN_JOINT_VEL = -500

int joint_angle_velocity_factor_test.MAX_JOINT_VEL = 500

int joint_angle_velocity_factor_test.JOINT_VELOCITY_FACTOR = 1000

list joint_angle_velocity_factor_test.x_pedal_record = [ ]
GLOBAL VARIABLES ###.

list joint_angle_velocity_factor_test.y_pedal_record = [ ]

string joint_angle_velocity_factor_test.ROS_JOINT_HIP_RIGHT = "joint_hip_right"

string joint_angle_velocity_factor_test.ROS_JOINT_KNEE_RIGHT = "joint_knee_right"

string joint_angle_velocity_factor_test.ROS_JOINT_ANKLE_RIGHT = "joint_foot_right"

string joint_angle_velocity_factor_test.ROS_JOINT_HIP_LEFT = "joint_hip_left"

string joint_angle_velocity_factor_test.ROS_JOINT_KNEE_LEFT = "joint_knee_left"

string joint_angle_velocity_factor_test.ROS_JOINT_ANKLE_LEFT = "joint_foot_left"

string joint_angle_velocity_factor_test.RIGHT_HIP_JOINT = "right_hip"

string joint_angle_velocity_factor_test.RIGHT_KNEE_JOINT = "right_knee"

string joint_angle_velocity_factor_test.RIGHT_ANKLE_JOINT = "right_ankle"

string joint_angle_velocity_factor_test.LEFT_HIP_JOINT = "left_hip"

```
string joint_angle_velocity_factor_test.LEFT_KNEE_JOINT =  "left_knee"
string joint_angle_velocity_factor_test.LEFT_ANKLE_JOINT =  "left_ankle"
joint_angle_velocity_factor_test.f_interpolated_hip_right =  None
joint_angle_velocity_factor_test.f_interpolated_hip_left =  None
joint_angle_velocity_factor_test.f_interpolated_knee_right =  None
joint_angle_velocity_factor_test.f_interpolated_knee_left =  None
joint_angle_velocity_factor_test.f_interpolated_ankle_right =  None
joint_angle_velocity_factor_test.f_interpolated_ankle_left =  None
joint_angle_velocity_factor_test.f_interpolated_pedal_angle =  None
float joint_angle_velocity_factor_test.velocity_error_factor_hip =  1.0
float joint_angle_velocity_factor_test.velocity_error_factor_knee =  1.0
float joint_angle_velocity_factor_test.velocity_error_factor_ankle =  1.0
joint_angle_velocity_factor_test.ros_right_hip_publisher =  rospy.Publisher('/joint_hi
joint_angle_velocity_factor_test.ros_right_knee_publisher =  rospy.Publisher('/joint_k
joint_angle_velocity_factor_test.ros_right_ankle_publisher =  rospy.Publisher('/joint_
joint_angle_velocity_factor_test.ros_left_hip_publisher =  rospy.Publisher('/joint_hip
joint_angle_velocity_factor_test.ros_left_knee_publisher =  rospy.Publisher('/joint_kn
joint_angle_velocity_factor_test.ros_left_ankle_publisher =  rospy.Publisher('/joint_f
float joint_angle_velocity_factor_test.PEDAL_CENTER_OFFSET_X =  0.20421
float joint_angle_velocity_factor_test.PEDAL_CENTER_OFFSET_Y =  -0.00062
float joint_angle_velocity_factor_test.PEDAL_CENTER_OFFSET_Z =  0.2101
list joint_angle_velocity_factor_test._jointsList=  [ RIGHT_HIP_JOINT, RIGHT_KNEE_JOIN
dictionary joint_angle_velocity_factor_test._parametersRightHip=  {    "param_p": 1500
dictionary joint_angle_velocity_factor_test._parametersRightKnee=  {    "param_p": 200
dictionary joint_angle_velocity_factor_test._parametersRightAnkle=  {    "param_p": 10
dictionary joint_angle_velocity_factor_test._parametersLeftHip=  {    "param_p": 1500.
dictionary joint_angle_velocity_factor_test._parametersLeftKnee=  {    "param_p": 2000
dictionary joint_angle_velocity_factor_test._parametersLeftAnkle=  {    "param_p": 100
dictionary joint_angle_velocity_factor_test._jointsControlData=  {    RIGHT_HIP_JOINT:
dictionary joint_angle_velocity_factor_test._jointsStatusData=  {    RIGHT_HIP_JOINT:
int joint_angle_velocity_factor_test.number_imported_trajectory_points =  -1
int joint_angle_velocity_factor_test.trajectoryStartingPoint =  0
list joint_angle_velocity_factor_test.pedalTrajectoryRight =  [ ]
list joint_angle_velocity_factor_test.pedalAngleTrajectoryRight =  []
list joint_angle_velocity_factor_test.pedalTrajectoryLeft =  [ ]
list joint_angle_velocity_factor_test.hipTrajectoryRight =  [ ]
```

list joint_angle_velocity_factor_test.kneeTrajectoryRight = [ ]

list joint_angle_velocity_factor_test.ankleTrajectoryRight = [ ]

list joint_angle_velocity_factor_test.hipTrajectoryLeft = [ ]

list joint_angle_velocity_factor_test.kneeTrajectoryLeft = [ ]

list joint_angle_velocity_factor_test.ankleTrajectoryLeft = [ ]

string joint_angle_velocity_factor_test.INIT = "INIT"
STATE MACHINE ###.

string joint_angle_velocity_factor_test.PEDAL = "PEDAL"

string joint_angle_velocity_factor_test.UPDATE_PARAMETERS = "UPDATE_PARAMETERS"

namespace kp_kp

Functions

setJointControllerParameters (*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)

main ()

Variables

string kp_kp.JOINT_SHOULDER_AXIS0_RIGHT = "right_shoulder_axis0"

string kp_kp.JOINT_SHOULDER_AXIS1_RIGHT = "right_shoulder_axis1"

string kp_kp.JOINT_SHOULDER_AXIS2_RIGHT = "right_shoulder_axis2"

string kp_kp.JOINT_SHOULDER_AXIS0_LEFT = "left_shoulder_axis0"

string kp_kp.JOINT_SHOULDER_AXIS1_LEFT = "left_shoulder_axis1"

string kp_kp.JOINT_SHOULDER_AXIS2_LEFT = "left_shoulder_axis2"

string kp_kp.JOINT_ELBOW_RIGHT = "elbow_right"

string kp_kp.JOINT_ELBOW_LEFT = "elbow_left"

string kp_kp.JOINT_WRIST_RIGHT_SPHERE_AXIS0 = "wrist_right_sphere_axis0"

string kp_kp.JOINT_WRIST_RIGHT_SPHERE_AXIS1 = "wrist_right_sphere_axis1"

string kp_kp.JOINT_WRIST_RIGHT_SPHERE_AXIS2 = "wrist_right_sphere_axis2"

string kp_kp.JOINT_WRIST_LEFT_SPHERE_AXIS0 = "wrist_left_sphere_axis0"

string kp_kp.JOINT_WRIST_LEFT_SPHERE_AXIS1 = "wrist_left_sphere_axis1"

string kp_kp.JOINT_WRIST_LEFT_SPHERE_AXIS2 = "wrist_left_sphere_axis2"

string kp_kp.ROS_JOINT_HIP_RIGHT = "joint_hip_right"

string kp_kp.ROS_JOINT_KNEE_RIGHT = "joint_knee_right"

string kp_kp.ROS_JOINT_ANKLE_RIGHT = "joint_foot_right"

string kp_kp.ROS_JOINT_HIP_LEFT = "joint_hip_left"

string kp_kp.ROS_JOINT_KNEE_LEFT = "joint_knee_left"

string kp_kp.ROS_JOINT_ANKLE_LEFT = "joint_foot_left"

list kp_kp.JOINT_LIST= [JOINT_SHOULDER_AXIS0_RIGHT, JOINT_SHOULDER_AXIS1_RIGHT, JOINT_

namespace new_hand_steering_capture_trajectory

Functions

computeSteeringAngles()
UTILITY FUNCTIONS ###.

computeHandTrajectories()

getPositionLeftHand()

getPositionRightHand()

setJointControllerParameters(*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)

jointStateCallback(*joint_data joint_data*)

inverse_kinematics_client(*endeffector endeffector*, *frame frame*, *x x*, *y y*, *z z*, *roll roll*, *pitch pitch*, *yaw yaw*)

main()
MAIN ###.

Variables

int new_hand_steering_capture_trajectory.MAX_TURNING_ANGLE = math.pi / 15
FUNCTION PARAMETERS ###.

int new_hand_steering_capture_trajectory.NUM_STEERING_ANGLES = 61

float new_hand_steering_capture_trajectory.RIKSHAW_TURN_JOINT_X_OFFSET = -0.230035468

float new_hand_steering_capture_trajectory.RIKSHAW_TURN_JOINT_Y_OFFSET = -0.010388308

float new_hand_steering_capture_trajectory.RIKSHAW_TURN_JOINT_Z_OFFSET = -0.205270696

int new_hand_steering_capture_trajectory.YAW_RIGHT_HAND_OFFSET = math.pi / 2 + math.p

int new_hand_steering_capture_trajectory.YAW_LEFT_HAND_OFFSET = 3 * math.pi / 2 + mat

float new_hand_steering_capture_trajectory.HANDLEBAR_X_OFFSET = 0.728713

float new_hand_steering_capture_trajectory.HANDLEBAR_Z_OFFSET = 0.719269

float new_hand_steering_capture_trajectory.HAND_Y_OFFSET = 0.2

string new_hand_steering_capture_trajectory.JSON_FILENAME = "new_hand_steering_traject

float new_hand_steering_capture_trajectory.JOINT_ANGLE_TOLERANCE_FK = 0.01

string new_hand_steering_capture_trajectory.ENDEFFECTOR_RIGHT = "right_arm"

string new_hand_steering_capture_trajectory.FRAME_RIGHT = "wrist_right_sphere_link1"

string new_hand_steering_capture_trajectory.ENDEFFECTOR_LEFT = "left_arm"

string new_hand_steering_capture_trajectory.FRAME_LEFT = "wrist_left_sphere_link1"

int new_hand_steering_capture_trajectory.BIKE_OFFSET_X = 0
MEASURED PARAMETERS ###.

int new_hand_steering_capture_trajectory.BIKE_OFFSET_Y = 0

int new_hand_steering_capture_trajectory.BIKE_OFFSET_Z = 0

list new_hand_steering_capture_trajectory._steeringAngles = []
GLOBAL VARIABLES ###.

list new_hand_steering_capture_trajectory._rightHandTrajectory = []

list new_hand_steering_capture_trajectory._leftHandTrajectory = []

list new_hand_steering_capture_trajectory._centerHandlebarTrajectory = []

string new_hand_steering_capture_trajectory.JOINT_SHOULDER_AXIS0_RIGHT = "right_shoul

string new_hand_steering_capture_trajectory.JOINT_SHOULDER_AXIS1_RIGHT = "right_shoul

string new_hand_steering_capture_trajectory.JOINT_SHOULDER_AXIS2_RIGHT = "right_shoul

string new_hand_steering_capture_trajectory.JOINT_SHOULDER_AXIS0_LEFT = "left_shoulde

string new_hand_steering_capture_trajectory.JOINT_SHOULDER_AXIS1_LEFT = "left_shoulde

string new_hand_steering_capture_trajectory.JOINT_SHOULDER_AXIS2_LEFT = "left_shoulde

string new_hand_steering_capture_trajectory.JOINT_ELBOW_RIGHT = "elbow_right"

string new_hand_steering_capture_trajectory.JOINT_ELBOW_LEFT = "elbow_left"

string new_hand_steering_capture_trajectory.JOINT_WRIST_RIGHT_SPHERE_AXIS0 = "wrist_r

string new_hand_steering_capture_trajectory.JOINT_WRIST_LEFT_SPHERE_AXIS0 = "wrist_le

list new_hand_steering_capture_trajectory.JOINT_LIST= [JOINT_SHOULDER_AXIS0_RIGHT, JO

dictionary new_hand_steering_capture_trajectory._jointsStatusData

namespace pedal_simulation

Functions

joint_state_callback (*joint_data joint_data*)
Documentation for a function.

This function collects the current status of the joint-angles and saves them in the global dictionary "joint_status_data".

import_joint_trajectory_record()
Documentation for a function.

Collects and saves all joint- and pedal-angles from the pre-captured trajectory from the (global variable).

get_joint_position (*jointName jointName*)
Documentation for a function.

Return current joint-angle of .

get_joint_velocity (*jointName jointName*)
Documentation for a function.

Return current joint-velocity of .

get_position (*endeffector endeffector*, *frame frame*)
Documentation for a function.

Return the postion of the of the correspondent .

set_joint_controller_parameters (*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)
Documentation for a function.

Sets Kp of joint-controller to Sets Kd of joint-controller to

get_position_left_foot()
Documentation for a function.

Return the position of the left foot of Roboy.

get_position_right_foot()
Documentation for a function.

Return the position of the right foot of Roboy.

get_distance(*point1 point1*, *point2 point2*)
Documentation for a function.

Return the distance between two points where points are a list of two coordinates.

check_output_limits(*inputVal inputVal*)
Documentation for a function.

Checks if is inside possible range of joint-angle velocities. If not, returns max-velocity if too high or min-velocity if to low instead of .

compute_velocity(*joint_name joint_name*, *next_joint_angle next_joint_angle*, *current_joint_angle current_joint_angle*, *end_time end_time*)
Documentation for a function.

Returns ideal joint-velocity for according to and joint-angle-difference between and :

ideal_velocity = joint_angle_difference / (end_time - current_time)

get_joint_angle(*joint_name joint_name*, *pedal_angle pedal_angle*)
Documentation for a function.

Evaluate and return joint-angle of correspondent to using the interpolated function:

The functions can be used by calling "<function_name>(<pedal_angle>)" ==> returns <joint_angle>

interpolate_functions()
Documentation for a function.

Initializing interpolated functions for joint-angles using pre-captured set points with pedal-angle as input and joint-angle as output:

The functions can be used by calling "<function_name>(<pedal_angle>)" ==> returns <joint_angle>

evaluate_current_pedal_angle(*current_point current_point*)
Documentation for a function.

Evaluating the current pedal-angle according to the current position of the left foot . Using trigonometric functions for the evaluation of the angle.

publish_velocity(*joint_name joint_name*, *next_joint_angle next_joint_angle*, *current_joint_angle current_joint_angle*, *end_time end_time*)
Documentation for a function.

For joint :

- Evaluate ideal velocity in rad/s according to joint-angle-difference and end-time of transition
- Multiply value with (global variable) to receive velocity in rad/s
- Multiply value with (global variable) to slow down simulation time.
- Multiply value with (global variable) of correspondent joint to erase joint-error
- Publish velocity to joint-controller and sleep until end-time of transition

update_velocity(*velocity_Twist velocity_Twist*)
Documentation for a function.

Updates the global variables , and TRAJECTORY_POINT_DURATION when a bike-velocity gets published to the topic "cmd_vel".

get_angle_difference(*angle_1 angle_1*, *angle_2 angle_2*)
Documentation for a function.

Returns the absolute difference of two angles within the interval [0;2pi]

control_pedaling()
Documentation for a function.

Controls the whole pedaling-process.

Evaluates next pedal-angle according to current pedal-angle and (global variable). Uses to compute joint-velocities for every joint-angle for every transition between two. trajectory points.

Use Threads to simultaneously publish and control joint-angles.

Computes joint-angle-error and adjusts error-factors for every joint to optimize ideal joint-velocity for further transitions.

Simplified Pseudo-Code:

while bike_velocity = 0:

```
for joint in joints:

    publish(0)

sleep()
```

current_pedal_angle = get_current_pedal_angle(left_foot_position)

next_pedal_angle = current_pedal_angle + (2pi / number_circulation_points)

for joint in joints:

```
next_joint_angle = interpolation_function(next_pedal_angle)

Thread.publish_velocity(joint_name, current_joint_angle, next_joint_angle,␣
↪end_time)
```

for Thread in created_threads:

```
Thread.join
```

for joint in joints:

```
update_error_factor()
```

main()
Documentation for a function.

Initializes the Control-Node for Pedaling and starts Pedaling-Algorithm.

