Tech United 2015/2016

Workshop – November 2015, Aveiro, Portugal

TU/e Technische Universiteit Eindhoven University of Technology

Content

Planning toward RoboCup 2016

- Kinect 2
- Shooting at goal
- Faster gameplay

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Kinect v1 has shortcomings

- Currently using Kinect v1
  - CCD has low sensitivity:

Much light	Low exposure	**30 Hz image stream**
Low-light	High exposure	**15 Hz image stream**

  - CCD has bad quality colors
  - Stability problems
  - Depth range limited to 6 m
    - Full speed ball (10 m/s) arrives in 0.6 seconds after first possible detection

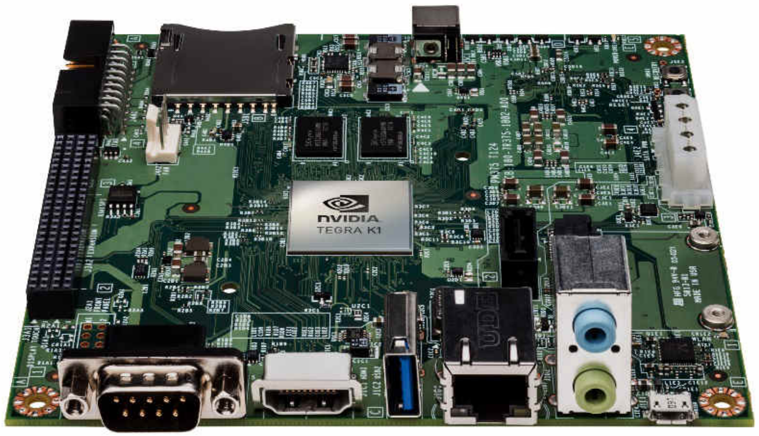
Solution: Kinect v2

- Use the Kinect v2
  - Higher quality CCD
    - More sensitive: always 30 Hz
    - Better color quality: easier to find the ball
  - Less stability issues (hopefully ☺)
  - Increased depth range to 9 m
    - Time-of-flight i.s.o structured light
  - Increased view angle

Implementation: GPU dev board

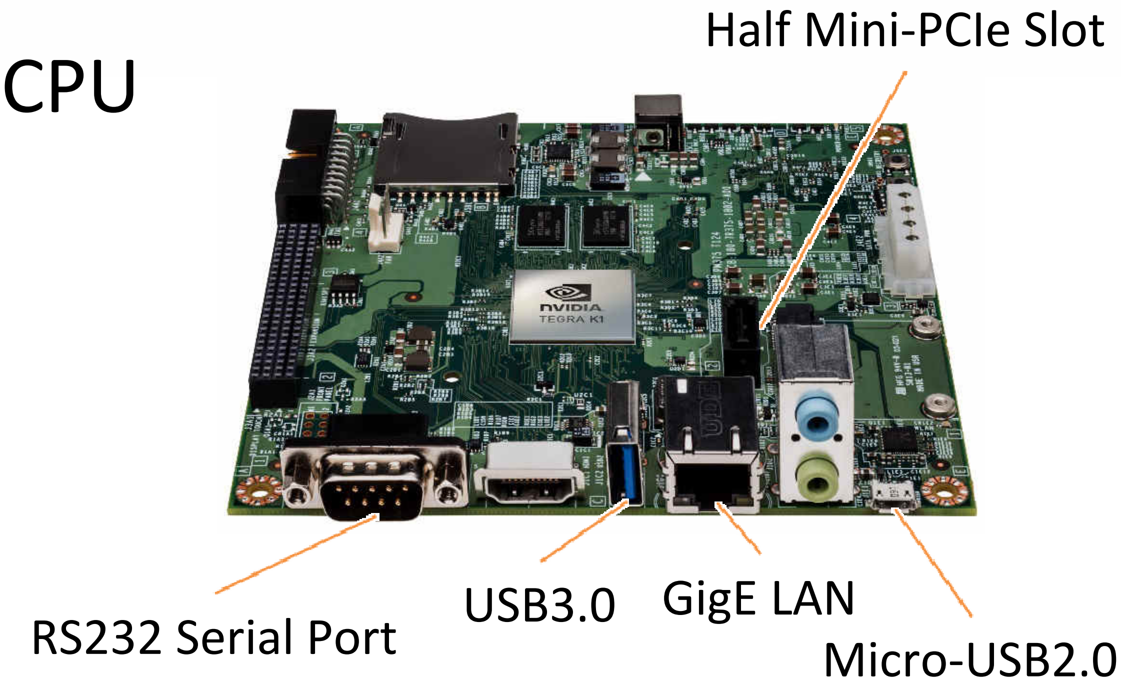
- Kinect v2 requires GPU
  - Robot pc's: Beckhoff industrial PC
    - No GPU
    - No space

