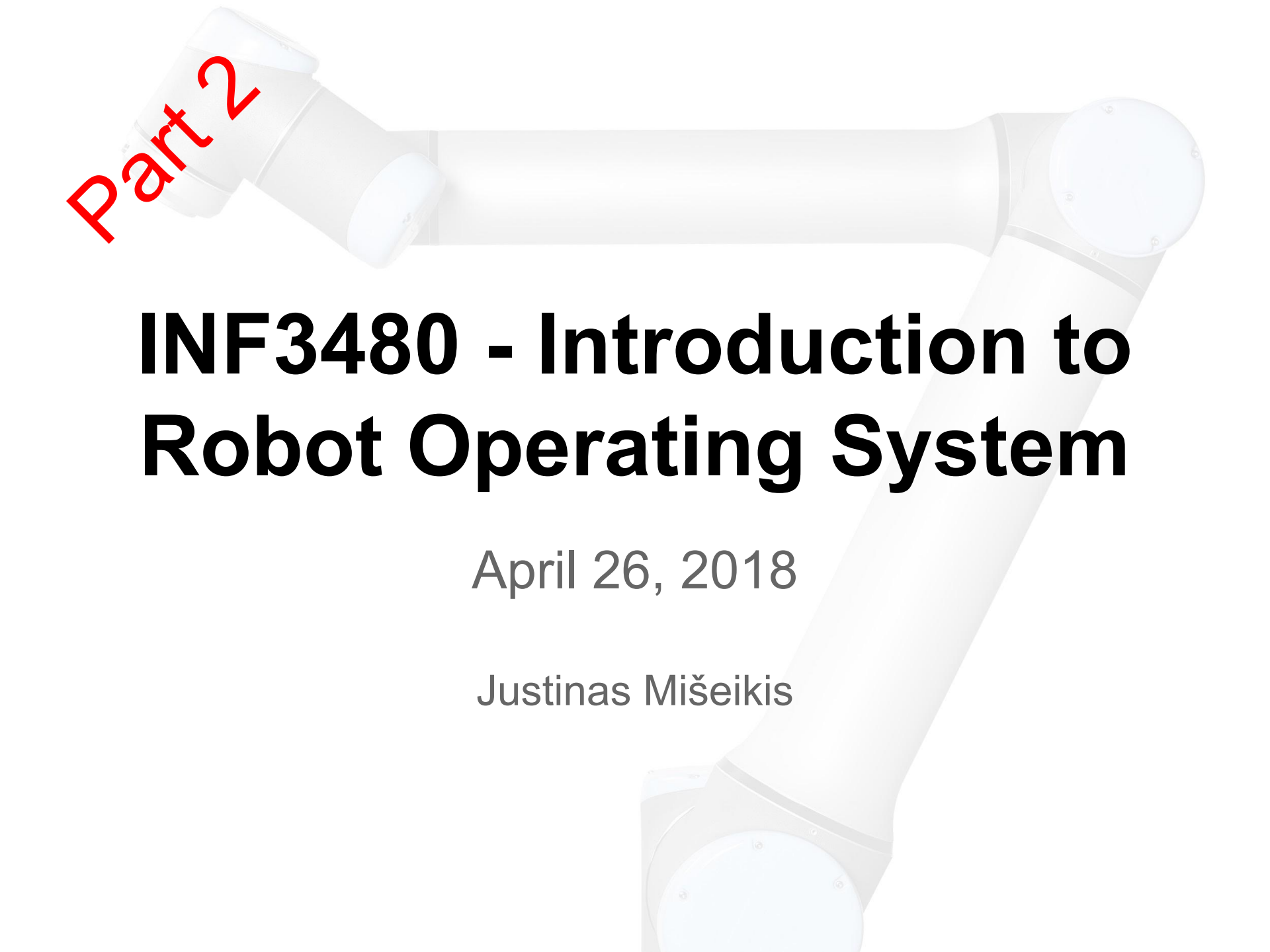


INF3480 - Introduction to Robot Operating System

April 26, 2018

Justinas Mišeikis

Recap of the previous lecture

- What ROS is?
- Consists of: Plumbing, Tools, Capabilities, Ecosystem
- Nodes, Topics, Services, Messages, ROS Master
- RQT Visualisation
- Rosbag

- Setting up a new ROS installation
- Creating workspace
- Compiling
- Creating package
- Simple publisher
- Listen to the topic, rostopic echo

Hands-on

Lecture Plan

1. Go through ROS-Industrial and MoveIt!
2. Show some example projects made on ROS
3. Practical coding session
4. Leave time for your questions on using ROS


ROS
industrial


MoveIt!