Variables

bool pedal_simulation.PRINT_DEBUG = True

```
float pedal_simulation.SIMULATION_FACTOR =  100.0
int pedal_simulation.NUMBER_CIRCULATION_POINTS =  30
string pedal_simulation.RECORDED_TRAJECTORY_FILENAME =  "trajectory_pedaling/captured_
float pedal_simulation.JOINT_VELOCITY_FACTOR_SIMULATION =  0.01
float pedal_simulation.PEDAL_POSITION_ERROR_TOLERANCE =  0.02
float pedal_simulation.JOINT_TRAJECTORY_ERROR_TOLERANCE =  0.02
int pedal_simulation.CONTROLLER_FREQUENCY =  100
float pedal_simulation.MIN_JOINT_VEL =  -500.0
float pedal_simulation.MAX_JOINT_VEL =  500.0
float pedal_simulation.RADIUS_BACK_TIRE =  0.294398
float pedal_simulation.RADIUS_GEAR_CLUSTER =  0.06
float pedal_simulation.RADIUS_FRONT_CHAIN_RING =  0.075
float pedal_simulation.BIKE_VELOCITY =  0.0
float pedal_simulation.PEDAL_SINGLE_ROTATION_DURATION =  0.0
float pedal_simulation.TRAJECTORY_POINT_DURATION =  0.0
list pedal_simulation.x_pedal_record =  [ ]
list pedal_simulation.y_pedal_record =  [ ]
string pedal_simulation.ROS_JOINT_HIP_RIGHT =  "joint_hip_right"
string pedal_simulation.ROS_JOINT_KNEE_RIGHT =  "joint_knee_right"
string pedal_simulation.ROS_JOINT_ANKLE_RIGHT =  "joint_foot_right"
string pedal_simulation.ROS_JOINT_HIP_LEFT =  "joint_hip_left"
string pedal_simulation.ROS_JOINT_KNEE_LEFT =  "joint_knee_left"
string pedal_simulation.ROS_JOINT_ANKLE_LEFT =  "joint_foot_left"
string pedal_simulation.RIGHT_HIP_JOINT =  "right_hip"
string pedal_simulation.RIGHT_KNEE_JOINT =  "right_knee"
string pedal_simulation.RIGHT_ANKLE_JOINT =  "right_ankle"
string pedal_simulation.LEFT_HIP_JOINT =  "left_hip"
string pedal_simulation.LEFT_KNEE_JOINT =  "left_knee"
string pedal_simulation.LEFT_ANKLE_JOINT =  "left_ankle"
pedal_simulation.f_interpolated_hip_right =  None
pedal_simulation.f_interpolated_hip_left =  None
pedal_simulation.f_interpolated_knee_right =  None
pedal_simulation.f_interpolated_knee_left =  None
pedal_simulation.f_interpolated_ankle_right =  None
pedal_simulation.f_interpolated_ankle_left =  None
pedal_simulation.f_interpolated_pedal_angle =  None
```

```
    float pedal_simulation.velocity_error_factor_hip =  1.0
    float pedal_simulation.velocity_error_factor_knee =  1.0
    float pedal_simulation.velocity_error_factor_ankle =  1.0
    int pedal_simulation.velocity_error_counter =  0
    pedal_simulation.ros_right_hip_publisher =  rospy.Publisher('/joint_hip_right/joint_hi
    pedal_simulation.ros_right_knee_publisher =  rospy.Publisher('/joint_knee_right/joint_
    pedal_simulation.ros_right_ankle_publisher =  rospy.Publisher('/joint_foot_right/joint
    pedal_simulation.ros_left_hip_publisher =  rospy.Publisher('/joint_hip_left/joint_hip_
    pedal_simulation.ros_left_knee_publisher =  rospy.Publisher('/joint_knee_left/joint_kn
    pedal_simulation.ros_left_ankle_publisher =  rospy.Publisher('/joint_foot_left/joint_f
    float pedal_simulation.PEDAL_CENTER_OFFSET_X =  0.20421
    float pedal_simulation.PEDAL_CENTER_OFFSET_Y =  -0.00062
    float pedal_simulation.PEDAL_CENTER_OFFSET_Z =  0.2101
    list pedal_simulation._jointsList=  [ RIGHT_HIP_JOINT, RIGHT_KNEE_JOINT, RIGHT_ANKLE_J
    dictionary pedal_simulation._parametersRightHip=  {    "param_p": 1500.0,    "param_i"
    dictionary pedal_simulation._parametersRightKnee=  {    "param_p": 2000.0,    "param_i
    dictionary pedal_simulation._parametersRightAnkle=  {    "param_p": 1000.0,    "param_
    dictionary pedal_simulation._parametersLeftHip=  {    "param_p": 1500.0,    "param_i":
    dictionary pedal_simulation._parametersLeftKnee=  {    "param_p": 2000.0,    "param_i"
    dictionary pedal_simulation._parametersLeftAnkle=  {    "param_p": 1000.0,    "param_i
    dictionary pedal_simulation._jointsControlData=  {    RIGHT_HIP_JOINT: _parametersRigh
    dictionary pedal_simulation.joint_status_data=  {    RIGHT_HIP_JOINT: {        "Pos":
    int pedal_simulation.number_imported_trajectory_points =  -1
    int pedal_simulation.trajectoryStartingPoint =  0
    list pedal_simulation.pedalTrajectoryRight =  [ ]
    list pedal_simulation.pedalAngleTrajectoryRight =  [ ]
    list pedal_simulation.pedalTrajectoryLeft =  [ ]
    list pedal_simulation.hipTrajectoryRight =  [ ]
    list pedal_simulation.kneeTrajectoryRight =  [ ]
    list pedal_simulation.ankleTrajectoryRight =  [ ]
    list pedal_simulation.hipTrajectoryLeft =  [ ]
    list pedal_simulation.kneeTrajectoryLeft =  [ ]
    list pedal_simulation.ankleTrajectoryLeft =  [ ]
namespace pedal_simulation_interpolation_cubic_derivative
```

Functions

jointStateCallback(*joint_data joint_data*)
UTILITY FUNCTIONS ###.

setJointControllerParameters(*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)

importJointTrajectoryRecord()

getJointPosition(*jointName jointName*)

getJointVelocity(*jointName jointName*)

getPositionLeftFoot()

getPositionRightFoot()

getDistance(*point1 point1*, *point2 point2*)

setPedalSingleRotationDuration(*new_duration_seconds new_duration_seconds*)

setTrajectoryPointDuration()

setPedalAngularVelocity()

getCurrentAngle(*current_point current_point*)

interpolateAllJointPositions()

printInterpolatedFunctions()

checkOutputLimits(*inputVal inputVal*)
CONTROL FUNCTIONS ###.

FSM()
STATE MACHINE ###.

main()
MAIN ###.

Variables

bool pedal_simulation_interpolation_cubic_derivative.PRINT_DEBUG = True
MODULE PARAMETERS ###.

string pedal_simulation_interpolation_cubic_derivative.RECORDED_TRAJECTORY_FILENAME =

float pedal_simulation_interpolation_cubic_derivative.PEDAL_POSITION_ERROR_TOLERANCE =

float pedal_simulation_interpolation_cubic_derivative.PEDAL_ANGLE_ERROR_TOLERANCE = 0

float pedal_simulation_interpolation_cubic_derivative.JOINT_TRAJECTORY_ERROR_TOLERANCE

int pedal_simulation_interpolation_cubic_derivative.PEDAL_SINGLE_ROTATION_DURATION =

int pedal_simulation_interpolation_cubic_derivative.CONTROLLER_FREQUENCY = 100

int pedal_simulation_interpolation_cubic_derivative.MIN_JOINT_VEL = -50

int pedal_simulation_interpolation_cubic_derivative.MAX_JOINT_VEL = 50

int pedal_simulation_interpolation_cubic_derivative.JOINT_VELOCITY_FACTOR = 1

float pedal_simulation_interpolation_cubic_derivative.PEDAL_CENTER_OFFSET_X = 0.20421

float pedal_simulation_interpolation_cubic_derivative.PEDAL_CENTER_OFFSET_Y = -0.0006

```
float pedal_simulation_interpolation_cubic_derivative.PEDAL_CENTER_OFFSET_Z =  0.2101
list pedal_simulation_interpolation_cubic_derivative.x_pedal_record =  []
    GLOBAL VARIABLES ###.
list pedal_simulation_interpolation_cubic_derivative.y_pedal_record =  []
string pedal_simulation_interpolation_cubic_derivative.ROS_JOINT_HIP_RIGHT =  "joint_h
string pedal_simulation_interpolation_cubic_derivative.ROS_JOINT_KNEE_RIGHT =  "joint_
string pedal_simulation_interpolation_cubic_derivative.ROS_JOINT_ANKLE_RIGHT =  "joint
string pedal_simulation_interpolation_cubic_derivative.ROS_JOINT_HIP_LEFT =  "joint_hi
string pedal_simulation_interpolation_cubic_derivative.ROS_JOINT_KNEE_LEFT =  "joint_k
string pedal_simulation_interpolation_cubic_derivative.ROS_JOINT_ANKLE_LEFT =  "joint_
string pedal_simulation_interpolation_cubic_derivative.RIGHT_HIP_JOINT =  "right_hip"
string pedal_simulation_interpolation_cubic_derivative.RIGHT_KNEE_JOINT =  "right_knee
string pedal_simulation_interpolation_cubic_derivative.RIGHT_ANKLE_JOINT =  "right_ank
string pedal_simulation_interpolation_cubic_derivative.LEFT_HIP_JOINT =  "left_hip"
string pedal_simulation_interpolation_cubic_derivative.LEFT_KNEE_JOINT =  "left_knee"
string pedal_simulation_interpolation_cubic_derivative.LEFT_ANKLE_JOINT =  "left_ankle
list pedal_simulation_interpolation_cubic_derivative._jointsList =  [RIGHT_HIP_JOINT,
list pedal_simulation_interpolation_cubic_derivative._jointsListROS=  [ROS_JOINT_HIP_R
dictionary pedal_simulation_interpolation_cubic_derivative._parametersRightHip=  {
dictionary pedal_simulation_interpolation_cubic_derivative._parametersRightKnee=  {
dictionary pedal_simulation_interpolation_cubic_derivative._parametersRightAnkle=  {
dictionary pedal_simulation_interpolation_cubic_derivative._parametersLeftHip=  {    "
dictionary pedal_simulation_interpolation_cubic_derivative._parametersLeftKnee=  {
dictionary pedal_simulation_interpolation_cubic_derivative._parametersLeftAnkle=  {
dictionary pedal_simulation_interpolation_cubic_derivative._jointsControlData=  {    R
dictionary pedal_simulation_interpolation_cubic_derivative._jointsStatusData=  {    RI
int pedal_simulation_interpolation_cubic_derivative._numTrajectoryPoints =  -1
int pedal_simulation_interpolation_cubic_derivative._trajectoryStartingPoint =  0
float pedal_simulation_interpolation_cubic_derivative._trajectoryPointDuration =  1.0
float pedal_simulation_interpolation_cubic_derivative._pedalAngularVelocity =  0.1
list pedal_simulation_interpolation_cubic_derivative._pedalTrajectoryRight =  []
list pedal_simulation_interpolation_cubic_derivative._pedalAngleTrajectoryRight =  []
list pedal_simulation_interpolation_cubic_derivative._hipTrajectoryRight =  []
list pedal_simulation_interpolation_cubic_derivative._kneeTrajectoryRight =  []
list pedal_simulation_interpolation_cubic_derivative._ankleTrajectoryRight =  []
list pedal_simulation_interpolation_cubic_derivative._pedalTrajectoryLeft =  []
```

list pedal_simulation_interpolation_cubic_derivative._pedalAngleTrajectoryLeft = []

list pedal_simulation_interpolation_cubic_derivative._hipTrajectoryLeft = []

list pedal_simulation_interpolation_cubic_derivative._kneeTrajectoryLeft = []

list pedal_simulation_interpolation_cubic_derivative._ankleTrajectoryLeft = []

namespace pedal_simulation_interpolation_linear_trajectory_points

Functions

jointStateCallback(*joint_data joint_data*)
UTILITY FUNCTIONS ###.

setJointControllerParameters(*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)

importJointTrajectoryRecord()

getJointPosition(*jointName jointName*)

getJointVelocity(*jointName jointName*)

getPosition(*endeffector endeffector*, *frame frame*)

getPositionLeftFoot()

getPositionRightFoot()

getDistance(*point1 point1*, *point2 point2*)

setPedalSingleRotationDuration(*new_duration_seconds new_duration_seconds*)

setTrajectoryPointDuration()

interpolateTrajectoryPoints(*value1 value1*, *value2 value2*, *startTime startTime*, *currTime currTime*, *endTime endTime*)
CONTROL FUNCTIONS ###.

checkOutputLimits(*inputVal inputVal*)

computeVelocitySetpoint(*jointName jointName*, *endPos endPos*, *startTime startTime*, *currTime currTime*, *endTime endTime*)

FSM()

main()
MAIN ###.

Variables

bool pedal_simulation_interpolation_linear_trajectory_points.PRINT_DEBUG = True
MODULE PARAMETERS ###.

string pedal_simulation_interpolation_linear_trajectory_points.RECORDED_TRAJECTORY_FIL

float pedal_simulation_interpolation_linear_trajectory_points.PEDAL_POSITION_ERROR_TOL

float pedal_simulation_interpolation_linear_trajectory_points.JOINT_TRAJECTORY_ERROR_T

int pedal_simulation_interpolation_linear_trajectory_points.PEDAL_SINGLE_ROTATION_DURA

int pedal_simulation_interpolation_linear_trajectory_points.TRAJECTORY_POINT_DURATION

int pedal_simulation_interpolation_linear_trajectory_points.CONTROLLER_FREQUENCY = 10

int pedal_simulation_interpolation_linear_trajectory_points.MIN_JOINT_VEL = -500

int pedal_simulation_interpolation_linear_trajectory_points.MAX_JOINT_VEL = 500

int pedal_simulation_interpolation_linear_trajectory_points.JOINT_VELOCITY_FACTOR = 1

list pedal_simulation_interpolation_linear_trajectory_points.x_pedal_record = []

GLOBAL VARIABLES ###.

list pedal_simulation_interpolation_linear_trajectory_points.y_pedal_record = []

string pedal_simulation_interpolation_linear_trajectory_points.ROS_JOINT_HIP_RIGHT =

string pedal_simulation_interpolation_linear_trajectory_points.ROS_JOINT_KNEE_RIGHT =

string pedal_simulation_interpolation_linear_trajectory_points.ROS_JOINT_ANKLE_RIGHT =

string pedal_simulation_interpolation_linear_trajectory_points.ROS_JOINT_HIP_LEFT = "

string pedal_simulation_interpolation_linear_trajectory_points.ROS_JOINT_KNEE_LEFT =

string pedal_simulation_interpolation_linear_trajectory_points.ROS_JOINT_ANKLE_LEFT =

string pedal_simulation_interpolation_linear_trajectory_points.RIGHT_HIP_JOINT = "rig

string pedal_simulation_interpolation_linear_trajectory_points.RIGHT_KNEE_JOINT = "ri

string pedal_simulation_interpolation_linear_trajectory_points.RIGHT_ANKLE_JOINT = "r

string pedal_simulation_interpolation_linear_trajectory_points.LEFT_HIP_JOINT = "left_

string pedal_simulation_interpolation_linear_trajectory_points.LEFT_KNEE_JOINT = "lef

string pedal_simulation_interpolation_linear_trajectory_points.LEFT_ANKLE_JOINT = "le

list pedal_simulation_interpolation_linear_trajectory_points._jointsList = [RIGHT_HIP_

list pedal_simulation_interpolation_linear_trajectory_points._jointsListROS = [ROS_JO

dictionary pedal_simulation_interpolation_linear_trajectory_points._parametersRightHip=

dictionary pedal_simulation_interpolation_linear_trajectory_points._parametersRightKne

dictionary pedal_simulation_interpolation_linear_trajectory_points._parametersRightAnk

dictionary pedal_simulation_interpolation_linear_trajectory_points._parametersLeftHip=

dictionary pedal_simulation_interpolation_linear_trajectory_points._parametersLeftKnee=

dictionary pedal_simulation_interpolation_linear_trajectory_points._parametersLeftAnkl

dictionary pedal_simulation_interpolation_linear_trajectory_points._jointsControlData=

dictionary pedal_simulation_interpolation_linear_trajectory_points._jointsStatusData=

int pedal_simulation_interpolation_linear_trajectory_points.numTrajectoryPoints = -1

int pedal_simulation_interpolation_linear_trajectory_points.trajectoryStartingPoint =

list pedal_simulation_interpolation_linear_trajectory_points.pedalTrajectoryRight = [

list pedal_simulation_interpolation_linear_trajectory_points.pedalTrajectoryLeft = []

list pedal_simulation_interpolation_linear_trajectory_points.hipTrajectoryRight = []

list pedal_simulation_interpolation_linear_trajectory_points.kneeTrajectoryRight = []

list pedal_simulation_interpolation_linear_trajectory_points.ankleTrajectoryRight = [

list pedal_simulation_interpolation_linear_trajectory_points.hipTrajectoryLeft = []

list pedal_simulation_interpolation_linear_trajectory_points.kneeTrajectoryLeft = []

list pedal_simulation_interpolation_linear_trajectory_points.ankleTrajectoryLeft = []

string pedal_simulation_interpolation_linear_trajectory_points.INIT = "INIT"
STATE MACHINE ###.

string pedal_simulation_interpolation_linear_trajectory_points.PEDAL = "PEDAL"

string pedal_simulation_interpolation_linear_trajectory_points.UPDATE_PARAMETERS = "U

namespace pedal_simulation_left_leg_experimental

Functions

joint_state_callback(*joint_data joint_data*)
Documentation for a function.

This function collects the current status of the joint-angles and saves them in the global dictionary "joint_status_data".

import_joint_trajectory_record()
Documentation for a function.

Collects and saves all joint- and pedal-angles from the pre-captured trajectory from the (global variable).

get_joint_position(*jointName jointName*)
Documentation for a function.

Return current joint-angle of .

get_joint_velocity(*jointName jointName*)
Documentation for a function.

Return current joint-velocity of .

get_position(*endeffector endeffector*, *frame frame*)
Documentation for a function.

Return the postion of the of the correspondent .

set_joint_controller_parameters(*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)
Documentation for a function.

Sets Kp of joint-controller to Sets Kd of joint-controller to

get_position_left_foot()
Documentation for a function.

Return the position of the left foot of Roboy.

get_position_right_foot()
Documentation for a function.

Return the position of the right foot of Roboy.

get_distance(*point1 point1*, *point2 point2*)
Documentation for a function.

Return the distance between two points where points are a list of two coordinates.

check_output_limits(*inputVal inputVal*)
Documentation for a function.

Checks if is inside possible range of joint-angle velocities. If not, returns max-velocity if too high or min-velocity if to low instead of .

compute_velocity (*joint_name joint_name*, *next_joint_angle next_joint_angle*, *current_joint_angle current_joint_angle*, *end_time end_time*)
Documentation for a function.

Returns ideal joint-velocity for according to and joint-angle-difference between and :

ideal_velocity = joint_angle_difference / (end_time - current_time)

get_joint_angle (*joint_name joint_name*, *pedal_angle pedal_angle*)
Documentation for a function.

Evaluate and return joint-angle of correspondent to using the interpolated function:

The functions can be used by calling "<function_name>(<pedal_angle>)" ==> returns <joint_angle>

interpolate_functions ()
Documentation for a function.

Initializing interpolated functions for joint-angles using pre-captured set points with pedal-angle as input and joint-angle as output:

The functions can be used by calling "<function_name>(<pedal_angle>)" ==> returns <joint_angle>

evaluate_current_pedal_angle (*current_point current_point*)
Documentation for a function.

Evaluating the current pedal-angle according to the current position of the left foot . Using trigonometric functions for the evaluation of the angle.

publish_velocity (*joint_name joint_name*, *next_joint_angle next_joint_angle*, *current_joint_angle current_joint_angle*, *end_time end_time*)
Documentation for a function.