- Solution:
  - Jetson TK1 dev board



Jetson TK1

- Tegra K1 SOC
  - NVIDIA Kepler GPU with 192 CUDA Cores
  - NVIDIA 4-Plus-1™ Quad-Core
  - ARM® Cortex™-A15 CPU



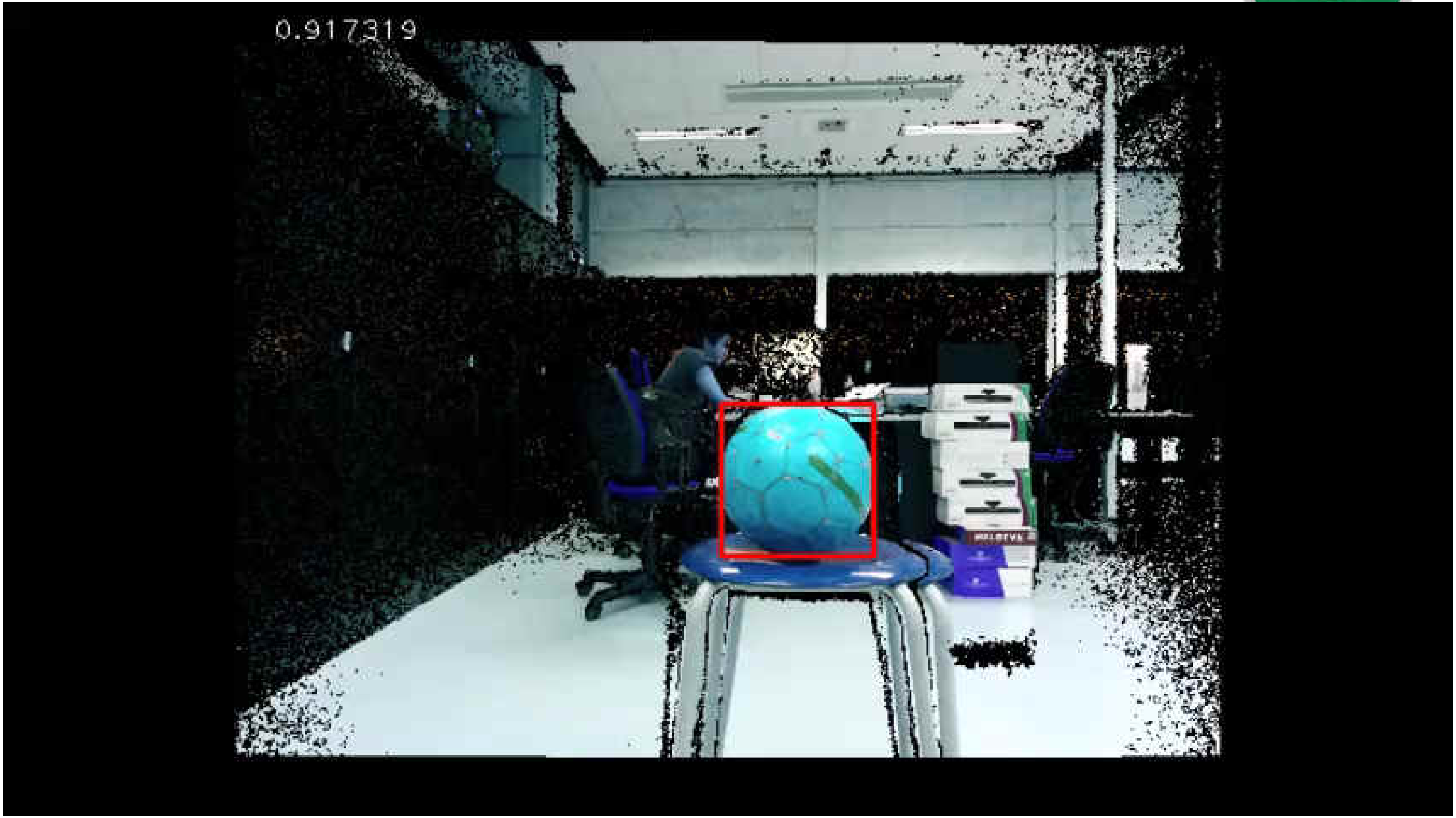
Ball detection

- Registration of depth and color image
- Color segmentation using Google annotated database
- Floodfill algorithm for blob detection
- Blob selection based on:
  - Size:distance ratio
  - Width:height ratio
- Transformation to robot coordinates