Technical Capabilities

- Motion Planning
  - Fast and good quality paths
  - Kinematic Constraints
- Fast and flexible collision checking
- Integrated Kinematics
- Integrated Perception for Environment Representation
- Standardised Interfaces to Controllers
- Execution and Monitoring
- Kinematic Analysis
- Simulated Robots

Motion Planning

MoveIt! includes a variety of motion planners:

- Sampling-based motion planners

  (implementations from [OMPL])
- Search-based motion planners

  (implementations from SBPL)
- Optimization-based motion planners (CHOMP)

Motion Planning - Constraints

You can specify the following kinematic constraints:

- **Position constraints** – restrict the position of a link to lie within a region of space
- **Orientation constraints** – restrict the orientation of a link to lie within specified roll, pitch or yaw limits
- **Visibility constraints** – restrict a point on a link to lie within the visibility cone for a particular sensor
- **Joint constraints** – restrict a joint to lie between two values
- **User-specified constraints** – you can also specify your own constraints with a user-defined callback.

Collision Detection

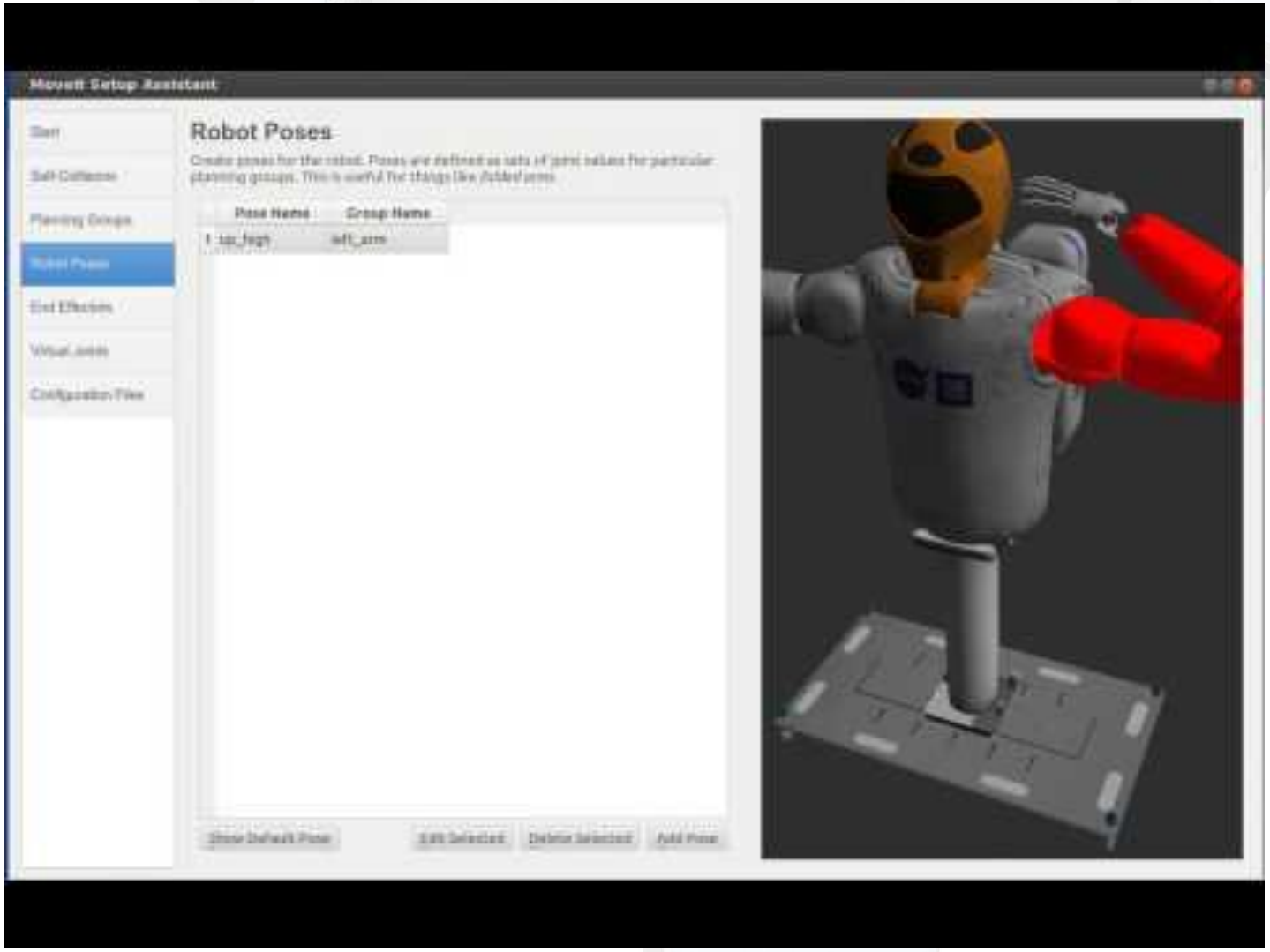
Flexible Collision Library (FCL) is used.