For joint :

- Evaluate ideal velocity in rad/s according to joint-angle-difference and end-time of transition
- Multiply value with (global variable) to receive velocity in rad/s
- Multiply value with (global variable) to slow down simulation time.
- Multiply value with (global variable) of correspondent joint to erase joint-error
- Publish velocity to joint-controller and sleep until end-time of transition

update_velocity (*velocity_Twist velocity_Twist*)
Documentation for a function.

Updates the global variables , and TRAJECTORY_POINT_DURATION when a bike-velocity gets published to the topic "cmd_vel".

get_angle_difference (*angle_1 angle_1*, *angle_2 angle_2*)
Documentation for a function.

Returns the absolute difference of two angles within the interval [0;2pi]

control_pedaling ()
Documentation for a function.

Controls the whole pedaling-process.

Evaluates next pedal-angle according to current pedal-angle and (global variable). Uses to compute joint-velocities for every joint-angle for every transition between two. trajectory points.

Use Threads to simultaneously publish and control joint-angles.

Computes joint-angle-error and adjusts error-factors for every joint to optimize ideal joint-velocity for further transitions.

Simplified Pseudo-Code:

while bike_velocity = 0:

```
for joint in joints:

    publish(0)

sleep()
```

current_pedal_angle = get_current_pedal_angle(left_foot_position)

next_pedal_angle = current_pedal_angle + (2pi / number_circulation_points)

for joint in joints:

```
next_joint_angle = interpolation_function(next_pedal_angle)

Thread.publish_velocity(joint_name, current_joint_angle, next_joint_angle,␣
↪end_time)
```

for Thread in created_threads:

```
Thread.join
```

for joint in joints:

```
update_error_factor()
```

main()

Documentation for a function.

Initializes the Control-Node for Pedaling and starts Pedaling-Algorithm.

Variables

bool pedal_simulation_left_leg_experimental.PRINT_DEBUG = True

float pedal_simulation_left_leg_experimental.SIMULATION_FACTOR = 100.0

int pedal_simulation_left_leg_experimental.NUMBER_CIRCULATION_POINTS = 30

string pedal_simulation_left_leg_experimental.RECORDED_TRAJECTORY_FILENAME = "trajecto

float pedal_simulation_left_leg_experimental.JOINT_VELOCITY_FACTOR_SIMULATION = 0.008

float pedal_simulation_left_leg_experimental.PEDAL_POSITION_ERROR_TOLERANCE = 0.02

float pedal_simulation_left_leg_experimental.JOINT_TRAJECTORY_ERROR_TOLERANCE = 0.02

int pedal_simulation_left_leg_experimental.CONTROLLER_FREQUENCY = 100

float pedal_simulation_left_leg_experimental.MIN_JOINT_VEL = -500.0

float pedal_simulation_left_leg_experimental.MAX_JOINT_VEL = 500.0

float pedal_simulation_left_leg_experimental.RADIUS_BACK_TIRE = 0.294398

```
float pedal_simulation_left_leg_experimental.RADIUS_GEAR_CLUSTER =  0.06
float pedal_simulation_left_leg_experimental.RADIUS_FRONT_CHAIN_RING =  0.075
float pedal_simulation_left_leg_experimental.BIKE_VELOCITY =  0.0
float pedal_simulation_left_leg_experimental.PEDAL_SINGLE_ROTATION_DURATION =  0.0
float pedal_simulation_left_leg_experimental.TRAJECTORY_POINT_DURATION =  0.0
list pedal_simulation_left_leg_experimental.x_pedal_record =  [ ]
list pedal_simulation_left_leg_experimental.y_pedal_record =  [ ]
string pedal_simulation_left_leg_experimental.ROS_JOINT_HIP_RIGHT =  "joint_hip_right"
string pedal_simulation_left_leg_experimental.ROS_JOINT_KNEE_RIGHT =  "joint_knee_righ
string pedal_simulation_left_leg_experimental.ROS_JOINT_ANKLE_RIGHT =  "joint_foot_rig
string pedal_simulation_left_leg_experimental.ROS_JOINT_HIP_LEFT =  "joint_hip_left"
string pedal_simulation_left_leg_experimental.ROS_JOINT_KNEE_LEFT =  "joint_knee_left"
string pedal_simulation_left_leg_experimental.ROS_JOINT_ANKLE_LEFT =  "joint_foot_left
string pedal_simulation_left_leg_experimental.RIGHT_HIP_JOINT =  "right_hip"
string pedal_simulation_left_leg_experimental.RIGHT_KNEE_JOINT =  "right_knee"
string pedal_simulation_left_leg_experimental.RIGHT_ANKLE_JOINT =  "right_ankle"
string pedal_simulation_left_leg_experimental.LEFT_HIP_JOINT =  "left_hip"
string pedal_simulation_left_leg_experimental.LEFT_KNEE_JOINT =  "left_knee"
string pedal_simulation_left_leg_experimental.LEFT_ANKLE_JOINT =  "left_ankle"
pedal_simulation_left_leg_experimental.f_interpolated_hip_right =  None
pedal_simulation_left_leg_experimental.f_interpolated_hip_left =  None
pedal_simulation_left_leg_experimental.f_interpolated_knee_right =  None
pedal_simulation_left_leg_experimental.f_interpolated_knee_left =  None
pedal_simulation_left_leg_experimental.f_interpolated_ankle_right =  None
pedal_simulation_left_leg_experimental.f_interpolated_ankle_left =  None
pedal_simulation_left_leg_experimental.f_interpolated_pedal_angle =  None
float pedal_simulation_left_leg_experimental.velocity_error_factor_hip =  1.0
float pedal_simulation_left_leg_experimental.velocity_error_factor_knee =  1.0
float pedal_simulation_left_leg_experimental.velocity_error_factor_ankle =  1.0
int pedal_simulation_left_leg_experimental.velocity_error_counter =  0
pedal_simulation_left_leg_experimental.ros_right_hip_publisher =  rospy.Publisher('/jo
pedal_simulation_left_leg_experimental.ros_right_knee_publisher =  rospy.Publisher('/j
pedal_simulation_left_leg_experimental.ros_right_ankle_publisher =  rospy.Publisher('/
pedal_simulation_left_leg_experimental.ros_left_hip_publisher =  rospy.Publisher('/joi
pedal_simulation_left_leg_experimental.ros_left_knee_publisher =  rospy.Publisher('/jo
pedal_simulation_left_leg_experimental.ros_left_ankle_publisher =  rospy.Publisher('/j
```

```
    float pedal_simulation_left_leg_experimental.PEDAL_CENTER_OFFSET_X =  0.00027829138673
    float pedal_simulation_left_leg_experimental.PEDAL_CENTER_OFFSET_Y =  -0.0351316495558
    float pedal_simulation_left_leg_experimental.PEDAL_CENTER_OFFSET_Z =  0.00100933134810
    float pedal_simulation_left_leg_experimental.OLD_X_OFFSET =  0.7163902600571725 + 0.23
    float pedal_simulation_left_leg_experimental.OLD_Y_OFFSET =  -0.010388552466272516 + 0
    float pedal_simulation_left_leg_experimental.OLD_Z_OFFSET =  0.2164376942146126 - 0.20
    float pedal_simulation_left_leg_experimental.NEW_X_OFFSET =  -0.23003546880974085 + (-
    float pedal_simulation_left_leg_experimental.NEW_Y_OFFSET =  -0.010388308215364166 + (
    float pedal_simulation_left_leg_experimental.NEW_Z_OFFSET =  -0.2052706960113988 + (0.
    float pedal_simulation_left_leg_experimental.DIFF_X_OFFSET =  NEW_X_OFFSET - OLD_X_OFF
    float pedal_simulation_left_leg_experimental.DIFF_Y_OFFSET =  NEW_Y_OFFSET - OLD_Y_OFF
    float pedal_simulation_left_leg_experimental.DIFF_Z_OFFSET =  NEW_Z_OFFSET - OLD_Z_OFF
    list pedal_simulation_left_leg_experimental._jointsList=  [ LEFT_HIP_JOINT, LEFT_KNEE_
    dictionary pedal_simulation_left_leg_experimental._parametersRightHip=  {    "param_p"
    dictionary pedal_simulation_left_leg_experimental._parametersRightKnee=  {    "param_p
    dictionary pedal_simulation_left_leg_experimental._parametersRightAnkle=  {    "param_
    dictionary pedal_simulation_left_leg_experimental._parametersLeftHip=  {    "param_p":
    dictionary pedal_simulation_left_leg_experimental._parametersLeftKnee=  {    "param_p"
    dictionary pedal_simulation_left_leg_experimental._parametersLeftAnkle=  {    "param_p
    dictionary pedal_simulation_left_leg_experimental._jointsControlData=  {    RIGHT_HIP_
    dictionary pedal_simulation_left_leg_experimental.joint_status_data=  {    RIGHT_HIP_J
    int pedal_simulation_left_leg_experimental.number_imported_trajectory_points =  -1
    int pedal_simulation_left_leg_experimental.trajectoryStartingPoint =  0
    list pedal_simulation_left_leg_experimental.pedalTrajectoryRight =  [ ]
    list pedal_simulation_left_leg_experimental.pedalAngleTrajectoryLeft =  []
    list pedal_simulation_left_leg_experimental.pedalTrajectoryLeft =  [ ]
    list pedal_simulation_left_leg_experimental.hipTrajectoryRight =  [ ]
    list pedal_simulation_left_leg_experimental.kneeTrajectoryRight =  [ ]
    list pedal_simulation_left_leg_experimental.ankleTrajectoryRight =  [ ]
    list pedal_simulation_left_leg_experimental.hipTrajectoryLeft =  [ ]
    list pedal_simulation_left_leg_experimental.kneeTrajectoryLeft =  [ ]
    list pedal_simulation_left_leg_experimental.ankleTrajectoryLeft =  [ ]
namespace pedal_simulation_left_leg_fk_pos
```

Functions

joint_state_callback(*joint_data joint_data*)
Documentation for a function.

This function collects the current status of the joint-angles and saves them in the global dictionary "joint_status_data".

import_joint_trajectory_record()
Documentation for a function.

Collects and saves all joint- and pedal-angles from the pre-captured trajectory from the (global variable).

get_joint_position(*jointName jointName*)
Documentation for a function.

Return current joint-angle of .

get_joint_velocity(*jointName jointName*)
Documentation for a function.

Return current joint-velocity of .

get_position(*endeffector endeffector*, *frame frame*)
Documentation for a function.

Return the postion of the of the correspondent .

set_joint_controller_parameters(*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)
Documentation for a function.

Sets Kp of joint-controller to Sets Kd of joint-controller to

get_position_left_foot()
Documentation for a function.

Return the position of the left foot of Roboy.

get_position_left_foot_with_coord_trans()

get_position_right_foot()
Documentation for a function.

Return the position of the right foot of Roboy.

get_distance(*point1 point1*, *point2 point2*)
Documentation for a function.

Return the distance between two points where points are a list of two coordinates.

check_output_limits(*inputVal inputVal*)
Documentation for a function.

Checks if is inside possible range of joint-angle velocities. If not, returns max-velocity if too high or min-velocity if to low instead of .

compute_velocity(*joint_name joint_name*, *next_joint_angle next_joint_angle*, *current_joint_angle current_joint_angle*, *end_time end_time*)
Documentation for a function.

Returns ideal joint-velocity for according to and joint-angle-difference between and :

ideal_velocity = joint_angle_difference / (end_time - current_time)

get_joint_angle (*joint_name joint_name*, *pedal_angle pedal_angle*)
Documentation for a function.

Evaluate and return joint-angle of correspondent to using the interpolated function:

The functions can be used by calling "<function_name>(<pedal_angle>)" ==> returns <joint_angle>

interpolate_functions ()
Documentation for a function.

Initializing interpolated functions for joint-angles using pre-captured set points with pedal-angle as input and joint-angle as output:

The functions can be used by calling "<function_name>(<pedal_angle>)" ==> returns <joint_angle>

evaluate_current_pedal_angle (*current_point current_point*)
Documentation for a function.

Evaluating the current pedal-angle according to the current position of the left foot . Using trigonometric functions for the evaluation of the angle.

publish_velocity (*joint_name joint_name*, *next_joint_angle next_joint_angle*, *current_joint_angle current_joint_angle*, *end_time end_time*)
Documentation for a function.

For joint :

- Evaluate ideal velocity in rad/s according to joint-angle-difference and end-time of transition
- Multiply value with (global variable) to receive velocity in rad/s
- Multiply value with (global variable) to slow down simulation time.
- Multiply value with (global variable) of correspondent joint to erase joint-error
- Publish velocity to joint-controller and sleep until end-time of transition

update_velocity (*velocity_Twist velocity_Twist*)
Documentation for a function.

Updates the global variables , and TRAJECTORY_POINT_DURATION when a bike-velocity gets published to the topic "cmd_vel".

get_angle_difference (*angle_1 angle_1*, *angle_2 angle_2*)
Documentation for a function.

Returns the absolute difference of two angles within the interval [0;2pi]

control_pedaling ()
Documentation for a function.

Controls the whole pedaling-process.

Evaluates next pedal-angle according to current pedal-angle and (global variable). Uses to compute joint-velocities for every joint-angle for every transition between two. trajectory points.

Use Threads to simultaneously publish and control joint-angles.

Computes joint-angle-error and adjusts error-factors for every joint to optimize ideal joint-velocity for further transitions.

Simplified Pseudo-Code:

while bike_velocity = 0:

```
for joint in joints:

    publish(0)

sleep()
```

current_pedal_angle = get_current_pedal_angle(left_foot_position)

next_pedal_angle = current_pedal_angle + (2pi / number_circulation_points)

for joint in joints:

```
next_joint_angle = interpolation_function(next_pedal_angle)

Thread.publish_velocity(joint_name, current_joint_angle, next_joint_angle,␣
↪end_time)
```

for Thread in created_threads:

```
Thread.join
```

for joint in joints:

```
update_error_factor()
```

main()

Documentation for a function.

Initializes the Control-Node for Pedaling and starts Pedaling-Algorithm.

Variables

bool pedal_simulation_left_leg_fk_pos.PRINT_DEBUG = True

float pedal_simulation_left_leg_fk_pos.SIMULATION_FACTOR = 100.0

int pedal_simulation_left_leg_fk_pos.NUMBER_CIRCULATION_POINTS = 30

string pedal_simulation_left_leg_fk_pos.RECORDED_TRAJECTORY_FILENAME = "trajectory_pe

float pedal_simulation_left_leg_fk_pos.JOINT_VELOCITY_FACTOR_SIMULATION = 0.008

float pedal_simulation_left_leg_fk_pos.PEDAL_POSITION_ERROR_TOLERANCE = 0.02

float pedal_simulation_left_leg_fk_pos.JOINT_TRAJECTORY_ERROR_TOLERANCE = 0.02

int pedal_simulation_left_leg_fk_pos.CONTROLLER_FREQUENCY = 100

float pedal_simulation_left_leg_fk_pos.MIN_JOINT_VEL = -10.0

float pedal_simulation_left_leg_fk_pos.MAX_JOINT_VEL = 10.0

float pedal_simulation_left_leg_fk_pos.RADIUS_BACK_TIRE = 0.294398

float pedal_simulation_left_leg_fk_pos.RADIUS_GEAR_CLUSTER = 0.06

float pedal_simulation_left_leg_fk_pos.RADIUS_FRONT_CHAIN_RING = 0.075

float pedal_simulation_left_leg_fk_pos.OLD_X_OFFSET = 0.7163902600571725 + 0.23003546

float pedal_simulation_left_leg_fk_pos.OLD_Y_OFFSET = -0.010388552466272516 + 0.01038