Jetson implementation

- GPU
  - JPEG decompression of color stream
  - Depth reconstruction from IR phase images
  - Floodfill
- CPU
  - Registration (near future: GPU)
  - Color segmentation (fast enough)
  - Blob selection

Result

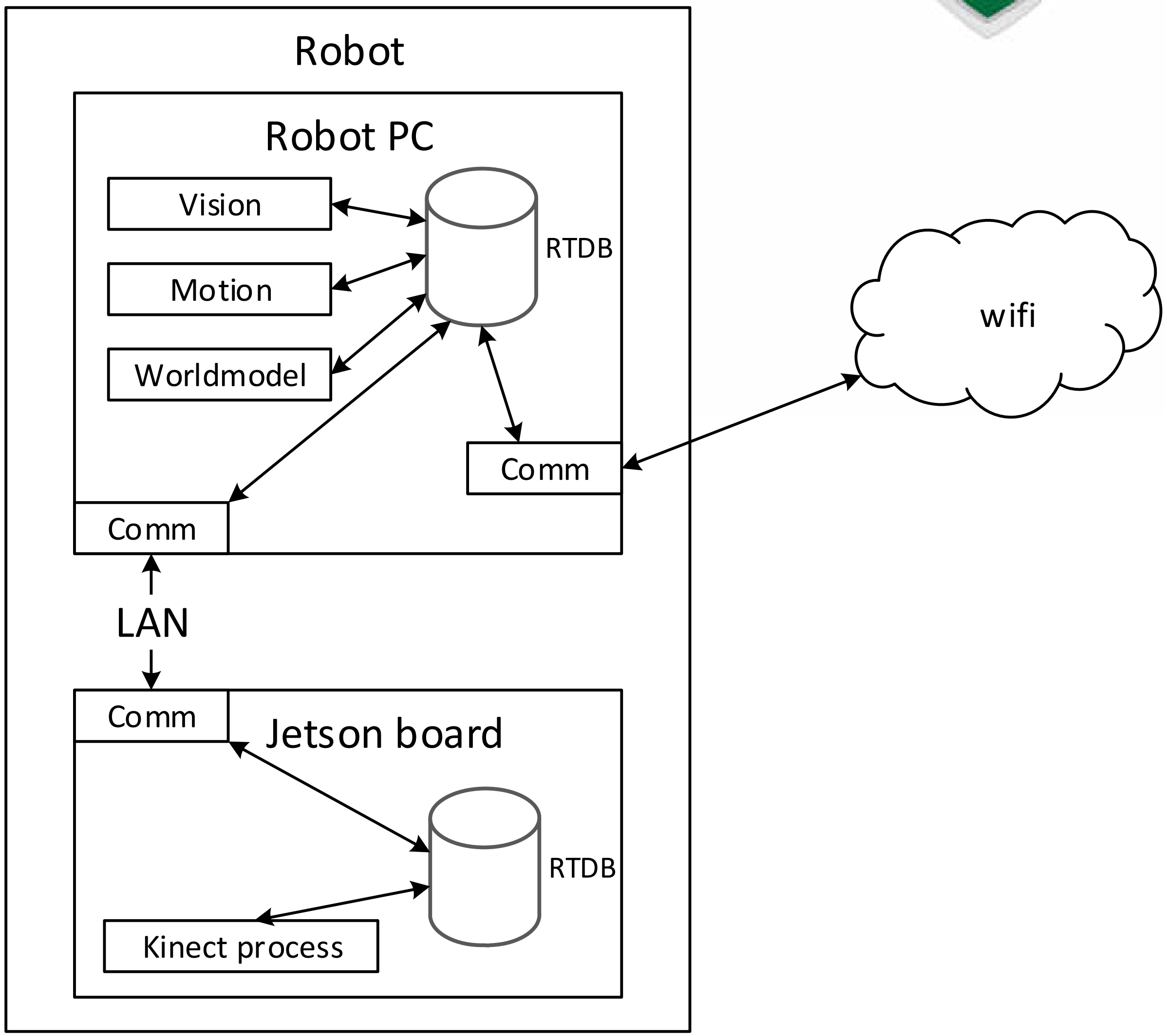


Future work

- Use field to compensate for mechanical tilt
  - Adopt from Kinect v1 implementation
    - Iteration with SVD and removal of outliers
    - Lowpass filter on tilt angles
- Detect obstacles
  - Remove field from registrated image
  - Everything left is ball or obstacle
- Detect lines + goal
  - Improves sensor fusion + shot accuracy

Communication with Jetson

- Re-use of RTDB/comm
  - Second comm process
  - Flexible interprocess communication
- Possible performance / reliability improvements
  - Remote records