Types of objects supported:

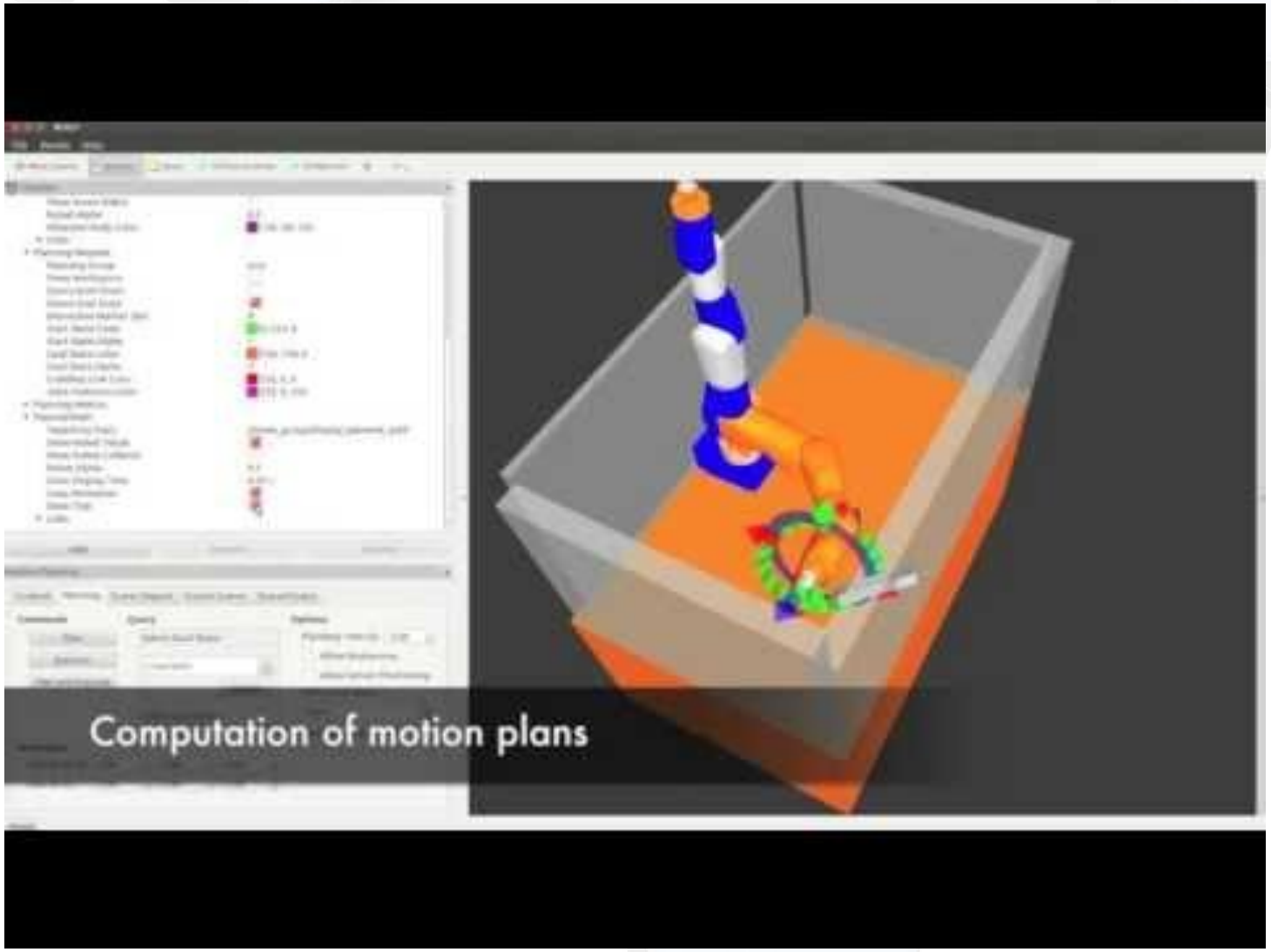
- Meshes
- Primitive shapes (boxes, cylinders, cones)
- Octomap

40,000 to 80,000 collision checks per second!

MoveIt - Robot Setup Assistant



MoveIt Capabilities



How to use it?