float pedal_simulation_left_leg_fk_pos.OLD_Z_OFFSET = 0.2164376942146126 - 0.20527069

```
float pedal_simulation_left_leg_fk_pos.NEW_X_OFFSET =  -0.23003546880974085 + (-0.7163
float pedal_simulation_left_leg_fk_pos.NEW_Y_OFFSET =  -0.010388308215364166 + (0.0103
float pedal_simulation_left_leg_fk_pos.NEW_Z_OFFSET =  -0.2052706960113988 + (0.216437
float pedal_simulation_left_leg_fk_pos.DIFF_X_OFFSET =  NEW_X_OFFSET - OLD_X_OFFSET
float pedal_simulation_left_leg_fk_pos.DIFF_Y_OFFSET =  NEW_Y_OFFSET - OLD_Y_OFFSET
float pedal_simulation_left_leg_fk_pos.DIFF_Z_OFFSET =  NEW_Z_OFFSET - OLD_Z_OFFSET
float pedal_simulation_left_leg_fk_pos.BIKE_VELOCITY =  0.0
float pedal_simulation_left_leg_fk_pos.PEDAL_SINGLE_ROTATION_DURATION =  20.0
float pedal_simulation_left_leg_fk_pos.TRAJECTORY_POINT_DURATION =  0.0
list pedal_simulation_left_leg_fk_pos.x_pedal_record =  [ ]
list pedal_simulation_left_leg_fk_pos.y_pedal_record =  [ ]
string pedal_simulation_left_leg_fk_pos.ROS_JOINT_HIP_RIGHT =  "joint_hip_right"
string pedal_simulation_left_leg_fk_pos.ROS_JOINT_KNEE_RIGHT =  "joint_knee_right"
string pedal_simulation_left_leg_fk_pos.ROS_JOINT_ANKLE_RIGHT =  "joint_foot_right"
string pedal_simulation_left_leg_fk_pos.ROS_JOINT_HIP_LEFT =  "joint_hip_left"
string pedal_simulation_left_leg_fk_pos.ROS_JOINT_KNEE_LEFT =  "joint_knee_left"
string pedal_simulation_left_leg_fk_pos.ROS_JOINT_ANKLE_LEFT =  "joint_foot_left"
string pedal_simulation_left_leg_fk_pos.RIGHT_HIP_JOINT =  "right_hip"
string pedal_simulation_left_leg_fk_pos.RIGHT_KNEE_JOINT =  "right_knee"
string pedal_simulation_left_leg_fk_pos.RIGHT_ANKLE_JOINT =  "right_ankle"
string pedal_simulation_left_leg_fk_pos.LEFT_HIP_JOINT =  "left_hip"
string pedal_simulation_left_leg_fk_pos.LEFT_KNEE_JOINT =  "left_knee"
string pedal_simulation_left_leg_fk_pos.LEFT_ANKLE_JOINT =  "left_ankle"
pedal_simulation_left_leg_fk_pos.f_interpolated_hip_right =  None
pedal_simulation_left_leg_fk_pos.f_interpolated_hip_left =  None
pedal_simulation_left_leg_fk_pos.f_interpolated_knee_right =  None
pedal_simulation_left_leg_fk_pos.f_interpolated_knee_left =  None
pedal_simulation_left_leg_fk_pos.f_interpolated_ankle_right =  None
pedal_simulation_left_leg_fk_pos.f_interpolated_ankle_left =  None
pedal_simulation_left_leg_fk_pos.f_interpolated_pedal_angle =  None
float pedal_simulation_left_leg_fk_pos.velocity_error_factor_hip =  1.0
float pedal_simulation_left_leg_fk_pos.velocity_error_factor_knee =  1.0
float pedal_simulation_left_leg_fk_pos.velocity_error_factor_ankle =  1.0
int pedal_simulation_left_leg_fk_pos.velocity_error_counter =  0
pedal_simulation_left_leg_fk_pos.ros_right_hip_publisher =  rospy.Publisher('/joint_hi
pedal_simulation_left_leg_fk_pos.ros_right_knee_publisher =  rospy.Publisher('/joint_k
```

```
pedal_simulation_left_leg_fk_pos.ros_right_ankle_publisher =  rospy.Publisher('/joint_
pedal_simulation_left_leg_fk_pos.ros_left_hip_publisher =  rospy.Publisher('/joint_hip
pedal_simulation_left_leg_fk_pos.ros_left_knee_publisher =  rospy.Publisher('/joint_kn
pedal_simulation_left_leg_fk_pos.ros_left_ankle_publisher =  rospy.Publisher('/joint_f
float pedal_simulation_left_leg_fk_pos.PEDAL_CENTER_OFFSET_X =  0.0002782913867391912
float pedal_simulation_left_leg_fk_pos.PEDAL_CENTER_OFFSET_Y =  -0.035131649555820536
float pedal_simulation_left_leg_fk_pos.PEDAL_CENTER_OFFSET_Z =  0.0010093313481022886
list pedal_simulation_left_leg_fk_pos._jointsList=  [ LEFT_HIP_JOINT, LEFT_KNEE_JOINT,
dictionary pedal_simulation_left_leg_fk_pos._parametersRightHip=  {    "param_p": 1500
dictionary pedal_simulation_left_leg_fk_pos._parametersRightKnee=  {    "param_p": 200
dictionary pedal_simulation_left_leg_fk_pos._parametersRightAnkle=  {    "param_p": 10
dictionary pedal_simulation_left_leg_fk_pos._parametersLeftHip=  {    "param_p": 1500.
dictionary pedal_simulation_left_leg_fk_pos._parametersLeftKnee=  {    "param_p": 2000
dictionary pedal_simulation_left_leg_fk_pos._parametersLeftAnkle=  {    "param_p": 100
dictionary pedal_simulation_left_leg_fk_pos._jointsControlData=  {    RIGHT_HIP_JOINT:
dictionary pedal_simulation_left_leg_fk_pos.joint_status_data=  {    RIGHT_HIP_JOINT:
int pedal_simulation_left_leg_fk_pos.number_imported_trajectory_points =  -1
int pedal_simulation_left_leg_fk_pos.trajectoryStartingPoint =  0
list pedal_simulation_left_leg_fk_pos.pedalTrajectoryRight =  [ ]
list pedal_simulation_left_leg_fk_pos.pedalAngleTrajectoryLeft =  []
list pedal_simulation_left_leg_fk_pos.pedalTrajectoryLeft =  [ ]
list pedal_simulation_left_leg_fk_pos.hipTrajectoryRight =  [ ]
list pedal_simulation_left_leg_fk_pos.kneeTrajectoryRight =  [ ]
list pedal_simulation_left_leg_fk_pos.ankleTrajectoryRight =  [ ]
list pedal_simulation_left_leg_fk_pos.hipTrajectoryLeft =  [ ]
list pedal_simulation_left_leg_fk_pos.kneeTrajectoryLeft =  [ ]
list pedal_simulation_left_leg_fk_pos.ankleTrajectoryLeft =  [ ]
```

namespace pedaling

Documentation for this module.

Control of Roboys' hip, knees and feet for pedaling. In order to reach the requested bike-velocity, we compute correspondent angular-velocity for the pedals. The circulation is ideally divided into trajectory points represented by angles within the circulation circle (pedal-angle). With angle-difference between two points and angular-velocity we use the correspondent transition time to control the joints in order to create a pedaling motion for Roboy.

For every joint, we use cubic spline interpolation of pre-captured set points with pedal_angle as input to receive continuous function to be able to get the corresponding joint-angle for every pedal-angle. This enables to use joint-angle-difference between two trajectory-points and transition time to compute and apply velocity-control to the joint-angles to create pedaling-motion

In order to decrease and hopefully erase velocity-error, we multiply the computed (ideal) velocity with an error-factor which is computed and dependent on the velocity-error of previous transitions and measured by pedal-angle-error

Test-script for testing the accuracy of a requested velocity and the transition-time (acceleration) between two different velocities, which is only important for testing in reality, because there is no transition-time between different velocities in simulation.

and determine the time-steps in seconds for the measurement of velocity and determine the size of a step between two different velocities in m/s

namespace qpOASES

namespace roboython

Functions

compute_leg_length(*hip_angle hip_angle*, *knee_angle knee_angle*, *ankle_angle ankle_angle*)

get_pedal_position_x(*pedal_angle pedal_angle*)

get_pedal_position_y(*pedal_angle pedal_angle*)

compute_distance(*x1 x1*, *y1 y1*, *x2 x2*, *y2 y2*)

Variables

int roboython.corner_angle = math.pi/2

float roboython.thigh_along = 309.75

float roboython.thigh_across = 7.46

float roboython.leg_along = 347.50

float roboython.leg_across = 7.0

float roboython.foot_along = 110.0

float roboython.foot_across = 47.0

float roboython.pedal_offset = 11.88

float roboython.pedal_radius = 169.24

roboython.maximum_length = compute_leg_length(0, 0, -(math.pi/4))

roboython.minimum_length = compute_leg_length(math.pi/2, 2*math.pi/3, (math.pi/4))

roboython.length_difference = maximum_length - minimum_length

list roboython.candidate_x_list = []

list roboython.candidate_y_list = []

list roboython.confirmed_hip_positions = [[]]

list roboython.confirmed_x_positions = []

list roboython.confirmed_y_positions = []

int roboython.N_ANGLES_CHECKED = 36

int roboython.discarded = 0

```
    roboython.pedal_x =  get_pedal_position_x(pedal_angle_iter*math.pi*2/N_ANGLES_CHECKED)
    roboython.pedal_y =  get_pedal_position_y(pedal_angle_iter * math.pi * 2 / N_ANGLES_CH
    roboython.this_distance =  compute_distance(pedal_x, pedal_y, candidate_x, candidate_y
namespace state_machine
```

Functions

importJointTrajectoryRecord()
UTILITY FUNCTIONS ###.

importJointPIDParameters()

setJointVelocity(*jointName jointName*, *jointVel jointVel*)

getJointVelocity(*jointName jointName*)

getJointPosition(*jointName jointName*)

getPedalPosition()

getDistance(*point1 point1*, *point2 point2*)

setPedalSingleRotationDuration(*new_duration_seconds new_duration_seconds*)

setTrajectoryPointDuration()

interpolateTrajectoryPoints(*jointName jointName*, *value1 value1*, *value2 value2*, *startTime startTime*, *currTime currTime*, *endTime endTime*)

FSM()

computeVelocitySetpoint(*jointName jointName*, *currPos currPos*, *currTime currTime*, *goalPos goalPos*)
CONTROL FUNCTIONS ###.

main()
MAIN ###.

Variables

string state_machine.CONTROL_PARAMETERS_FILENAME = "control_parameters_ddr.json"
MODULE PARAMETERS ###.

string state_machine.RECORDED_TRAJECTORY_FILENAME = "recorded_trajectory_ddr.json"

int state_machine.PEDAL_POSITION_ERROR_TOLERANCE = 10

int state_machine.PEDAL_SINGLE_ROTATION_DURATION = 10

int state_machine.TRAJECTORY_POINT_DURATION = 0

int state_machine.CONTROLLER_FREQUENCY = 20

float state_machine.TESTING_VELOCITY1 = 0.0
GLOBAL VARIABLES ###.

string state_machine.RIGHT_HIP_JOINT = "right_hip"

string state_machine.RIGHT_KNEE_JOINT = "right_knee"

string state_machine.RIGHT_ANKLE_JOINT = "right_ankle"

string state_machine.LEFT_HIP_JOINT = "left_hip"

string state_machine.LEFT_KNEE_JOINT = "left_knee"

string state_machine.LEFT_ANKLE_JOINT = "left_ankle"

list state_machine._jointsList = [RIGHT_HIP_JOINT, RIGHT_KNEE_JOINT, RIGHT_ANKLE_JOIN

dictionary state_machine._parametersRightHip= { "param_p": 1.0, "para

dictionary state_machine._parametersRightKnee= { "param_p": 1.0, "pa

dictionary state_machine._parametersRightAnkle= { "param_p": 1.0, "p

dictionary state_machine._parametersLeftHip= { "param_p": 1.0, "paran

dictionary state_machine._parametersLeftKnee= { "param_p": 1.0, "para

dictionary state_machine._parametersLeftAnkle= { "param_p": 1.0, "pa

dictionary state_machine._jointsControlData= { RIGHT_HIP_JOINT: _parametersRigh

int state_machine._numTrajectoryPoints = 0

int state_machine._trajectoryStartingPoint = 0

list state_machine._pedalTrajectory = []

list state_machine._hipTrajectory = []

list state_machine._kneeTrajectory = []

list state_machine._ankleTrajectory = []

string state_machine.INIT = "INIT"
STATE MACHINE ###.

string state_machine.PEDAL = "PEDAL"

string state_machine.UPDATE_PARAMETERS = "UPDATE_PARAMETERS"

namespace std

namespace steering
Documentation for this module.

Control of Roboys' shoulders, elbows and wrists for steering. In order to reach the requested steering-angle we target intermediate points between the current and the requested steering-angle to ensure Roboys' hands are following the captured steering-trajectory.

In order to target a point on the steering-trajectory for the hands, we use an interpolation-function for the joint angles with steering-angle as input that uses precomputed set-points of all joint-angles according to a certain steering-angle.

Test-script for testing the transition-time between two different-steering-angles. Accuracy-measurement is not important as we are using position-control for the joint-angles and assume they are working.

determines the amount of steps for measurement between min and max angle. The program saves all transition-times between two angles going from min to max and from max to min anngle and saves them in two separate lists.

namespace steering_capture_multiple_trajectories

Functions

setJointControllerParameters (*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)
UTILITY FUNCTIONS ###.

computeSteeringAngles ()

computeHandTrajectories ()

getPositionLeftHand ()

getPositionRightHand ()

jointStateCallback (*joint_data joint_data*)

inverse_kinematics_client (*endeffector endeffector*, *frame frame*, *x x*, *y y*, *z z*, *roll roll*, *pitch pitch*, *yaw yaw*)

main ()
MAIN ###.

Variables

int steering_capture_multiple_trajectories.MAX_TURNING_ANGLE = math.pi / 15
FUNCTION PARAMETERS ###.

int steering_capture_multiple_trajectories.NUM_STEERING_ANGLES = 61

int steering_capture_multiple_trajectories.POINT_MULTIPLICITY = 50

string steering_capture_multiple_trajectories.JSON_FILENAME = "multiple_steering_traj

float steering_capture_multiple_trajectories.JOINT_ANGLE_TOLERANCE_FK = 0.01

string steering_capture_multiple_trajectories.ENDEFFECTOR_RIGHT = "right_hand"

string steering_capture_multiple_trajectories.FRAME_RIGHT = "right_hand"

string steering_capture_multiple_trajectories.ENDEFFECTOR_LEFT = "left_hand"

string steering_capture_multiple_trajectories.FRAME_LEFT = "left_hand"

int steering_capture_multiple_trajectories.BIKE_OFFSET_X = 0
MEASURED PARAMETERS ###.

int steering_capture_multiple_trajectories.BIKE_OFFSET_Y = 0

int steering_capture_multiple_trajectories.BIKE_OFFSET_Z = 0

float steering_capture_multiple_trajectories.RIKSHAW_TURN_JOINT_X_OFFSET = 0.71639026

float steering_capture_multiple_trajectories.RIKSHAW_TURN_JOINT_Y_OFFSET = -0.0103885

float steering_capture_multiple_trajectories.RIKSHAW_TURN_JOINT_Z_OFFSET = 0.21643769

int steering_capture_multiple_trajectories.YAW_RIGHT_HAND_OFFSET = math.pi / 2 + math

int steering_capture_multiple_trajectories.YAW_LEFT_HAND_OFFSET = 3 * math.pi / 2 + ma

float steering_capture_multiple_trajectories.HANDLEBAR_X_OFFSET = 0.728713

float steering_capture_multiple_trajectories.HANDLEBAR_Z_OFFSET = 0.719269

float steering_capture_multiple_trajectories.HAND_Y_OFFSET = 0.2

list steering_capture_multiple_trajectories._steeringAngles = []
GLOBAL VARIABLES ###.

```
    list steering_capture_multiple_trajectories._rightHandTrajectory =  []
    list steering_capture_multiple_trajectories._leftHandTrajectory =  []
    list steering_capture_multiple_trajectories._centerHandlebarTrajectory =  []
    string steering_capture_multiple_trajectories.JOINT_SHOULDER_AXIS0_RIGHT =  "right_sho
    string steering_capture_multiple_trajectories.JOINT_SHOULDER_AXIS1_RIGHT =  "right_sho
    string steering_capture_multiple_trajectories.JOINT_SHOULDER_AXIS2_RIGHT =  "right_sho
    string steering_capture_multiple_trajectories.JOINT_SHOULDER_AXIS0_LEFT =  "left_shoul
    string steering_capture_multiple_trajectories.JOINT_SHOULDER_AXIS1_LEFT =  "left_shoul
    string steering_capture_multiple_trajectories.JOINT_SHOULDER_AXIS2_LEFT =  "left_shoul
    string steering_capture_multiple_trajectories.JOINT_ELBOW_ROT0_RIGHT =  "elbow_right_r
    string steering_capture_multiple_trajectories.JOINT_ELBOW_ROT1_RIGHT =  "elbow_right_r
    string steering_capture_multiple_trajectories.JOINT_ELBOW_ROT0_LEFT =  "elbow_left_rot
    string steering_capture_multiple_trajectories.JOINT_ELBOW_ROT1_LEFT =  "elbow_left_rot
    string steering_capture_multiple_trajectories.JOINT_WRIST_0_RIGHT =  "right_wrist_0"
    string steering_capture_multiple_trajectories.JOINT_WRIST_1_RIGHT =  "right_wrist_1"
    string steering_capture_multiple_trajectories.JOINT_WRIST_0_LEFT =  "left_wrist_0"
    string steering_capture_multiple_trajectories.JOINT_WRIST_1_LEFT =  "left_wrist_1"
    list steering_capture_multiple_trajectories.JOINT_LIST=  [JOINT_SHOULDER_AXIS0_RIGHT, 
    dictionary steering_capture_multiple_trajectories._jointsStatusData
namespace steering_capture_trajectory
```

Functions

computeSteeringAngles()
UTILITY FUNCTIONS ###.

computeHandTrajectories()

getPositionLeftHand()

getPositionRightHand()

setJointControllerParameters(*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)

jointStateCallback(*joint_data joint_data*)

inverse_kinematics_client(*endeffector endeffector*, *frame frame*, *x x*, *y y*, *z z*, *roll roll*, *pitch pitch*, *yaw yaw*)

main()
MAIN ###.