  - TCPIP i.s.o UDP
  - Triggered i.s.o fixed rate



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Shooting at goal

Efficiency semi-final and final RoboCup 2015

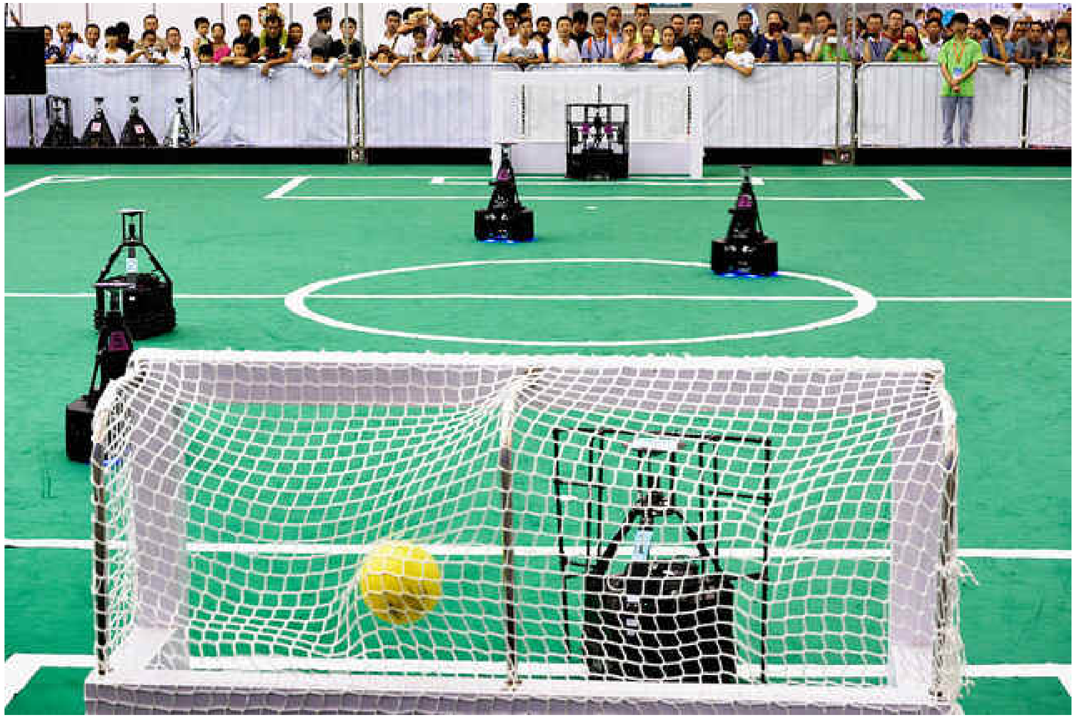
•Semi-final 29% successful goal attempts

•Final 7% successful goal attempts

Shooting at goal

Solution for improvements

- Improve lob shots at goal
- Implement shooting with effect at goal



Improve lob shots

Problems with current lob shots

- Inaccurate
- Shooting angle fixed at 45 degrees
- Low velocity in *xy*-direction

Goal

- Accurate lob shot with adjustable shooting angle

Improve lob shots

Objectives

- Validate ball model for a bouncing ball
- Determination of relation ball trajectory and lever settings
- Inverse problem; from desired target *xyz* to initial inputs *K* and *L*