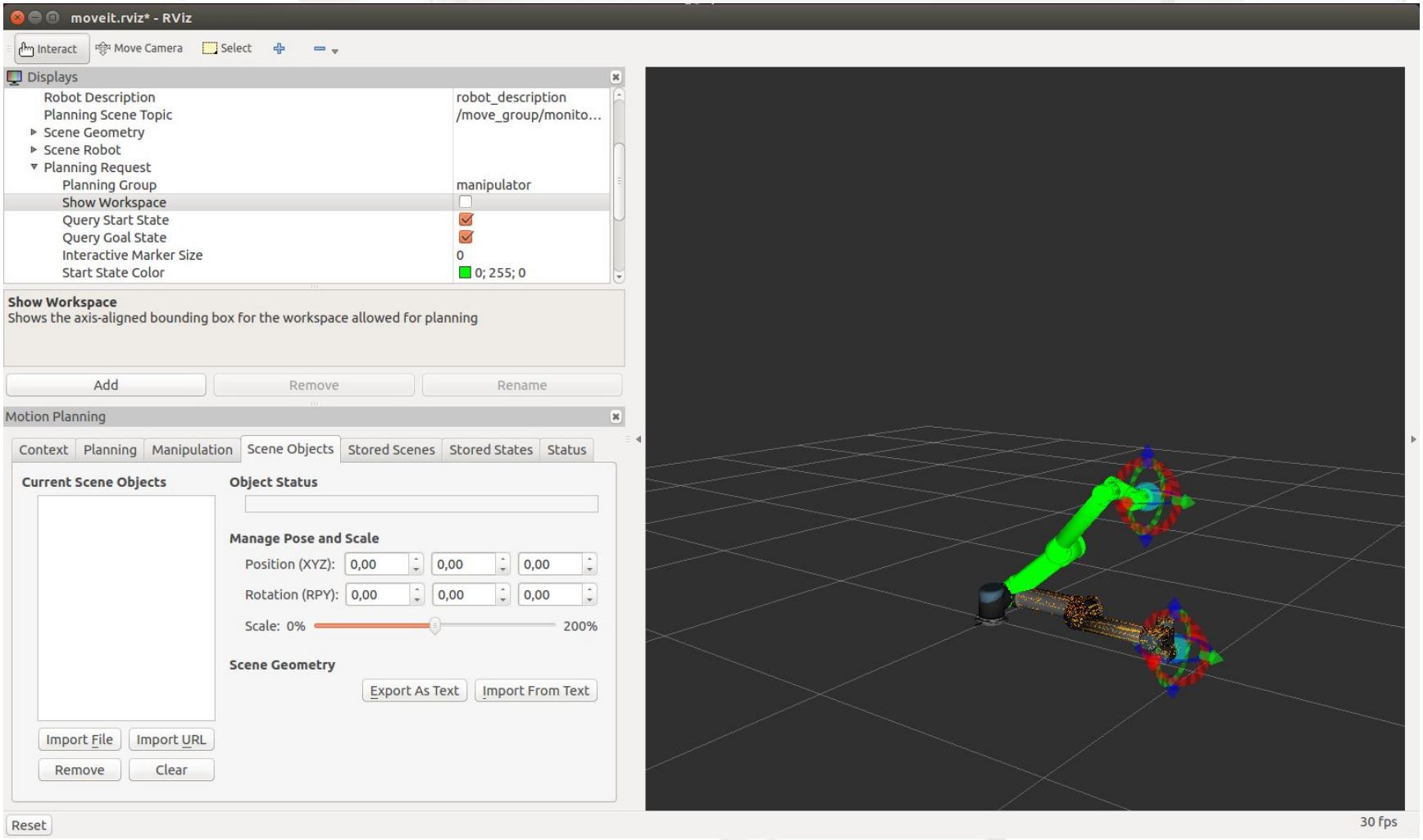
To simulate and play around with Universal Robot UR5

1) Have ROS installed (example version: Kinetic)
2) Install MoveIt for UR5:
    - “sudo apt-get install ros-kinetic-ur5-moveit-config”
3) Launch UR5 RViz simulator:
    - “roslaunch ur5_moveit_config demo.launch”

That’s it!

http://wiki.ros.org/universal_robot/Tutorials/Getting%20Started%20with%20a%20Universal%20Robot%20and%20ROS-Industrial

How to use it?


moveit.rviz* - RViz
Interact
Move Camera
Select
Displays
Robot Description
robot_description
Planning Scene Topic
/move_group/monito…
Scene Geometry
Scene Robot
Planning Request
Planning Group
manipulator
Show Workspace
Query Start State
Query Goal State
Interactive Marker Size
0
Start State Color
0; 255; 0
Show Workspace
Shows the axis-aligned bounding box for the workspace allowed for planning
Add
Remove
Rename
Motion Planning
Context
Planning
Manipulation
Scene Objects
Stored Scenes
Stored States
Status
Current Scene Objects
Object Status
Manage Pose and Scale
Position (XYZ):
0,00
0,00
0,00
Rotation (RPY):
0,00
0,00
0,00
Scale: 0%
200%
Scene Geometry
Export As Text
Import From Text
Import File
Import URL
Remove
Clear
Reset
30 fps

Future?

ROS 2

coming soon...

ETH Zürich

Autonomous Systems Lab

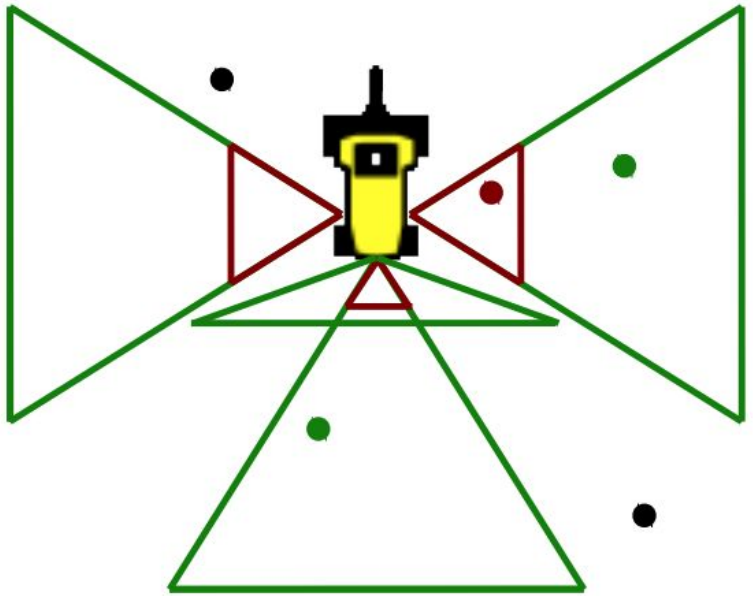
CSIRO

Actual Projects:

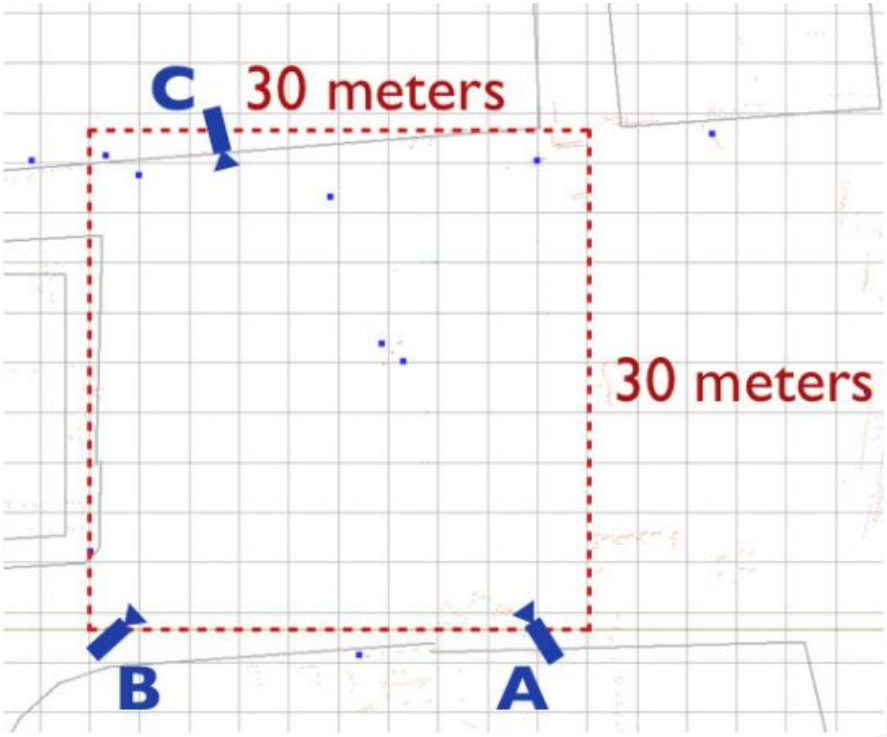
People detection for HMC

Joint Human Detection From Static and Mobile Cameras
http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6894232&tag=1

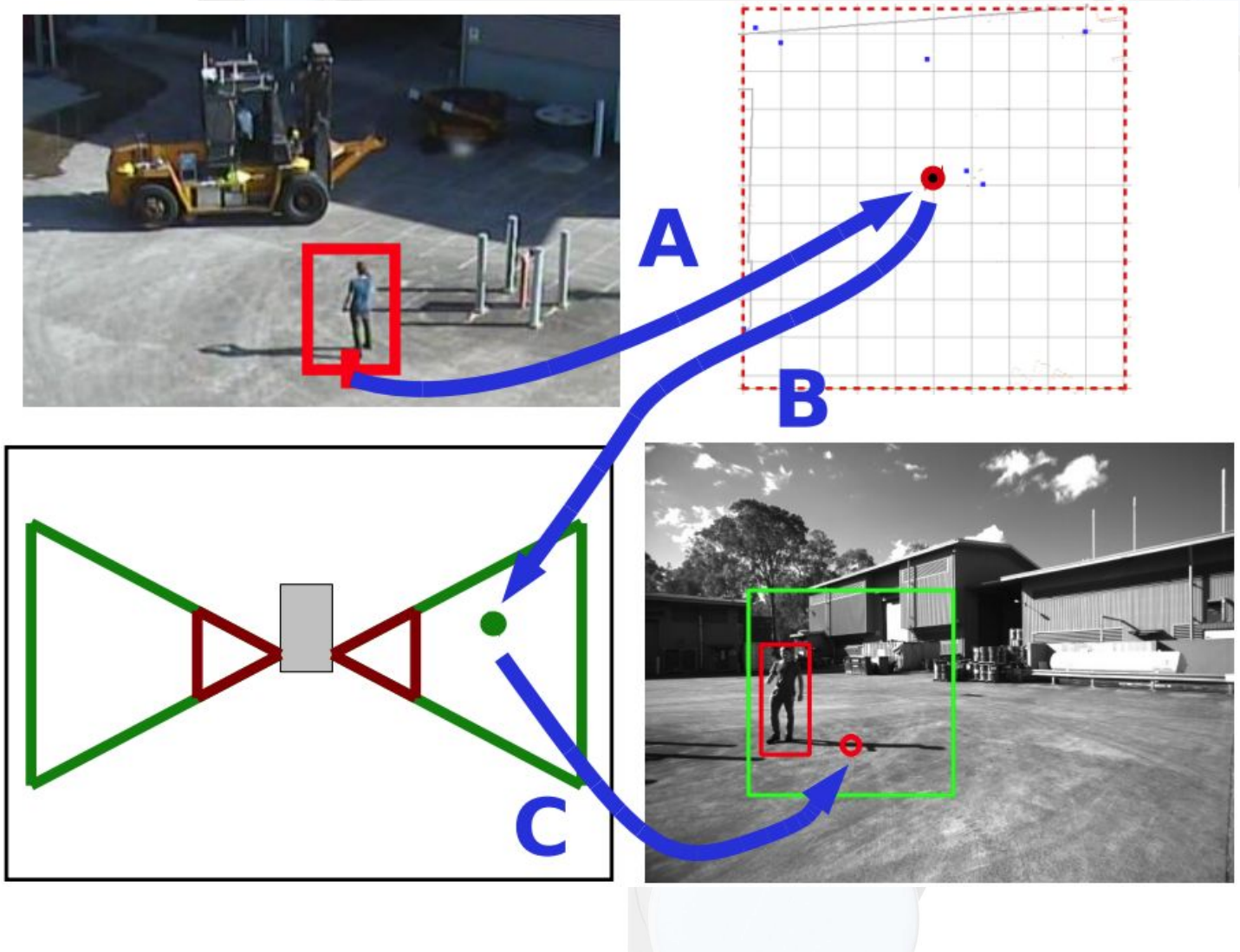
Autonomous Hot Metal Carrier (HMC)