Variables

int steering_capture_trajectory.MAX_TURNING_ANGLE = math.pi / 15
FUNCTION PARAMETERS ###.

int steering_capture_trajectory.NUM_STEERING_ANGLES = 61

float steering_capture_trajectory.RIKSHAW_TURN_JOINT_X_OFFSET = 0.7163902600571725 +

float steering_capture_trajectory.RIKSHAW_TURN_JOINT_Y_OFFSET = -0.010388552466272516

float steering_capture_trajectory.RIKSHAW_TURN_JOINT_Z_OFFSET = 0.2164376942146126 -

int steering_capture_trajectory.YAW_RIGHT_HAND_OFFSET = math.pi / 2 + math.pi

int steering_capture_trajectory.YAW_LEFT_HAND_OFFSET = 3 * math.pi / 2 + math.pi

float steering_capture_trajectory.HANDLEBAR_X_OFFSET = 0.728713

float steering_capture_trajectory.HANDLEBAR_Z_OFFSET = 0.719269

float steering_capture_trajectory.HAND_Y_OFFSET = 0.2

string steering_capture_trajectory.JSON_FILENAME = "steering_trajectory.json"

float steering_capture_trajectory.JOINT_ANGLE_TOLERANCE_FK = 0.01

string steering_capture_trajectory.ENDEFFECTOR_RIGHT = "right_hand"

string steering_capture_trajectory.FRAME_RIGHT = "right_hand"

string steering_capture_trajectory.ENDEFFECTOR_LEFT = "left_hand"

string steering_capture_trajectory.FRAME_LEFT = "left_hand"

int steering_capture_trajectory.BIKE_OFFSET_X = 0
MEASURED PARAMETERS ###.

int steering_capture_trajectory.BIKE_OFFSET_Y = 0

int steering_capture_trajectory.BIKE_OFFSET_Z = 0

list steering_capture_trajectory._steeringAngles = []
GLOBAL VARIABLES ###.

list steering_capture_trajectory._rightHandTrajectory = []

list steering_capture_trajectory._leftHandTrajectory = []

list steering_capture_trajectory._centerHandlebarTrajectory = []

string steering_capture_trajectory.JOINT_SHOULDER_AXIS0_RIGHT = "right_shoulder_axis0

string steering_capture_trajectory.JOINT_SHOULDER_AXIS1_RIGHT = "right_shoulder_axis1

string steering_capture_trajectory.JOINT_SHOULDER_AXIS2_RIGHT = "right_shoulder_axis2

string steering_capture_trajectory.JOINT_SHOULDER_AXIS0_LEFT = "left_shoulder_axis0"

string steering_capture_trajectory.JOINT_SHOULDER_AXIS1_LEFT = "left_shoulder_axis1"

string steering_capture_trajectory.JOINT_SHOULDER_AXIS2_LEFT = "left_shoulder_axis2"

string steering_capture_trajectory.JOINT_ELBOW_ROT0_RIGHT = "elbow_right_rot0"

string steering_capture_trajectory.JOINT_ELBOW_ROT1_RIGHT = "elbow_right_rot1"

string steering_capture_trajectory.JOINT_ELBOW_ROT0_LEFT = "elbow_left_rot0"

string steering_capture_trajectory.JOINT_ELBOW_ROT1_LEFT = "elbow_left_rot1"

```
    string steering_capture_trajectory.JOINT_WRIST_0_RIGHT =  "right_wrist_0"
    string steering_capture_trajectory.JOINT_WRIST_1_RIGHT =  "right_wrist_1"
    string steering_capture_trajectory.JOINT_WRIST_0_LEFT =  "left_wrist_0"
    string steering_capture_trajectory.JOINT_WRIST_1_LEFT =  "left_wrist_1"
    list steering_capture_trajectory.JOINT_LIST=  [JOINT_SHOULDER_AXIS0_RIGHT, JOINT_SHOULD
    dictionary steering_capture_trajectory._jointsStatusData
namespace steering_interpolate_and_print
```

Functions

importJointTrajectoryRecord()
UTILITY FUNCTIONS ###.

interpolateAllJointPositions()

printInterpolatedFunctions()

main()
MAIN ###.

Variables

```
string steering_interpolate_and_print.RECORDED_TRAJECTORY_FILENAME =  "steering_trajec
```
MODULE PARAMETERS ###.

```
bool steering_interpolate_and_print.PRINT_DEBUG =  True
string steering_interpolate_and_print.JOINT_SHOULDER_AXIS0_RIGHT =  "right_shoulder_ax
```
GLOBAL VARIABLES ###.

```
string steering_interpolate_and_print.JOINT_SHOULDER_AXIS1_RIGHT =  "right_shoulder_ax
string steering_interpolate_and_print.JOINT_SHOULDER_AXIS2_RIGHT =  "right_shoulder_ax
string steering_interpolate_and_print.JOINT_SHOULDER_AXIS0_LEFT =  "left_shoulder_axis
string steering_interpolate_and_print.JOINT_SHOULDER_AXIS1_LEFT =  "left_shoulder_axis
string steering_interpolate_and_print.JOINT_SHOULDER_AXIS2_LEFT =  "left_shoulder_axis
string steering_interpolate_and_print.JOINT_ELBOW_ROT0_RIGHT =  "elbow_right_rot0"
string steering_interpolate_and_print.JOINT_ELBOW_ROT1_RIGHT =  "elbow_right_rot1"
string steering_interpolate_and_print.JOINT_ELBOW_ROT0_LEFT =  "elbow_left_rot0"
string steering_interpolate_and_print.JOINT_ELBOW_ROT1_LEFT =  "elbow_left_rot1"
string steering_interpolate_and_print.JOINT_WRIST_0_RIGHT =  "right_wrist_0"
string steering_interpolate_and_print.JOINT_WRIST_1_RIGHT =  "right_wrist_1"
string steering_interpolate_and_print.JOINT_WRIST_0_LEFT =  "left_wrist_0"
string steering_interpolate_and_print.JOINT_WRIST_1_LEFT =  "left_wrist_1"
int steering_interpolate_and_print._numTrajectoryPoints =  0
list steering_interpolate_and_print._trajectorySteering =  []
```

```
    list steering_interpolate_and_print._trajectoryShoulder0Right =  []
    list steering_interpolate_and_print._trajectoryShoulder1Right =  []
    list steering_interpolate_and_print._trajectoryShoulder2Right =  []
    list steering_interpolate_and_print._trajectoryShoulder0Left =  []
    list steering_interpolate_and_print._trajectoryShoulder1Left =  []
    list steering_interpolate_and_print._trajectoryShoulder2Left =  []
    list steering_interpolate_and_print._trajectoryElbow0Right =  []
    list steering_interpolate_and_print._trajectoryElbow1Right =  []
    list steering_interpolate_and_print._trajectoryElbow0Left =  []
    list steering_interpolate_and_print._trajectoryElbow1Left =  []
    list steering_interpolate_and_print._trajectoryWrist0Right =  []
    list steering_interpolate_and_print._trajectoryWrist1Right =  []
    list steering_interpolate_and_print._trajectoryWrist0Left =  []
    list steering_interpolate_and_print._trajectoryWrist1Left =  []
    steering_interpolate_and_print._interpolatedShoulder0Right =  None
    steering_interpolate_and_print._interpolatedShoulder1Right =  None
    steering_interpolate_and_print._interpolatedShoulder2Right =  None
    steering_interpolate_and_print._interpolatedShoulder0Left =  None
    steering_interpolate_and_print._interpolatedShoulder1Left =  None
    steering_interpolate_and_print._interpolatedShoulder2Left =  None
    steering_interpolate_and_print._interpolatedElbow0Right =  None
    steering_interpolate_and_print._interpolatedElbow1Right =  None
    steering_interpolate_and_print._interpolatedElbow0Left =  None
    steering_interpolate_and_print._interpolatedElbow1Left =  None
    steering_interpolate_and_print._interpolatedWrist0Right =  None
    steering_interpolate_and_print._interpolatedWrist1Right =  None
    steering_interpolate_and_print._interpolatedWrist0Left =  None
    steering_interpolate_and_print._interpolatedWrist1Left =  None
namespace steering_interpolate_multiple_trajectories_and_print
```

Functions

importJointTrajectoryRecord()
UTILITY FUNCTIONS ###.

regressAllJointPositions(*order order*)

printRegressedFunctions()

printAllTrajectories()

saveRegressionToFile (*filename filename*, *order order*)

main ()
MAIN ###.

Variables

string steering_interpolate_multiple_trajectories_and_print.RECORDED_TRAJECTORY_FILENA
MODULE PARAMETERS ###.

bool steering_interpolate_multiple_trajectories_and_print.PRINT_DEBUG = True

int steering_interpolate_multiple_trajectories_and_print.MAX_TURNING_ANGLE = math.pi

string steering_interpolate_multiple_trajectories_and_print.JOINT_SHOULDER_AXIS0_RIGHT
GLOBAL VARIABLES ###.

string steering_interpolate_multiple_trajectories_and_print.JOINT_SHOULDER_AXIS1_RIGHT

string steering_interpolate_multiple_trajectories_and_print.JOINT_SHOULDER_AXIS2_RIGHT

string steering_interpolate_multiple_trajectories_and_print.JOINT_SHOULDER_AXIS0_LEFT =

string steering_interpolate_multiple_trajectories_and_print.JOINT_SHOULDER_AXIS1_LEFT =

string steering_interpolate_multiple_trajectories_and_print.JOINT_SHOULDER_AXIS2_LEFT =

string steering_interpolate_multiple_trajectories_and_print.JOINT_ELBOW_ROT0_RIGHT =

string steering_interpolate_multiple_trajectories_and_print.JOINT_ELBOW_ROT1_RIGHT =

string steering_interpolate_multiple_trajectories_and_print.JOINT_ELBOW_ROT0_LEFT = "

string steering_interpolate_multiple_trajectories_and_print.JOINT_ELBOW_ROT1_LEFT = "

string steering_interpolate_multiple_trajectories_and_print.JOINT_WRIST_0_RIGHT = "ri

string steering_interpolate_multiple_trajectories_and_print.JOINT_WRIST_1_RIGHT = "ri

string steering_interpolate_multiple_trajectories_and_print.JOINT_WRIST_0_LEFT = "lef

string steering_interpolate_multiple_trajectories_and_print.JOINT_WRIST_1_LEFT = "lef

int steering_interpolate_multiple_trajectories_and_print._numTrajectoryPoints = 0

list steering_interpolate_multiple_trajectories_and_print._trajectorySteering = []

list steering_interpolate_multiple_trajectories_and_print._trajectoryShoulder0Right =

list steering_interpolate_multiple_trajectories_and_print._trajectoryShoulder1Right =

list steering_interpolate_multiple_trajectories_and_print._trajectoryShoulder2Right =

list steering_interpolate_multiple_trajectories_and_print._trajectoryShoulder0Left =

list steering_interpolate_multiple_trajectories_and_print._trajectoryShoulder1Left =

list steering_interpolate_multiple_trajectories_and_print._trajectoryShoulder2Left =

list steering_interpolate_multiple_trajectories_and_print._trajectoryElbow0Right = []

list steering_interpolate_multiple_trajectories_and_print._trajectoryElbow1Right = []

list steering_interpolate_multiple_trajectories_and_print._trajectoryElbow0Left = []

list steering_interpolate_multiple_trajectories_and_print._trajectoryElbow1Left = []

list steering_interpolate_multiple_trajectories_and_print._trajectoryWrist0Right = []

list steering_interpolate_multiple_trajectories_and_print._trajectoryWrist1Right = []

list steering_interpolate_multiple_trajectories_and_print._trajectoryWrist0Left = []

list steering_interpolate_multiple_trajectories_and_print._trajectoryWrist1Left = []

steering_interpolate_multiple_trajectories_and_print._regressedShoulder0Right = None

steering_interpolate_multiple_trajectories_and_print._regressedShoulder1Right = None

steering_interpolate_multiple_trajectories_and_print._regressedShoulder2Right = None

steering_interpolate_multiple_trajectories_and_print._regressedShoulder0Left = None

steering_interpolate_multiple_trajectories_and_print._regressedShoulder1Left = None

steering_interpolate_multiple_trajectories_and_print._regressedShoulder2Left = None

steering_interpolate_multiple_trajectories_and_print._regressedElbow0Right = None

steering_interpolate_multiple_trajectories_and_print._regressedElbow1Right = None

steering_interpolate_multiple_trajectories_and_print._regressedElbow0Left = None

steering_interpolate_multiple_trajectories_and_print._regressedElbow1Left = None

steering_interpolate_multiple_trajectories_and_print._regressedWrist0Right = None

steering_interpolate_multiple_trajectories_and_print._regressedWrist1Right = None

steering_interpolate_multiple_trajectories_and_print._regressedWrist0Left = None

steering_interpolate_multiple_trajectories_and_print._regressedWrist1Left = None

namespace steering_response_test

Functions

import_joint_trajectory_record()
Documentation for a function.

Collects and saves all joint- and steering-angles from the pre-captured trajectory from the (global variable).

regress_joint_positions_from_file(*filename filename*)
Documentation for a function.

Initializes the interpolation-functions for every joint-angle using regression. The input value of the function is a steering angle and the output value of the function is the correspondent joint angle.

The functions can be used by calling "<function_name>(<steering_angle>)" ==> returns <joint_angle>

joint_state_callback(*joint_data joint_data*)
Documentation for a function.

This function collects the current status of the joint-angles and saves them in the global dictionary "_jointStatusData".

check_joint_angle(*joint_name joint_name*, *steering_angle steering_angle*)
Documentation for a function.

Checks if joint has reached the joint-angle within error-tolerance corresponding to the steering angle and returns if so or if has been reached.

steering_angle_reached(*steering_angle steering_angle*)
Documentation for a function.

Checks if a steering-angle has been reached with checking if all joint-angles have reached the correspondent joint-angles

steering_test(*pub pub*)
Documentation for a function.

Program for testing the transition-time between two different steering-angles. Saves measurements in lists and displays them using pyplot, or just the average values for all steps in

main()
Documentation for a function.

Initializes the Test-Node for the steering-test

Variables

```
bool steering_response_test.PRINT_DEBUG =  False
list steering_response_test.STEPS_DISTRIBUTION_TEST =  [2, 4, 6, 8]
bool steering_response_test.SHOW_AVERAGE =  True
float steering_response_test.UPDATE_FREQUENCY =  0.01
int steering_response_test.ERROR_TOLERANCE =  np.pi/36
int steering_response_test.INITIAL_STARTING_TIME =  10
int steering_response_test.MAX_TRANSITION_TIME =  5
string steering_response_test.JOINT_SHOULDER_AXIS0_RIGHT =  "right_shoulder_axis0"
string steering_response_test.JOINT_SHOULDER_AXIS1_RIGHT =  "right_shoulder_axis1"
string steering_response_test.JOINT_SHOULDER_AXIS2_RIGHT =  "right_shoulder_axis2"
string steering_response_test.JOINT_SHOULDER_AXIS0_LEFT =  "left_shoulder_axis0"
string steering_response_test.JOINT_SHOULDER_AXIS1_LEFT =  "left_shoulder_axis1"
string steering_response_test.JOINT_SHOULDER_AXIS2_LEFT =  "left_shoulder_axis2"
string steering_response_test.JOINT_ELBOW_ROT0_RIGHT =  "elbow_right_rot0"
string steering_response_test.JOINT_ELBOW_ROT1_RIGHT =  "elbow_right_rot1"
string steering_response_test.JOINT_ELBOW_ROT0_LEFT =  "elbow_left_rot0"
string steering_response_test.JOINT_ELBOW_ROT1_LEFT =  "elbow_left_rot1"
string steering_response_test.JOINT_WRIST_0_RIGHT =  "right_wrist_0"
string steering_response_test.JOINT_WRIST_1_RIGHT =  "right_wrist_1"
string steering_response_test.JOINT_WRIST_0_LEFT =  "left_wrist_0"
string steering_response_test.JOINT_WRIST_1_LEFT =  "left_wrist_1"
dictionary steering_response_test.joint_status_data=  {    JOINT_SHOULDER_AXIS0_LEFT: (
list steering_response_test._joints_list=  [JOINT_SHOULDER_AXIS0_RIGHT, JOINT_SHOULDER_
steering_response_test.ros_right_shoulder_axis0_pub =  rospy.Publisher('/right_shoulde
steering_response_test.ros_right_shoulder_axis1_pub =  rospy.Publisher('/right_shoulde
steering_response_test.ros_right_shoulder_axis2_pub =  rospy.Publisher('/right_shoulde
```

```
steering_response_test.ros_left_shoulder_axis0_pub =  rospy.Publisher('/left_shoulder_
steering_response_test.ros_left_shoulder_axis1_pub =  rospy.Publisher('/left_shoulder_
steering_response_test.ros_left_shoulder_axis2_pub =  rospy.Publisher('/left_shoulder_
steering_response_test.ros_elbow_right_rot0_pub =  rospy.Publisher('/elbow_right_rot0/
steering_response_test.ros_elbow_right_rot1_pub =  rospy.Publisher('/elbow_right_rot1/
steering_response_test.ros_elbow_left_rot0_pub =  rospy.Publisher('/elbow_left_rot0/el
steering_response_test.ros_elbow_left_rot1_pub =  rospy.Publisher('/elbow_left_rot1/el
steering_response_test.ros_right_wrist_0_pub =  rospy.Publisher('/right_wrist_0/right_
steering_response_test.ros_right_wrist_1_pub =  rospy.Publisher('/right_wrist_1/right_
steering_response_test.ros_left_wrist_0_pub =  rospy.Publisher('/left_wrist_0/left_wri
steering_response_test.ros_left_wrist_1_pub =  rospy.Publisher('/left_wrist_1/left_wri
int steering_response_test._numTrajectoryPoints =  0
list steering_response_test._trajectorySteering =  [ ]
list steering_response_test._trajectoryShoulder0Right =  [ ]
list steering_response_test._trajectoryShoulder1Right =  [ ]
list steering_response_test._trajectoryShoulder2Right =  [ ]
list steering_response_test._trajectoryShoulder0Left =  [ ]
list steering_response_test._trajectoryShoulder1Left =  [ ]
list steering_response_test._trajectoryShoulder2Left =  [ ]
list steering_response_test._trajectoryElbow0Right =  [ ]
list steering_response_test._trajectoryElbow1Right =  [ ]
list steering_response_test._trajectoryElbow0Left =  [ ]
list steering_response_test._trajectoryElbow1Left =  [ ]
list steering_response_test._trajectoryWrist0Right =  [ ]
list steering_response_test._trajectoryWrist1Right =  [ ]
list steering_response_test._trajectoryWrist0Left =  [ ]
list steering_response_test._trajectoryWrist1Left =  [ ]
steering_response_test._interpolatedShoulder0Right =  None
steering_response_test._interpolatedShoulder1Right =  None
steering_response_test._interpolatedShoulder2Right =  None
steering_response_test._interpolatedShoulder0Left =  None
steering_response_test._interpolatedShoulder1Left =  None
steering_response_test._interpolatedShoulder2Left =  None
steering_response_test._interpolatedElbow0Right =  None
steering_response_test._interpolatedElbow1Right =  None
steering_response_test._interpolatedElbow0Left =  None
```

```
    steering_response_test._interpolatedElbow1Left =  None
    steering_response_test._interpolatedWrist0Right =  None
    steering_response_test._interpolatedWrist1Right =  None
    steering_response_test._interpolatedWrist0Left =  None
    steering_response_test._interpolatedWrist1Left =  None
    steering_response_test._regressedShoulder0Right =  None
    steering_response_test._regressedShoulder1Right =  None
    steering_response_test._regressedShoulder2Right =  None
    steering_response_test._regressedShoulder0Left =  None
    steering_response_test._regressedShoulder1Left =  None
    steering_response_test._regressedShoulder2Left =  None
    steering_response_test._regressedElbow0Right =  None
    steering_response_test._regressedElbow1Right =  None
    steering_response_test._regressedElbow0Left =  None
    steering_response_test._regressedElbow1Left =  None
    steering_response_test._regressedWrist0Right =  None
    steering_response_test._regressedWrist1Right =  None
    steering_response_test._regressedWrist0Left =  None
    steering_response_test._regressedWrist1Left =  None
    string steering_response_test.RECORDED_TRAJECTORY_FILENAME =  "trajectory_steering/ste
namespace steering_simulation
```

Functions

joint_state_callback(*joint_data joint_data*)
Documentation for a function.