Improve lob shots

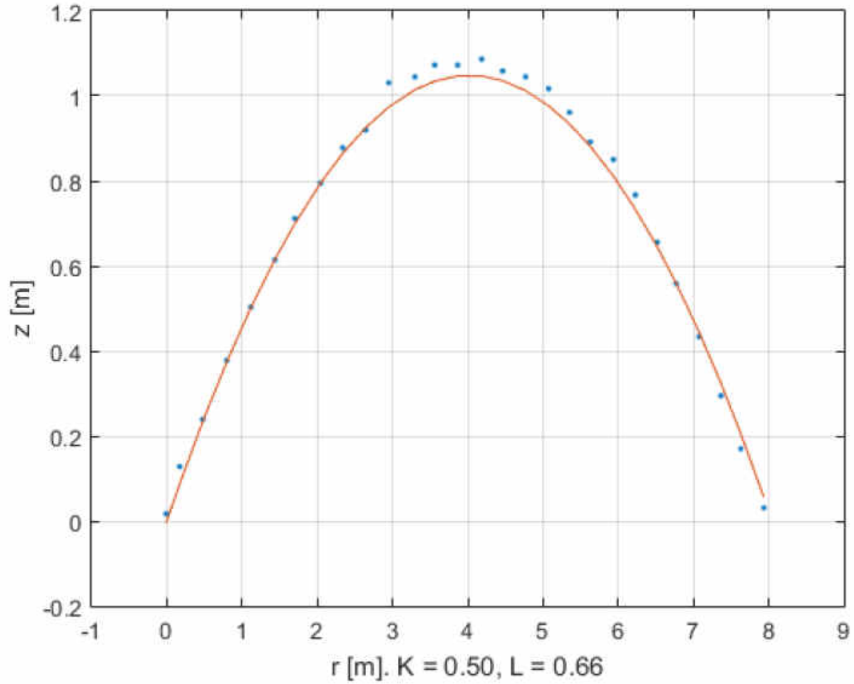
Ball model validation

•Parabolic ball trajectory dependent on gravity, ball velocity v_0 shooting angle α_0.

Improve lob shots

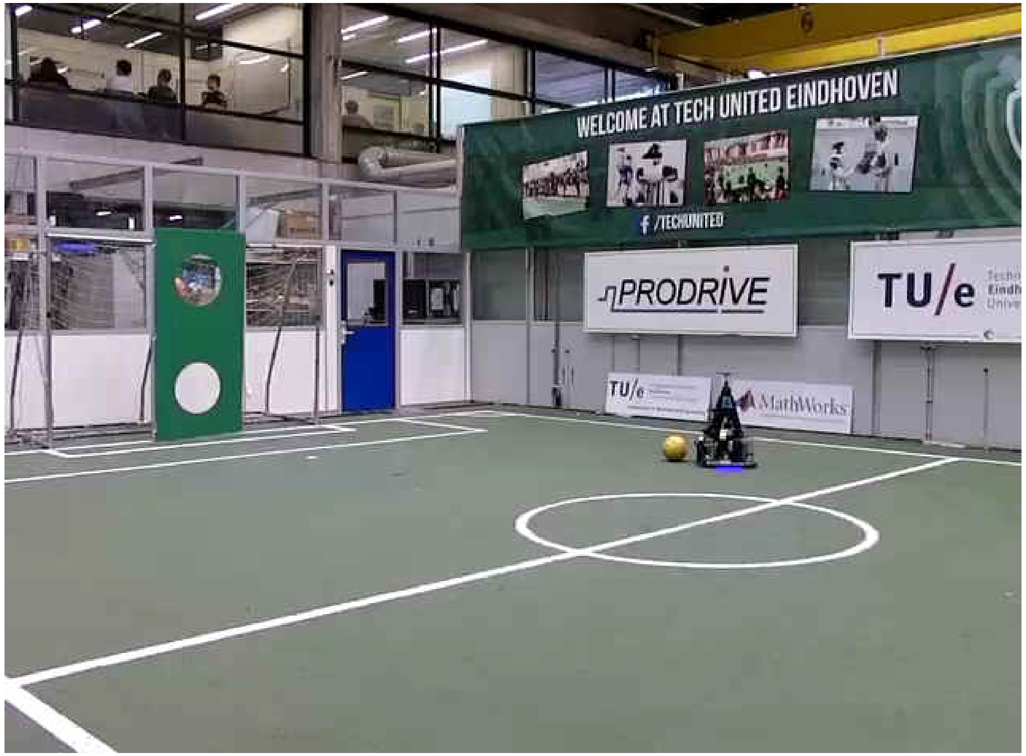
Ball trajectory for *K* and *L*

•Determination of relation ball trajectory and lever settings (*K* and *L*)