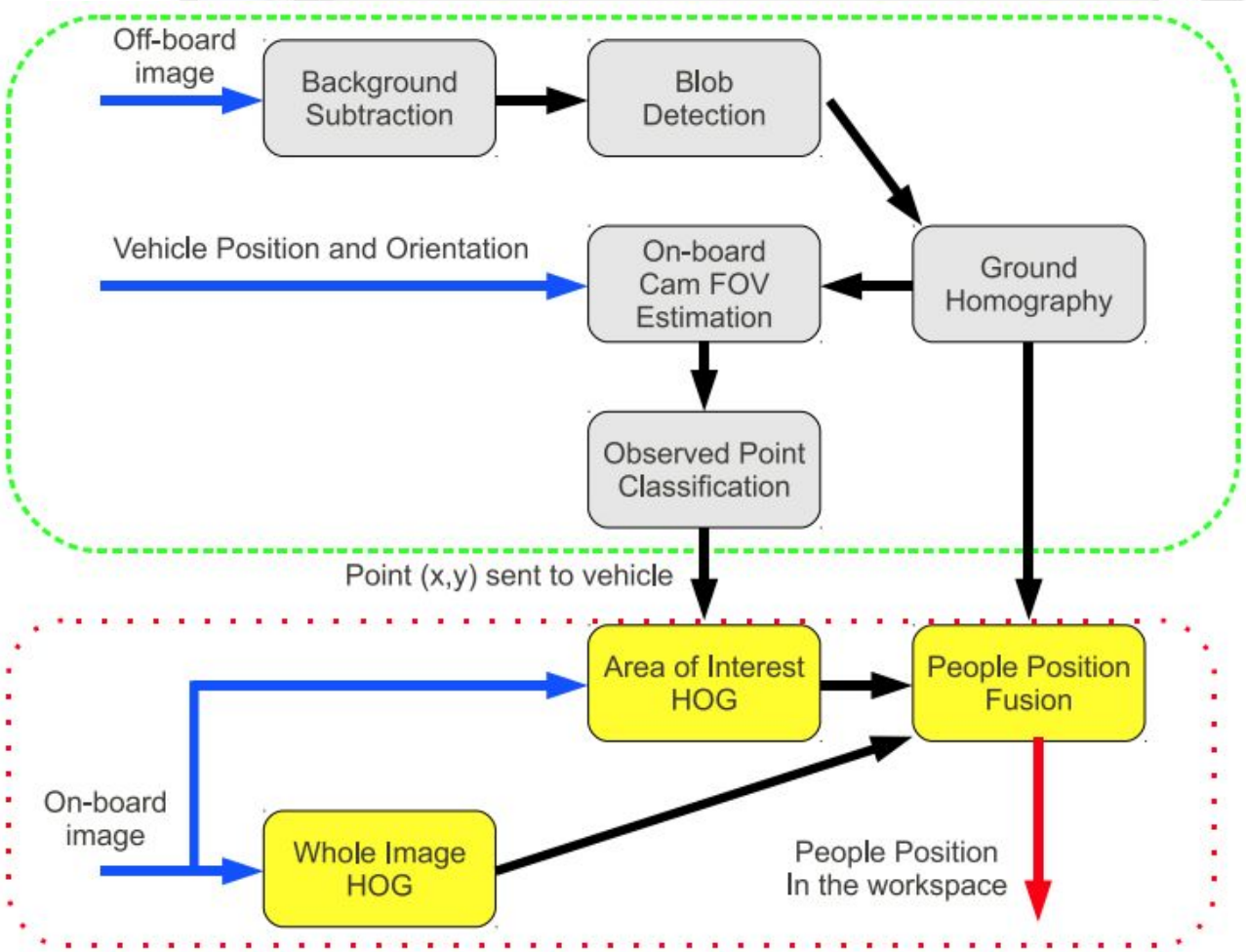
Workspace



Detection Process



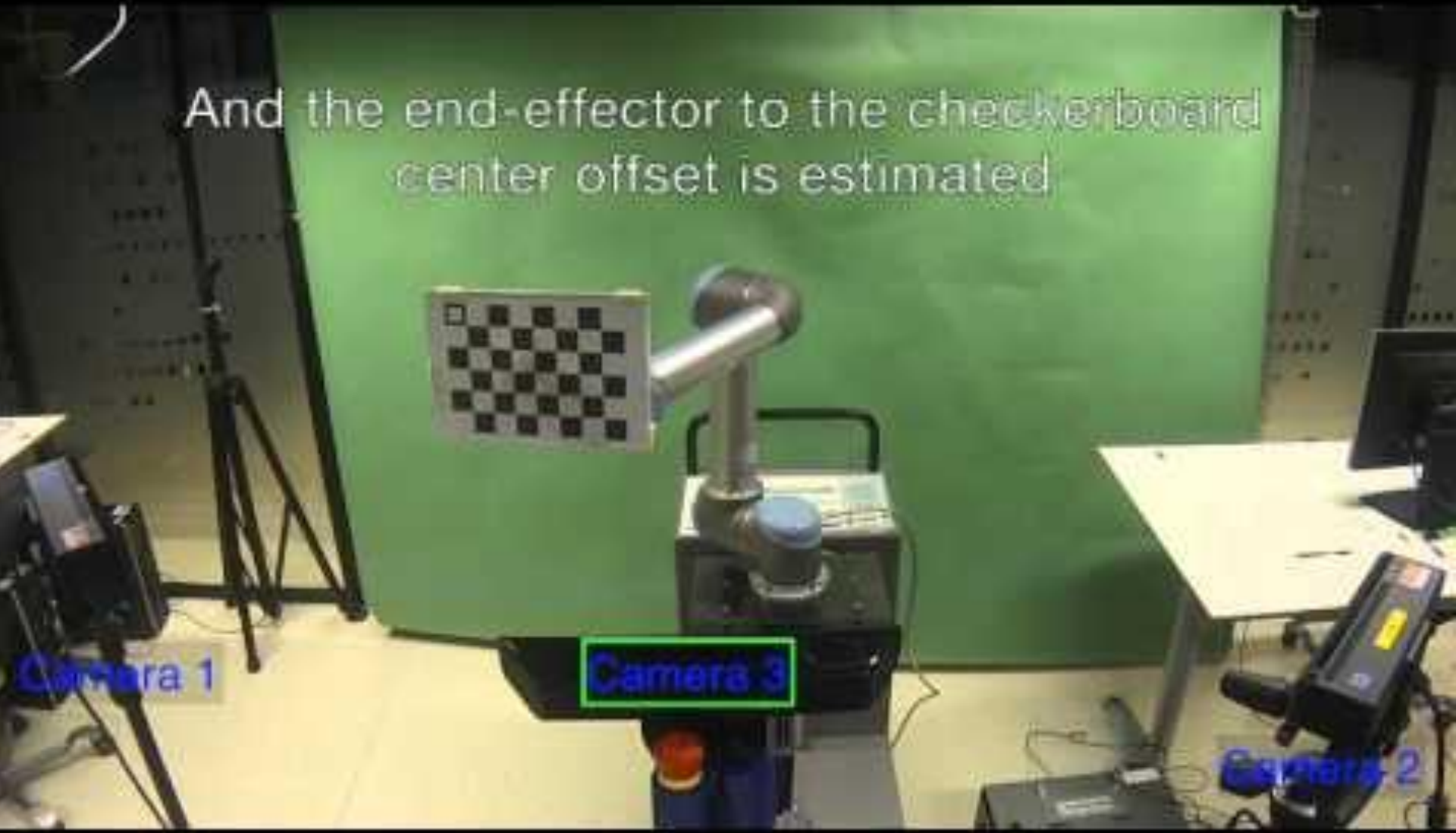
Algorithm Diagram



UiO : University of Oslo

Automatic Calibration of Kinect - Robot System

Automatic Calibration of a Robot Manipulator and Multi 3D Camera System
https://arxiv.org/abs/1601.01566