This function collects the current status of the joint-angles and saves them in the global dictionary "_jointStatusData".

get_joint_position(*joint_name joint_name*)
Documentation for a function.

Returns current position of joint-angle . .

regress_joint_positions_from_file(*filename filename*)
Documentation for a function.

Initializes the interpolation-functions for every joint-angle using regression. The input value of the function is a steering angle and the output value of the function is the correspondent joint angle.

The functions can be used by calling "<function_name>(<steering_angle>)" ==> returns <joint_angle>

import_joint_trajectory_record()
Documentation for a function.

Collects and saves all joint- and steering-angles from the pre-captured trajectory from the (global variable).

interpolate_joint_angles()
Documentation for a function.

Initializes the interpolation-functions for every joint-angle using cubic spline interpolation. The input value of the function is a steering angle and the output value of the function the correspondent joint angle.

The functions can be used by calling "<function_name>(<steering_angle>)" ==> returns <joint_angle>

get_angle_difference(*angle_1 angle_1*, *angle_2 angle_2*)
Documentation for a function.

Returns the absolute difference of two angles within the interval [0;2pi]

set_joint_controller_parameters(*proportional_value proportional_value*, *derivative_value derivative_value*)
Documentation for a function.

Sets Kp of joint-controller to Sets Kd of joint-controller to

update_steering_angle(*steering_angle_F32 steering_angle_F32*)
Documentation for a function.

Updates the global variable when another node publishes a new requested steering_angle to the topic "cmd_steering_angle_rickshaw".

check_steering_angle_range(*steering_angle steering_angle*)
Documentation for a function.

Checks if the parameter is within the range of reachable steering-angles of Roboy.

publish_joint_angle(*joint_name joint_name*, *steering_angle steering_angle*)
Documentation for a function.

Evaluates the correspondent joint-angle of to given using the interpolation-function of

Publishes the computed value to the correspondent ros-topic of to apply position control.

Waits until the joint_angle has reached requested joint_angle within error tolerance.

steering_control()
Documentation for a function.

Controls the whole steering-process. Evaluates the target_steering_angles between requested_steering_angle and current_steering_angle and creates a Thread for every joint-angle with which is responsible to apply correspondent joint-angle given current target_steering_angle.

Simplified Pseudo-code:

while requested_steering_angle = current_steering_angle:

```
sleep()
```

if angle_difference(requested_steering_angle, current_steering_angle) > max_angle_change

```
target_steering_angle = current_steering_angle + max_angle_change
```

else:

```
target_steering_angle = requested_steering_angle
```

for joint in joint_list:

```
Thread.publish_joint_angle(joint_name, target_joint_angle)
```

for Thread in created_threads:

```
    Thread.join
```

current_steering_angle = target_steering_angle

main()

Documentation for a function.

Initializes the Control-Node for Steering and starts Steering-Algorithm.

Variables

bool steering_simulation.PRINT_DEBUG = True

string steering_simulation.RECORDED_TRAJECTORY_FILENAME = "trajectory_steering/steeri

float steering_simulation.JOINT_TARGET_ERROR_TOLERANCE = 0.01

float steering_simulation.UPDATE_FREQUENCY = 0.001

int steering_simulation.MAX_ANGLE_CHANGE = np.pi / 72

float steering_simulation.STEP_TRANSITION_TIME = 2.5

string steering_simulation.JOINT_SHOULDER_AXIS0_RIGHT = "right_shoulder_axis0"

string steering_simulation.JOINT_SHOULDER_AXIS1_RIGHT = "right_shoulder_axis1"

string steering_simulation.JOINT_SHOULDER_AXIS2_RIGHT = "right_shoulder_axis2"

string steering_simulation.JOINT_SHOULDER_AXIS0_LEFT = "left_shoulder_axis0"

string steering_simulation.JOINT_SHOULDER_AXIS1_LEFT = "left_shoulder_axis1"

string steering_simulation.JOINT_SHOULDER_AXIS2_LEFT = "left_shoulder_axis2"

string steering_simulation.JOINT_ELBOW_RIGHT = "elbow_right"

string steering_simulation.JOINT_ELBOW_LEFT = "elbow_left"

string steering_simulation.JOINT_WRIST_RIGHT_SPHERE_AXIS0 = "wrist_right_sphere_axis0

string steering_simulation.JOINT_WRIST_RIGHT_SPHERE_AXIS1 = "wrist_right_sphere_axis1

string steering_simulation.JOINT_WRIST_RIGHT_SPHERE_AXIS2 = "wrist_right_sphere_axis2

string steering_simulation.JOINT_WRIST_LEFT_SPHERE_AXIS0 = "wrist_left_sphere_axis0"

string steering_simulation.JOINT_WRIST_LEFT_SPHERE_AXIS1 = "wrist_left_sphere_axis1"

string steering_simulation.JOINT_WRIST_LEFT_SPHERE_AXIS2 = "wrist_left_sphere_axis2"

string steering_simulation.JOINT_BIKE_FRONT = "joint_front"

list steering_simulation._joints_list= [JOINT_SHOULDER_AXIS0_RIGHT, JOINT_SHOULDER_AX

int steering_simulation._numTrajectoryPoints = 0

list steering_simulation._trajectorySteering = []

list steering_simulation._trajectoryShoulder0Right = []

list steering_simulation._trajectoryShoulder1Right = []

list steering_simulation._trajectoryShoulder2Right = []

list steering_simulation._trajectoryShoulder0Left = []

```
list steering_simulation._trajectoryShoulder1Left =  []
list steering_simulation._trajectoryShoulder2Left =  []
list steering_simulation._trajectoryElbowRight =  []
list steering_simulation._trajectoryElbowLeft =  []
list steering_simulation._trajectoryWrist0Right =  []
list steering_simulation._trajectoryWrist1Right =  []
list steering_simulation._trajectoryWrist2Right =  []
list steering_simulation._trajectoryWrist0Left =  []
list steering_simulation._trajectoryWrist1Left =  []
list steering_simulation._trajectoryWrist2Left =  []
steering_simulation._interpolatedShoulder0Right =  None
steering_simulation._interpolatedShoulder1Right =  None
steering_simulation._interpolatedShoulder2Right =  None
steering_simulation._interpolatedShoulder0Left =  None
steering_simulation._interpolatedShoulder1Left =  None
steering_simulation._interpolatedShoulder2Left =  None
steering_simulation._interpolatedElbowRight =  None
steering_simulation._interpolatedElbowLeft =  None
steering_simulation._interpolatedWrist0Right =  None
steering_simulation._interpolatedWrist1Right =  None
steering_simulation._interpolatedWrist2Right =  None
steering_simulation._interpolatedWrist0Left =  None
steering_simulation._interpolatedWrist1Left =  None
steering_simulation._interpolatedWrist2Left =  None
steering_simulation._regressedShoulder0Right =  None
steering_simulation._regressedShoulder1Right =  None
steering_simulation._regressedShoulder2Right =  None
steering_simulation._regressedShoulder0Left =  None
steering_simulation._regressedShoulder1Left =  None
steering_simulation._regressedShoulder2Left =  None
steering_simulation._regressedElbowRight =  None
steering_simulation._regressedElbowLeft =  None
steering_simulation._regressedWrist0Right =  None
steering_simulation._regressedWrist1Right =  None
steering_simulation._regressedWrist2Right =  None
steering_simulation._regressedWrist0Left =  None
```

```
    steering_simulation._regressedWrist1Left =  None
    steering_simulation._regressedWrist2Left =  None
    dictionary steering_simulation._jointsStatusData
    steering_simulation.ros_right_shoulder_axis0_pub=  rospy.Publisher('/right_shoulder_ax
    steering_simulation.ros_right_shoulder_axis1_pub=  rospy.Publisher('/right_shoulder_ax
    steering_simulation.ros_right_shoulder_axis2_pub=  rospy.Publisher('/right_shoulder_ax
    steering_simulation.ros_left_shoulder_axis0_pub =  rospy.Publisher('/left_shoulder_axi
    steering_simulation.ros_left_shoulder_axis1_pub =  rospy.Publisher('/left_shoulder_axi
    steering_simulation.ros_left_shoulder_axis2_pub =  rospy.Publisher('/left_shoulder_axi
    steering_simulation.ros_elbow_right_pub =  rospy.Publisher('/elbow_right/elbow_right/t
    steering_simulation.ros_elbow_left_pub =  rospy.Publisher('/elbow_left/elbow_left/targ
    steering_simulation.ros_right_wrist_0_pub =  rospy.Publisher('/wrist_right_sphere_axis
    steering_simulation.ros_right_wrist_1_pub =  rospy.Publisher('/wrist_right_sphere_axis
    steering_simulation.ros_right_wrist_2_pub =  rospy.Publisher('/wrist_right_sphere_axis
    steering_simulation.ros_left_wrist_0_pub =  rospy.Publisher('/wrist_left_sphere_axis0/
    steering_simulation.ros_left_wrist_1_pub =  rospy.Publisher('/wrist_left_sphere_axis1/
    steering_simulation.ros_left_wrist_2_pub =  rospy.Publisher('/wrist_left_sphere_axis2/
    steering_simulation.ros_bike_front_pub =  rospy.Publisher('/joint_front/joint_front/ta
    steering_simulation.ros_log_error_pub =  rospy.Publisher('chatter', String, queue_size
    int steering_simulation.requested_steering_angle =  0
    bool steering_simulation.angle_change_successful =  True
namespace steering_simulation_old_hand
```

Functions

joint_state_callback (*joint_data joint_data*)
Documentation for a function.

This function collects the current status of the joint-angles and saves them in the global dictionary "_jointStatusData".

get_joint_position (*joint_name joint_name*)
Documentation for a function.

Returns current position of joint-angle . .

regress_joint_positions_from_file (*filename filename*)
Documentation for a function.

Initializes the interpolation-functions for every joint-angle using regression. The input value of the function is a steering angle and the output value of the function is the correspondent joint angle.

The functions can be used by calling "<function_name>(<steering_angle>)" ==> returns <joint_angle>

import_joint_trajectory_record()
Documentation for a function.

Collects and saves all joint- and steering-angles from the pre-captured trajectory from the (global variable).

interpolate_joint_angles()
Documentation for a function.

Initializes the interpolation-functions for every joint-angle using cubic spline interpolation. The input value of the function is a steering angle and the output value of the function the correspondent joint angle.

The functions can be used by calling "<function_name>(<steering_angle>)" ==> returns <joint_angle>

get_angle_difference(*angle_1 angle_1*, *angle_2 angle_2*)
Documentation for a function.

Returns the absolute difference of two angles within the interval [0;2pi]

set_joint_controller_parameters(*proportional_value proportional_value*, *derivative_value derivative_value*)
Documentation for a function.

Sets Kp of joint-controller to Sets Kd of joint-controller to

update_steering_angle(*steering_angle_F32 steering_angle_F32*)
Documentation for a function.

Updates the global variable when another node publishes a new requested steering_angle to the topic "cmd_steering_angle_rickshaw".

check_steering_angle_range(*steering_angle steering_angle*)
Documentation for a function.

Checks if the parameter is within the range of reachable steering-angles of Roboy.

publish_joint_angle(*joint_name joint_name*, *steering_angle steering_angle*)
Documentation for a function.

Evaluates the correspondent joint-angle of to given using the interpolation-function of

Publishes the computed value to the correspondent ros-topic of to apply position control.

Waits until the joint_angle has reached requested joint_angle within error tolerance.

steering_control()
Documentation for a function.

Controls the whole steering-process. Evaluates the target_steering_angles between requested_steering_angle and current_steering_angle and creates a Thread for every joint-angle with which is responsible to apply correspondent joint-angle given current target_steering_angle.

Simplified Pseudo-code:

while requested_steering_angle = current_steering_angle:

```
sleep()
```

if angle_difference(requested_steering_angle, current_steering_angle) > max_angle_change

```
target_steering_angle = current_steering_angle + max_angle_change
```

else:

```
target_steering_angle = requested_steering_angle
```

for joint in joint_list:

```
Thread.publish_joint_angle(joint_name, target_joint_angle)
```

for Thread in created_threads:

```
    Thread.join
```

current_steering_angle = target_steering_angle

main()

Documentation for a function.

Initializes the Control-Node for Steering and starts Steering-Algorithm.

Variables

bool steering_simulation_old_hand.PRINT_DEBUG = True

string steering_simulation_old_hand.RECORDED_TRAJECTORY_FILENAME = "trajectory_steeri

float steering_simulation_old_hand.JOINT_TARGET_ERROR_TOLERANCE = 0.01

float steering_simulation_old_hand.UPDATE_FREQUENCY = 0.001

int steering_simulation_old_hand.MAX_ANGLE_CHANGE = np.pi / 72

float steering_simulation_old_hand.STEP_TRANSITION_TIME = 2.5

string steering_simulation_old_hand.JOINT_SHOULDER_AXIS0_RIGHT = "right_shoulder_axis

string steering_simulation_old_hand.JOINT_SHOULDER_AXIS1_RIGHT = "right_shoulder_axis

string steering_simulation_old_hand.JOINT_SHOULDER_AXIS2_RIGHT = "right_shoulder_axis

string steering_simulation_old_hand.JOINT_SHOULDER_AXIS0_LEFT = "left_shoulder_axis0"

string steering_simulation_old_hand.JOINT_SHOULDER_AXIS1_LEFT = "left_shoulder_axis1"

string steering_simulation_old_hand.JOINT_SHOULDER_AXIS2_LEFT = "left_shoulder_axis2"

string steering_simulation_old_hand.JOINT_ELBOW_ROT0_RIGHT = "elbow_right_rot0"

string steering_simulation_old_hand.JOINT_ELBOW_ROT1_RIGHT = "elbow_right_rot1"

string steering_simulation_old_hand.JOINT_ELBOW_ROT0_LEFT = "elbow_left_rot0"

string steering_simulation_old_hand.JOINT_ELBOW_ROT1_LEFT = "elbow_left_rot1"

string steering_simulation_old_hand.JOINT_WRIST_0_RIGHT = "right_wrist_0"

string steering_simulation_old_hand.JOINT_WRIST_1_RIGHT = "right_wrist_1"

string steering_simulation_old_hand.JOINT_WRIST_0_LEFT = "left_wrist_0"

string steering_simulation_old_hand.JOINT_WRIST_1_LEFT = "left_wrist_1"

string steering_simulation_old_hand.JOINT_BIKE_FRONT = "joint_front"

list steering_simulation_old_hand._joints_list= [JOINT_SHOULDER_AXIS0_RIGHT, JOINT_SH

int steering_simulation_old_hand._numTrajectoryPoints = 0

list steering_simulation_old_hand._trajectorySteering = []

list steering_simulation_old_hand._trajectoryShoulder0Right = []

```
list steering_simulation_old_hand._trajectoryShoulder1Right =  []
list steering_simulation_old_hand._trajectoryShoulder2Right =  []
list steering_simulation_old_hand._trajectoryShoulder0Left =  []
list steering_simulation_old_hand._trajectoryShoulder1Left =  []
list steering_simulation_old_hand._trajectoryShoulder2Left =  []
list steering_simulation_old_hand._trajectoryElbow0Right =  []
list steering_simulation_old_hand._trajectoryElbow1Right =  []
list steering_simulation_old_hand._trajectoryElbow0Left =  []
list steering_simulation_old_hand._trajectoryElbow1Left =  []
list steering_simulation_old_hand._trajectoryWrist0Right =  []
list steering_simulation_old_hand._trajectoryWrist1Right =  []
list steering_simulation_old_hand._trajectoryWrist0Left =  []
list steering_simulation_old_hand._trajectoryWrist1Left =  []
steering_simulation_old_hand._interpolatedShoulder0Right =  None
steering_simulation_old_hand._interpolatedShoulder1Right =  None
steering_simulation_old_hand._interpolatedShoulder2Right =  None
steering_simulation_old_hand._interpolatedShoulder0Left =  None
steering_simulation_old_hand._interpolatedShoulder1Left =  None
steering_simulation_old_hand._interpolatedShoulder2Left =  None
steering_simulation_old_hand._interpolatedElbow0Right =  None
steering_simulation_old_hand._interpolatedElbow1Right =  None
steering_simulation_old_hand._interpolatedElbow0Left =  None
steering_simulation_old_hand._interpolatedElbow1Left =  None
steering_simulation_old_hand._interpolatedWrist0Right =  None
steering_simulation_old_hand._interpolatedWrist1Right =  None
steering_simulation_old_hand._interpolatedWrist0Left =  None
steering_simulation_old_hand._interpolatedWrist1Left =  None
steering_simulation_old_hand._regressedShoulder0Right =  None
steering_simulation_old_hand._regressedShoulder1Right =  None
steering_simulation_old_hand._regressedShoulder2Right =  None
steering_simulation_old_hand._regressedShoulder0Left =  None
steering_simulation_old_hand._regressedShoulder1Left =  None
steering_simulation_old_hand._regressedShoulder2Left =  None
steering_simulation_old_hand._regressedElbow0Right =  None
steering_simulation_old_hand._regressedElbow1Right =  None
steering_simulation_old_hand._regressedElbow0Left =  None
```

steering_simulation_old_hand._regressedElbow1Left = None

steering_simulation_old_hand._regressedWrist0Right = None

steering_simulation_old_hand._regressedWrist1Right = None

steering_simulation_old_hand._regressedWrist0Left = None

steering_simulation_old_hand._regressedWrist1Left = None

dictionary steering_simulation_old_hand._jointsStatusData

steering_simulation_old_hand.ros_right_shoulder_axis0_pub= rospy.Publisher('/right_sh

steering_simulation_old_hand.ros_right_shoulder_axis1_pub= rospy.Publisher('/right_sh

steering_simulation_old_hand.ros_right_shoulder_axis2_pub= rospy.Publisher('/right_sh

steering_simulation_old_hand.ros_left_shoulder_axis0_pub = rospy.Publisher('/left_sho

steering_simulation_old_hand.ros_left_shoulder_axis1_pub = rospy.Publisher('/left_sho

steering_simulation_old_hand.ros_left_shoulder_axis2_pub = rospy.Publisher('/left_sho

steering_simulation_old_hand.ros_elbow_right_rot0_pub = rospy.Publisher('/elbow_right

steering_simulation_old_hand.ros_elbow_right_rot1_pub = rospy.Publisher('/elbow_right

steering_simulation_old_hand.ros_elbow_left_rot0_pub = rospy.Publisher('/elbow_left_r

steering_simulation_old_hand.ros_elbow_left_rot1_pub = rospy.Publisher('/elbow_left_r

steering_simulation_old_hand.ros_right_wrist_0_pub = rospy.Publisher('/right_wrist_0/

steering_simulation_old_hand.ros_right_wrist_1_pub = rospy.Publisher('/right_wrist_1/

steering_simulation_old_hand.ros_left_wrist_0_pub = rospy.Publisher('/left_wrist_0/le

steering_simulation_old_hand.ros_left_wrist_1_pub = rospy.Publisher('/left_wrist_1/le

steering_simulation_old_hand.ros_bike_front_pub = rospy.Publisher('/joint_front/joint

steering_simulation_old_hand.ros_log_error_pub = rospy.Publisher('chatter', String, q

int steering_simulation_old_hand.requested_steering_angle = 0

bool steering_simulation_old_hand.angle_change_successful = True

namespace steering_trajectory_following_test

Functions

regressFunctionsFromFile(*filename_coefficients filename_coefficients*)
UTILITY FUNCTIONS ###.

setJointControllerParameters(*proportionalVal proportionalVal*, *derivativeVal derivativeVal*)

computeSteeringAngles()

computeHandTrajectories()

getPositionLeftHand()

getPositionRightHand()

jointStateCallback(*joint_data joint_data*)

recordActualHandTrajectories(*ros_right_shoulder0_publisher*, *ros_right_shoulder0_publisher*, *ros_right_shoulder1_publisher*, *ros_right_shoulder1_publisher*, *ros_right_shoulder2_publisher*, *ros_right_shoulder2_publisher*, *ros_right_elbow0_publisher*, *ros_right_elbow0_publisher*, *ros_right_elbow1_publisher*, *ros_right_elbow1_publisher*, *ros_right_wrist0_publisher*, *ros_right_wrist0_publisher*, *ros_right_wrist1_publisher*, *ros_right_wrist1_publisher*, *ros_left_shoulder0_publisher*, *ros_left_shoulder0_publisher*, *ros_left_shoulder1_publisher*, *ros_left_shoulder1_publisher*, *ros_left_shoulder2_publisher*, *ros_left_shoulder2_publisher*, *ros_left_elbow0_publisher*, *ros_left_elbow0_publisher*, *ros_left_elbow1_publisher*, *ros_left_elbow1_publisher*, *ros_left_wrist0_publisher*, *ros_left_wrist0_publisher*, *ros_left_wrist1_publisher*, *ros_left_wrist1_publisher*)

printPlannedActualHandTrajectories()

main()
MAIN ###.

Variables

int steering_trajectory_following_test.MAX_TURNING_ANGLE = math.pi/15
MODULE PARAMETERS ###.

int steering_trajectory_following_test.NUM_STEERING_ANGLES = 61

float steering_trajectory_following_test.JOINT_ANGLE_TOLERANCE_FK = 0.01

string steering_trajectory_following_test.ENDEFFECTOR_RIGHT = "right_hand"

string steering_trajectory_following_test.FRAME_RIGHT = "right_hand"

string steering_trajectory_following_test.ENDEFFECTOR_LEFT = "left_hand"

string steering_trajectory_following_test.FRAME_LEFT = "left_hand"

int steering_trajectory_following_test.BIKE_OFFSET_X = 0
MEASURED PARAMETERS ###.

int steering_trajectory_following_test.BIKE_OFFSET_Y = 0

int steering_trajectory_following_test.BIKE_OFFSET_Z = 0

float steering_trajectory_following_test.RIKSHAW_TURN_JOINT_X_OFFSET = 0.716390260057

float steering_trajectory_following_test.RIKSHAW_TURN_JOINT_Y_OFFSET = -0.01038855246

float steering_trajectory_following_test.RIKSHAW_TURN_JOINT_Z_OFFSET = 0.216437694214

int steering_trajectory_following_test.YAW_RIGHT_HAND_OFFSET = math.pi / 2 + math.pi

int steering_trajectory_following_test.YAW_LEFT_HAND_OFFSET = 3 * math.pi / 2 + math.p

float steering_trajectory_following_test.HANDLEBAR_X_OFFSET = 0.728713

float steering_trajectory_following_test.HANDLEBAR_Z_OFFSET = 0.719269

float steering_trajectory_following_test.HAND_Y_OFFSET = 0.2

```
list steering_trajectory_following_test._steeringAngles =  []
    GLOBAL VARIABLES ###.
list steering_trajectory_following_test._rightHandTrajectoryPlanned =  []
list steering_trajectory_following_test._leftHandTrajectoryPlanned =  []
list steering_trajectory_following_test._centerHandlebarTrajectoryPlanned =  []
list steering_trajectory_following_test._rightHandTrajectoryActual =  []
list steering_trajectory_following_test._leftHandTrajectoryActual =  []
string steering_trajectory_following_test.JOINT_SHOULDER_AXIS0_RIGHT =  "right_shoulde
string steering_trajectory_following_test.JOINT_SHOULDER_AXIS1_RIGHT =  "right_shoulde
string steering_trajectory_following_test.JOINT_SHOULDER_AXIS2_RIGHT =  "right_shoulde
string steering_trajectory_following_test.JOINT_SHOULDER_AXIS0_LEFT =  "left_shoulder_
string steering_trajectory_following_test.JOINT_SHOULDER_AXIS1_LEFT =  "left_shoulder_
string steering_trajectory_following_test.JOINT_SHOULDER_AXIS2_LEFT =  "left_shoulder_
string steering_trajectory_following_test.JOINT_ELBOW_ROT0_RIGHT =  "elbow_right_rot0"
string steering_trajectory_following_test.JOINT_ELBOW_ROT1_RIGHT =  "elbow_right_rot1"
string steering_trajectory_following_test.JOINT_ELBOW_ROT0_LEFT =  "elbow_left_rot0"
string steering_trajectory_following_test.JOINT_ELBOW_ROT1_LEFT =  "elbow_left_rot1"
string steering_trajectory_following_test.JOINT_WRIST_0_RIGHT =  "right_wrist_0"
string steering_trajectory_following_test.JOINT_WRIST_1_RIGHT =  "right_wrist_1"
string steering_trajectory_following_test.JOINT_WRIST_0_LEFT =  "left_wrist_0"
string steering_trajectory_following_test.JOINT_WRIST_1_LEFT =  "left_wrist_1"
list steering_trajectory_following_test.JOINT_LIST =  [JOINT_SHOULDER_AXIS0_RIGHT, JOI
steering_trajectory_following_test._regressedShoulder0Right =  None
steering_trajectory_following_test._regressedShoulder1Right =  None
steering_trajectory_following_test._regressedShoulder2Right =  None
steering_trajectory_following_test._regressedShoulder0Left =  None
steering_trajectory_following_test._regressedShoulder1Left =  None
steering_trajectory_following_test._regressedShoulder2Left =  None
steering_trajectory_following_test._regressedElbow0Right =  None
steering_trajectory_following_test._regressedElbow1Right =  None
steering_trajectory_following_test._regressedElbow0Left =  None
steering_trajectory_following_test._regressedElbow1Left =  None
steering_trajectory_following_test._regressedWrist0Right =  None
steering_trajectory_following_test._regressedWrist1Right =  None
steering_trajectory_following_test._regressedWrist0Left =  None
steering_trajectory_following_test._regressedWrist1Left =  None
```

dictionary steering_trajectory_following_test._jointsStatusData

namespace velocity_test

Functions

get_twist(*velocity velocity*)
Documentation for a function.

Return a Twist-msg with the linear velocity #velocity

get_position_left_foot()
Documentation for a function.

Return the position of the left foot of Roboy.

get_position_right_foot()
Documentation for a function.

Return the position of the right foot of Roboy.

evaluate_current_pedal_angle(*current_point current_point*)
Documentation for a function.

Evaluating the current pedal-angle according to the current position of the left foot . Using trigonometric functions for the evaluation of the angle.

get_angle_difference(*angle_1 angle_1*, *angle_2 angle_2*)
Documentation for a function.

Returns the absolute difference of two angles within the interval [0;2pi]

evaluate_error(*velocity velocity*, *leg leg*)
Documentation for a function.

Evaluate the angle-error for velocity after seconds

simulation_test(*pub pub*)
Documentation for a function.

Test program for evaluating the accuracy of velocity. Saves ten error-results for every target velocity and determines average error and max error for every velocity and displays them using pyplot.

velocity_reached(*velocity velocity*)
Documentation for a function.

Returns if has been reached within the error-tolerance

reality_test_acceleration(*pub pub*)
Documentation for a function.

Test program for evaluating the acceleration time (time needed to change between two velocities.

Uses to determine the difference between two different velocities and measures the time needed to change between the two velocities. Displays all acceleration times using pyplot.

main()
Documentation for a function.

Initializes the Test-Node for the velocity-tests

Variables

float velocity_test.TIME_STEP_SIMULATION = 0.5

float velocity_test.TIME_STEP_REALITY = 0.5

float velocity_test.VELOCITY_STEP_SIMULATION = 0.1

list velocity_test.VELOCITY_STEPS_REALITY = [0.1, 0.2, 0.5]

int velocity_test.ERROR_TOLERANCE_REALITY = 2*np.pi / 720

int velocity_test.MAX_VELOCITY = 5

float velocity_test.PEDAL_CENTER_OFFSET_X = 0.20421

float velocity_test.PEDAL_CENTER_OFFSET_Y = -0.00062

float velocity_test.PEDAL_CENTER_OFFSET_Z = 0.2101

float velocity_test.RADIUS_BACK_TIRE = 0.294398

float velocity_test.RADIUS_GEAR_CLUSTER = 0.06

float velocity_test.RADIUS_FRONT_CHAIN_RING = 0.075

string velocity_test.ROS_JOINT_HIP_RIGHT = "joint_hip_right"

string velocity_test.ROS_JOINT_KNEE_RIGHT = "joint_knee_right"

string velocity_test.ROS_JOINT_ANKLE_RIGHT = "joint_foot_right"

string velocity_test.ROS_JOINT_HIP_LEFT = "joint_hip_left"

string velocity_test.ROS_JOINT_KNEE_LEFT = "joint_knee_left"

string velocity_test.ROS_JOINT_ANKLE_LEFT = "joint_foot_left"

string velocity_test.RIGHT_HIP_JOINT = "right_hip"

string velocity_test.RIGHT_KNEE_JOINT = "right_knee"

string velocity_test.RIGHT_ANKLE_JOINT = "right_ankle"

string velocity_test.LEFT_HIP_JOINT = "left_hip"

string velocity_test.LEFT_KNEE_JOINT = "left_knee"

string velocity_test.LEFT_ANKLE_JOINT = "left_ankle"

dictionary velocity_test.joint_status_data= { RIGHT_HIP_JOINT: { "Pos": 0.0

namespace visualization_msgs

file **cardsflow_rviz.hpp**

#include <QPainter>#include <QCheckBox>#include <QPushButton>#include <QLineEdit>#include <QSlider>#include <QVBoxLayout>#include <QHBoxLayout>#include <QLabel>#include <QTableWidget>#include <QComboBox>#include <QTimer>#include <QScrollArea>#include <QListWidget>#include <QStyledItemDelegate>#include <ros/ros.h>#include <tf/tf.h>#include <tf/transform_listener.h>#include <tf/transform_broadcaster.h>#include <tf_conversions/tf_eigen.h>#include <Eigen/Core>#include <Eigen/Dense>#include <rviz/panel.h>#include <pluginlib/class_loader.h>#include <pluginlib/class_list_macros.h>#include <common_utilities/rviz_visualization.hpp>#include <geometry_msgs/PoseStamped.h>#include <roboy_simulation_msgs/Tendon.h>#include <moveit_msgs/DisplayRobotState.h>#include <roboy_simulation_msgs/JointState.h>#include <map>#include <thread>

file **cardsflow_rviz.cpp**
#include "include/cardsflow_rviz/cardsflow_rviz.hpp"

file **measureExecutionTime.hpp**
#include <string>#include <chrono>#include <boost/shared_ptr.hpp>#include <fstream>

Typedefs

using Clock = *std*::chrono::steady_clock

typedef boost::shared_ptr<*MeasureExecutionTime*> **MeasureExecutionTimePtr**

file **MotorConfig.hpp**
#include <ros/ros.h>#include <map>#include <yaml-cpp/yaml.h>#include <fstream>#include <sys/types.h>#include <sys/stat.h>#include <unistd.h>#include <common_utilities/CommonDefinitions.h>

file **rviz_visualization.hpp**
#include <ros/ros.h>#include <ros/package.h>#include <visualization_msgs/Marker.h>#include <visualization_msgs/MarkerArray.h>#include <Eigen/Core>#include <Eigen/Dense>#include <tf/tf.h>#include <tf/transform_listener.h>#include <tf/transform_broadcaster.h>#include <tf_conversions/tf_eigen.h>#include <interactive_markers/menu_handler.h>#include <interactive_markers/interactive_marker_server.h>#include <geometry_msgs/Pose.h>#include <string>#include <sys/stat.h>

file **UDPSocket.hpp**
#include <stdlib.h>#include <unistd.h>#include <errno.h>#include <string.h>#include <sys/types.h>#include <sys/socket.h>#include <netinet/in.h>#include <arpa/inet.h>#include <netdb.h>#include <string>#include <ifaddrs.h>#include <stdio.h>#include <time.h>#include <bitset>#include <iostream>#include <boost/shared_ptr.hpp>#include <vector>#include <ros/ros.h>

Defines

MAXBUFLENGTH

BYTE_TO_BINARY_PATTERN

BYTE_TO_BINARY(byte)

BROADCAST_PORT

pack754_32(f)

pack754_64(f)

unpack754_32(i)

unpack754_64(i)

Typedefs

typedef boost::shared_ptr<*UDPSocket*> **UDPSocketPtr**

Functions

uint64_t **pack754**(long double *f*, unsigned *bits*, unsigned *expbits*)

long double **unpack754**(uint64_t *i*, unsigned *bits*, unsigned *expbits*)

file **MotorConfig.cpp**
#include "common_utilities/MotorConfig.hpp"

file **rfid_unlocker.cpp**
#include "common_utilities/UDPSocket.hpp"#include <chrono>

Functions

int **main** (int *argc*, char **argv*[])

Variables

const char* key= "The path of the righteous man is beset on all sides by the inequitie

uint8_t **user**[4] = {0xBF, , , }

file **ROS_MASTER_URI_broadcaster.cpp**
#include <ros/ros.h>#include "common_utilities/UDPSocket.hpp"

Functions

int **main** (int *argc*, char **argv*[])

Variables

const char* key= "The path of the righteous man is beset on all sides by the inequitie

file **ROS_MASTER_URI_receiver.cpp**
#include <ros/ros.h>#include <common_utilities/UDPSocket.hpp>

Functions

int **main** (int *argc*, char **argv*[])

Variables

const char* key= "The path of the righteous man is beset on all sides by the inequitie

file **rviz_visualization.cpp**
#include "common_utilities/rviz_visualization.hpp"

file **UDPSocket.cpp**
#include <ifaddrs.h>#include "common_utilities/UDPSocket.hpp"

Functions

uint64_t **pack754** (long double *f*, unsigned *bits*, unsigned *expbits*)

long double **unpack754** (uint64_t *i*, unsigned *bits*, unsigned *expbits*)

file **cable.hpp**
#include <Eigen/Core>#include <Eigen/Dense>#include <vector>

file **cardsflow_command_interface.hpp**

#include <cassert>#include <string>#include <hardware_interface/internal/hardware_resource_manager.h>#include "kindyn/controller/cardsflow_state_interface.hpp"#include <Eigen/Core>#include <Eigen/Dense>

file **cardsflow_state_interface.hpp**

#include <hardware_interface/internal/hardware_resource_manager.h>#include <cassert>#include <string>#include <Eigen/Core>#include <Eigen/Dense>

file **EigenExtension.hpp**

#include <iostream>#include <Eigen/Dense>#include <Eigen/Geometry>#include <Eigen/SVD>

file **robot.hpp**

#include <ros/ros.h>#include <Eigen/Core>#include <Eigen/Dense>#include <iDynTree/Model/FreeFloatingState.h>#include <iDynTree/KinDynComputations.h>#include <iDynTree/ModelIO/ModelLoader.h>#include <iDynTree/Core/EigenHelpers.h>#include <iDynTree/InverseKinematics.h>#include "tinyxml.h"#include "kindyn/cable.hpp"#include "kindyn/EigenExtension.hpp"#include "kindyn/controller/cardsflow_state_interface.hpp"#include "kindyn/controller/cardsflow_command_interface.hpp"#include <actionlib/server/simple_action_server.h>#include <geometry_msgs/PoseStamped.h>#include <geometry_msgs/Vector3.h>#include <std_msgs/Float32.h>#include <sensor_msgs/JointState.h>#include <roboy_simulation_msgs/Tendon.h>#include <roboy_simulation_msgs/ControllerType.h>#include <roboy_simulation_msgs/JointState.h>#include <roboy_middleware_msgs/ForwardKinematics.h>#include <roboy_middleware_msgs/InverseKinematics.h>#include <roboy_middleware_msgs/InverseKinematicsMultipleFrames.h>#include <roboy_middleware_msgs/MotorCommand.h>#includ <roboy_middleware_msgs/MotorStatus.h>#include <roboy_control_msgs/MoveEndEffectorAction.h>#include <tf/tf.h>#include <tf/transform_broadcaster.h>#include <tf/transform_listener.h>#include <tf_conversions/tf_eigen.h>#include <eigen_conversions/eigen_msg.h>#include <qpOASES.hpp>#include <controller_manager/controller_manager.h>#include <controller_manager_msgs/LoadController.h>#include <hardware_interface/joint_state_interface.h>#include <hardware_interface/joint_command_interface.h>#include <hardware_interface/robot_hw.h>#include <boost/numeric/odeint.hpp>#include <common_utilities/rviz_visualization.hpp>#include <visualization_msgs/InteractiveMarkerFeedback.h>#include <thread>