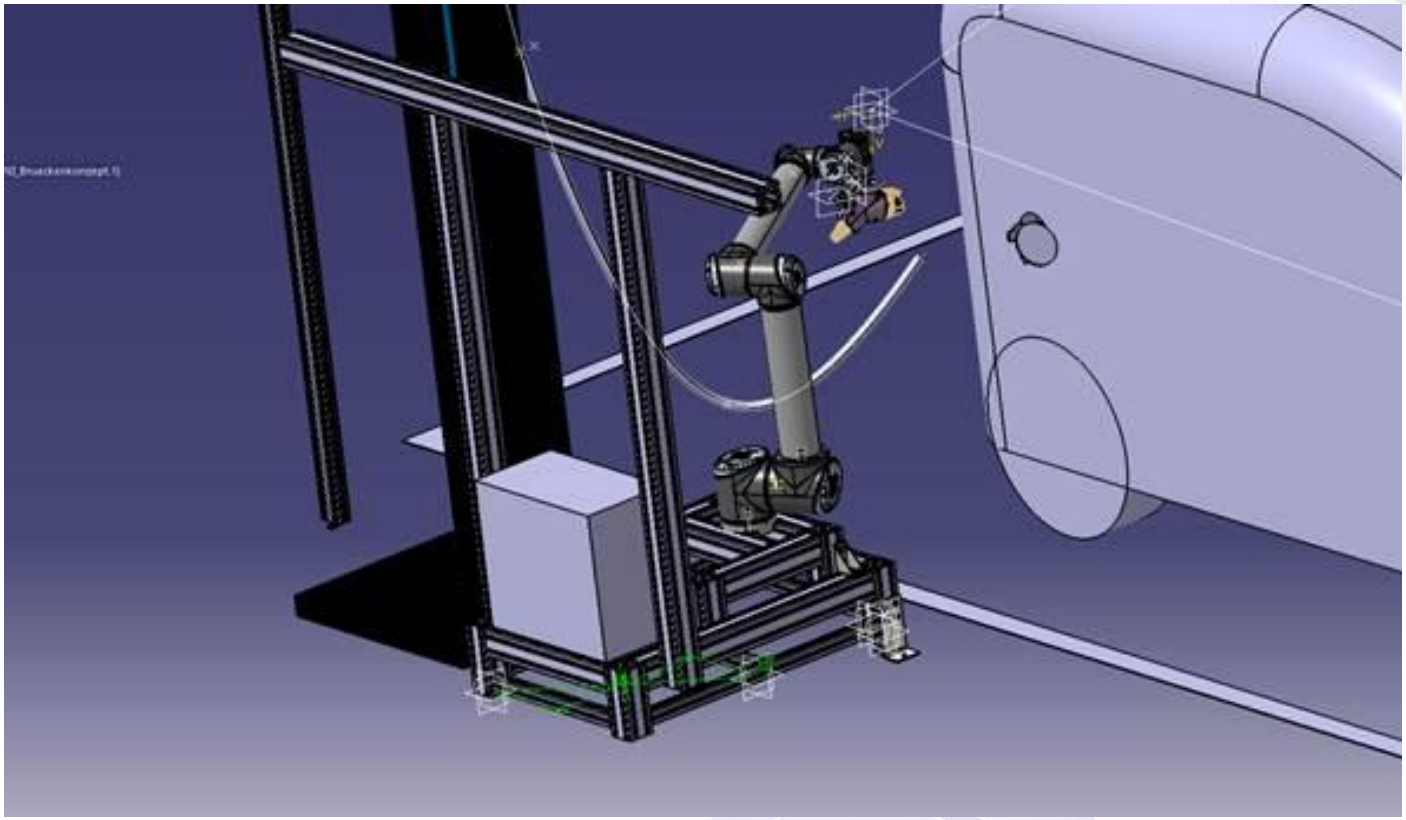

And the end-effector to the checkerboard
center offset is estimated
Camera 3

UiO : University of Oslo

TU Graz

Robot-Based Electric Vehicle Charging Station

Work in progress...



Summary

- ROS is a meta-operating system for robotics
- Provides basic (and many!) algorithms for robotics
- Modular approach allows easy adaptation to hardware changes and both hw and sw updates
- Effective visualisation and simulation tools
- World-wide spread in research and commercial use
- BSD license - open source, free to use!
- Over 120 robot platforms support ROS, and growing!
- Easy to start
- Linux based, best works on Ubuntu
- Easy to parallelise, nodes based approach communicate over TCP and can be synchronised using timestamps for messages

Useful URLs

- http://www.ros.org/ - ROS homepage
- http://www.ros.org/is-ros-for-me/ - Is ROS for me?
- http://wiki.ros.org/ROS/Installation/TwoLineInstall
- http://moveit.ros.org/ - MoveIt!
- http://wiki.ros.org/rviz - RViz
- http://nootrix.com/downloads/ - ROS virtual machine
- http://opencv.org/ - OpenCV
- http://pointclouds.org/ - Point Cloud Library
- http://www.theconstructsim.com/ - ROS Academy

Thank You!

Any Questions?