Typedefs

typedef boost::shared_ptr<*cardsflow*::*kindyn*::*Robot*> **RobotPtr**

file **vrpuppet.hpp**

#include <ros/ros.h>#include <Eigen/Core>#include <Eigen/Dense>#include <iDynTree/Model/FreeFloatingState.h>#include <iDynTree/KinDynComputations.h>#include <iDynTree/ModelIO/ModelLoader.h>#include <iDynTree/Core/EigenHelpers.h>#include <iDynTree/InverseKinematics.h>#include "tinyxml.h"#include "kindyn/cable.hpp"#include "kindyn/EigenExtension.hpp"#include "kindyn/controller/cardsflow_state_interface.hpp"#include "kindyn/controller/cardsflow_command_interface.hpp"#include <actionlib/server/simple_action_server.h>#include <geometry_msgs/PoseStamped.h>#include <geometry_msgs/Vector3.h>#include <std_msgs/Float32.h>#include <sensor_msgs/JointState.h>#include <roboy_simulation_msgs/Tendon.h>#include <roboy_simulation_msgs/ControllerType.h>#include <roboy_simulation_msgs/JointState.h>#include <roboy_middleware_msgs/ForwardKinematics.h>#include <roboy_middleware_msgs/InverseKinematics.h>#include <roboy_middleware_msgs/InverseKinematicsMultipleFrames.h>#include <roboy_middleware_msgs/MotorCommand.h>#includ <roboy_middleware_msgs/MotorStatus.h>#include <roboy_control_msgs/MoveEndEffectorAction.h>#include <tf/tf.h>#include <tf/transform_broadcaster.h>#include <tf/transform_listener.h>#include <tf_conversions/tf_eigen.h>#include <eigen_conversions/eigen_msg.h>#include <qpOASES.hpp>#include <controller_manager/controller_manager.h>#include <controller_manager_msgs/LoadController.h>#include <hardware_interface/joint_state_interface.h>#include <hardware_interface/joint_command_interface.h>#include <hardware_interface/robot_hw.h>#include

<boost/numeric/odeint.hpp>#include <common_utilities/rviz_visualization.hpp>#include <visualization_msgs/InteractiveMarkerFeedback.h>#include <thread>

Typedefs

typedef boost::shared_ptr<*cardsflow*::*vrpuppet*::*Robot*> **RobotPtr**

file **cableLengthController.cpp**

#include <type_traits>#include <controller_interface/controller.h>#include <hardware_interface/joint_command_interface.h>#include <pluginlib/class_list_macros.h>#include "kindyn/robot.hpp"#include "kindyn/controller/cardsflow_state_interface.hpp"#include <roboy_simulation_msgs/ControllerType.h>#include <std_msgs/Float32.h>#include <roboy_control_msgs/SetControllerParameters.h>

Functions

PLUGINLIB_EXPORT_CLASS(*CableLengthController*, controller_interface::ControllerBase)

file **cableLengthVelocityController.cpp**

#include <type_traits>#include <controller_interface/controller.h>#include <hardware_interface/joint_command_interface.h>#include <pluginlib/class_list_macros.h>#include "kindyn/robot.hpp"#include "kindyn/controller/cardsflow_state_interface.hpp"#include <roboy_simulation_msgs/ControllerType.h>#include <std_msgs/Float32.h>#include <roboy_control_msgs/SetControllerParameters.h>

Functions

PLUGINLIB_EXPORT_CLASS(*CableLengthVelocityController*, controller_interface::ControllerBase)

file **cardsflow_command_interface.cpp**

#include "kindyn/controller/cardsflow_command_interface.hpp"

file **cardsflow_state_interface.cpp**

#include "kindyn/controller/cardsflow_state_interface.hpp"

file **forcePositionController.cpp**

#include <type_traits>#include <controller_interface/controller.h>#include <hardware_interface/joint_command_interface.h>#include <pluginlib/class_list_macros.h>#include "kindyn/robot.hpp"#include "kindyn/controller/cardsflow_state_interface.hpp"#include <roboy_simulation_msgs/ControllerType.h>#include <std_msgs/Float32.h>#include <roboy_control_msgs/SetControllerParameters.h>

Functions

PLUGINLIB_EXPORT_CLASS(*ForcePositionController*, controller_interface::ControllerBase)

file **torquePositionController.cpp**

#include <type_traits>#include <controller_interface/controller.h>#include <hardware_interface/joint_command_interface.h>#include <pluginlib/class_list_macros.h>#include "kindyn/robot.hpp"#include "kindyn/controller/cardsflow_command_interface.hpp"#include <roboy_simulation_msgs/ControllerType.h>#include <std_msgs/Float32.h>#include <roboy_control_msgs/SetControllerParameters.h>

Functions

PLUGINLIB_EXPORT_CLASS (*TorquePositionController*, controller_interface::ControllerBase)

file **EigenExtension.cpp**
#include "kindyn/EigenExtension.hpp"

file **pedal_simulation.py**

file **pedal_simulation_interpolation_cubic_derivative.py**

file **pedal_simulation_interpolation_linear_trajectory_points.py**

file **pedal_simulation_left_leg_experimental.py**

file **pedal_simulation_left_leg_fk_pos.py**

file **finals_simulation_pedaling.py**

file **joint_angle_velocity_factor_test.py**

file **velocity_test.py**

file **capture_pedal_trajectory_left_leg_only.py**

file **capture_pedal_trajectory.py**

file **README.md**

file **robot.cpp**
#include "kindyn/robot.hpp"

file **msj_platform.cpp**
#include "kindyn/robot.hpp"#include <thread>#include <roboy_middleware_msgs/MotorCommand.h>#include <roboy_simulation_msgs/GymStep.h>#include <roboy_simulation_msgs/GymReset.h>#include <common_utilities/CommonDefinitions.h>

Defines

NUMBER_OF_MOTORS

SPINDLERADIUS

msjMeterPerEncoderTick (encoderTicks)

msjEncoderTicksPerMeter (meter)

Functions

void **update** (controller_manager::ControllerManager **cm*)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main** (int *argc*, char **argv*[])

file **rickshaw_pedaling.cpp**
#include "kindyn/robot.hpp"#include <thread>#include <roboy_middleware_msgs/MotorCommand.h>#include <roboy_middleware_msgs/ControlMode.h>#include <common_utilities/CommonDefinitions.h>#include <roboy_control_msgs/SetControllerParameters.h>

Functions

void **update**(controller_manager::ControllerManager *_cm_)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main**(int _argc_, char *_argv_[])

file **rikshaw.cpp**
#include "kindyn/robot.hpp"#include <thread>#include <roboy_middleware_msgs/MotorCommand.h>#include <roboy_middleware_msgs/ControlMode.h>#include <common_utilities/CommonDefinitions.h>#include <roboy_control_msgs/SetControllerParameters.h>

Functions

void **update**(controller_manager::ControllerManager *_cm_)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main**(int _argc_, char *_argv_[])

file **rikshaw_new_hands.cpp**
#include "kindyn/robot.hpp"#include <thread>#include <std_msgs/Float32.h>#include <roboy_middleware_msgs/MotorCommand.h>#include <roboy_middleware_msgs/MotorConfig.h>#include <roboy_middleware_msgs/MotorStatus.h>#include <roboy_middleware_msgs/ControlMode.h>#include <common_utilities/CommonDefinitions.h>#include <roboy_control_msgs/SetControllerParameters.h>

Functions

void **update**(controller_manager::ControllerManager *_cm_)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main**(int _argc_, char *_argv_[])

file **robot_configuration_estimator.cpp**
#include <Eigen/Core>#include <Eigen/Dense>#include <unsupported/Eigen/NonLinearOptimization>#include <unsupported/Eigen/NumericalDiff>#include <iostream>#include "kindyn/robot.hpp"#include <std_msgs/Float32.h>#include <controller_manager_msgs/LoadController.h>#include <controller_manager_msgs/SwitchController.h>#include <tf/transform_broadcaster.h>

Defines

NUMBER_OF_MOTORS

SPINDLERADIUS

msjMeterPerEncoderTick(encoderTicks)

msjEncoderTicksPerMeter(meter)

Functions

void **update**(controller_manager::ControllerManager *_cm_)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main**()

file **roboy2.cpp**
#include "kindyn/vrpuppet.hpp"#include <thread>#include <roboy_middleware_msgs/MotorCommand.h>#include <roboy_middleware_msgs/ControlMode.h>#include <roboy_middleware_msgs/MotorConfigService.h>#include <common_utilities/CommonDefinitions.h>#include <roboy_control_msgs/SetControllerParameters.h>#include <std_srvs/Empty.h>

Functions

int **main**(int *argc*, char **argv*[])

file **roboy_arcade_maschine.cpp**
#include "kindyn/robot.hpp"#include <thread>#include <roboy_middleware_msgs/MotorCommand.h>

Functions

void **update**(controller_manager::ControllerManager *_cm_)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main**(int *argc*, char **argv*[])

file **roboy_head.cpp**
#include "kindyn/robot.hpp"#include <thread>#include <std_msgs/Float32.h>#include <roboy_middleware_msgs/MotorCommand.h>#include <roboy_middleware_msgs/MotorConfig.h>#include <roboy_middleware_msgs/MotorConfigService.h>#include <roboy_middleware_msgs/MotorStatus.h>#include <roboy_middleware_msgs/ControlMode.h>#include <common_utilities/CommonDefinitions.h>#include <roboy_control_msgs/SetControllerParameters.h>

Functions

void **update**(controller_manager::ControllerManager *_cm_)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main**(int _argc_, char *_argv_[])

file **roboy_icecream.cpp**
#include "kindyn/vrpuppet.hpp"#include <thread>#include <roboy_middleware_msgs/MotorCommand.h>#include <roboy_middleware_msgs/ControlMode.h>#include <roboy_middleware_msgs/MotorConfigService.h>#include <common_utilities/CommonDefinitions.h>#include <roboy_control_msgs/SetControllerParameters.h>#include <std_srvs/Empty.h>

Functions

int **main**(int _argc_, char *_argv_[])

file **roboy_upper_body.cpp**
#include "kindyn/robot.hpp"#include <thread>#include <roboy_middleware_msgs/MotorCommand.h>#include <roboy_middleware_msgs/ControlMode.h>#include <common_utilities/CommonDefinitions.h>#include <roboy_control_msgs/SetControllerParameters.h>

Functions

void **update**(controller_manager::ControllerManager *_cm_)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main**(int _argc_, char *_argv_[])

file **roboy_xylophone.cpp**
#include "kindyn/robot.hpp"#include <thread>#include <roboy_middleware_msgs/MotorCommand.h>#include <common_utilities/CommonDefinitions.h>

Functions

void **update**(controller_manager::ControllerManager *_cm_)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main**(int _argc_, char *_argv_[])

file **shoulder_testbed.cpp**
#include "kindyn/robot.hpp"#include <thread>#include <roboy_middleware_msgs/MotorCommand.h>#include <common_utilities/CommonDefinitions.h>

Defines

NUMBER_OF_MOTORS

Functions

void **update**(controller_manager::ControllerManager *_cm_)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main**(int *argc*, char *_argv_[])

file **test_robot.cpp**
#include "kindyn/robot.hpp"#include <thread>

Functions

void **update**(controller_manager::ControllerManager *_cm_)

int **main**(int *argc*, char *_argv_[])

file **theClaw.cpp**
#include "kindyn/robot.hpp"#include <thread>#include <roboy_middleware_msgs/MotorCommand.h>

Defines

SPINDLERADIUS

FS5103R_MAX_SPEED

FS5103R_FULL_SPEED_BACKWARDS

FS5103R_STOP

FS5103R_FULL_SPEED_FORWARDS

Functions

void **update**(controller_manager::ControllerManager *_cm_)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main**(int *argc*, char *_argv_[])

file **VRpuppet.cpp**
#include "kindyn/robot.hpp"#include <thread>#include <roboy_middleware_msgs/MotorCommand.h>#include <roboy_middleware_msgs/ControlMode.h>#include <common_utilities/CommonDefinitions.h>#include <roboy_control_msgs/SetControllerParameters.h>

Functions

void **update**(controller_manager::ControllerManager *cm)
controller manager update thread.

Here you can define how fast your controllers should run

Parameters

- cm: pointer to the controller manager

int **main**(int *argc*, char *argv[])

file **vrpuppet.cpp**
#include "kindyn/vrpuppet.hpp"

file **yatr.cpp**
#include "kindyn/robot.hpp"#include <thread>

Functions

void **update**(controller_manager::ControllerManager *cm)

int **main**(int *argc*, char *argv[])

file **steering_simulation_old_hand.py**

file **steering_simulation.py**

file **steering_response_test.py**

file **steering_trajectory_following_test.py**

file **compute_steering_path.py**

file **steering_capture_multiple_trajectories.py**

file **steering_capture_trajectory.py**

file **steering_interpolate_and_print.py**

file **steering_interpolate_multiple_trajectories_and_print.py**

file **new_hand_steering_capture_trajectory.py**

file **interpolation.py**

file **kp_kp.py**

file **roboython.py**

file **state_machine.py**

file **test_idyntree.cpp**
#include <ros/ros.h>#include <cstdlib>#include <Eigen/Core>#include <iDynTree/Model/FreeFloatingState.h>#include <iDynTree/KinDynComputations.h>#include <iDynTree/ModelIO/ModelLoader.h>#include <iDynTree/Core/EigenHelpers.h>#include <iDynTree/InverseKinematics.h>

Functions

int **main** (int *argc*, char **argv*[])

page **md__home_docs_checkouts_readthedocs.org_user_builds_cardsflow_checkouts_master_kindyn_s**

This folder contains the control files for CARDSFlow robots.

Doxygen documentation is found in documentation/html/index.html.

Before the Python scripts related to the Rickshaw can be run, the Rickshaw robot must be launched. This can at the time of writing be done with: \ `roslaunch kindyn robot.launch robot_name:=rikshaw start_controllers:='joint_hip_left joint_hip_right joint_wheel_right joint_wheel_back joint_pedal spine_joint joint_wheel_left joint_front joint_pedal_right joint_pedal_left elbow_right_rot1 joint_foot_left joint_knee_right joint_knee_left joint_foot_right left_shoulder_axis0 left_shoulder_axis1 left_shoulder_axis2 elbow_left_rot1 elbow_left_rot0 left_wrist_0 left_wrist_1 right_shoulder_axis0 right_shoulder_axis2 right_shoulder_axis1 elbow_right_rot0 right_wrist_0 right_wrist_1 head_axis0 head_axis1 head_axis2'`

#roslaunch kindyn robot.launch robot_name:=rikshaw start_controllers:='spine_joint sphere_head_axis0 sphere_head_axis1 sphere_head_axis2 joint_hip_left joint_knee_left joint_foot_left joint_hip_right joint_knee_right joint_foot_right left_shoulder_axis0 left_shoulder_axis1 left_shoulder_axis2 elbow_left wrist_left_sphere_axis0 wrist_left_sphere_axis1 wrist_left_sphere_axis2 right_shoulder_axis0 right_shoulder_axis1 right_shoulder_axis2 elbow_right wrist_right_sphere_axis0 wrist_right_sphere_axis1 wrist_right_sphere_axis2 little_right_joint0 ring_right_joint0 middle_right_joint0 index_right_joint0 thumb_right_joint0 little_right_joint1 ring_right_joint1 middle_right_joint1 index_right_joint1 thumb_right_joint1 little_right_joint2 ring_right_joint2 middle_right_joint2 index_right_joint2 thumb_right_joint2 little_left_joint0 ring_left_joint0 middle_left_joint0 index_left_joint0 thumb_left_joint0 little_left_joint1 ring_left_joint1 middle_left_joint1 index_left_joint1 thumb_left_joint1 little_left_joint2 ring_left_joint2 middle_left_joint2 index_left_joint2 thumb_left_joint2 joint_wheel_left joint_wheel_right joint_front joint_wheel_back joint_pedal joint_pedal_right joint_pedal_left'

#roslaunch kindyn robot.launch robot_name:=rikshaw start_controllers:='joint_hip_left joint_knee_left joint_foot_left joint_hip_right joint_knee_right joint_foot_right left_shoulder_axis0 left_shoulder_axis1 left_shoulder_axis2 elbow_left wrist_left_sphere_axis0 right_shoulder_axis0 right_shoulder_axis1 right_shoulder_axis2 elbow_right wrist_right_sphere_axis0 joint_front joint_pedal joint_pedal_right joint_pedal_left'

Below is a content description of each subfolder:

controller \ This folder contains myo-muscle control files.

images \ This folder contains graphs and images relevant to steering and pedaling control of Roboy.

pedaling \ This folder contains files relevant to Roboy pedaling the rickshaw.

robots \ This folder contains the CARDSFlow implementation of each robot.

steering \ This folder contains files relevant to Roboy steering the rickshaw.

utilities \ This folder contains files used in the Rickshaw project.

Todo: \ Add usage information? \ Add description of files inside folders \ Add prerequisites \ Add installation guide

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dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/c**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/p**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/s**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/p**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/s**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/common_utili**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/inclu**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/cardsflow_rv**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/inclu**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/p**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/r**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/common_utili**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/cardsflow_rv**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/s**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/p**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/s**
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dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/s**
dir **/home/docs/checkouts/readthedocs.org/user_builds/cardsflow/checkouts/master/kindyn/src/u**

INDEX

B

C

E

F

H

I

J

K

M

N

P

Q

R

S

T

U

V

Y