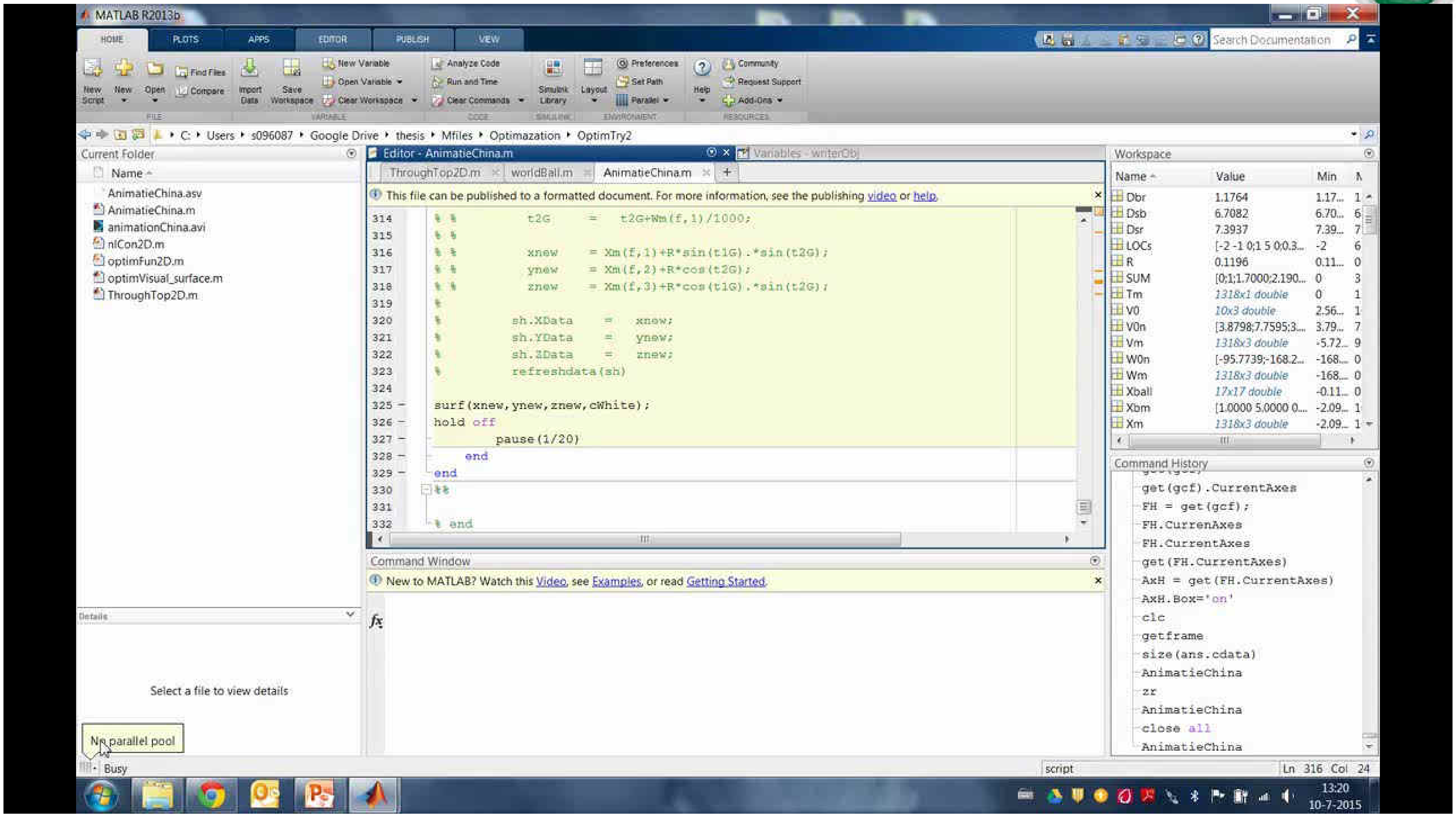


Results

Inverse model; desired target *xyz*



Implement shooting with effect



Shooting with effect

Objectives

- Estimating path of ball for n bounces as a function of initial velocity $\bar{V}_0$ and initial rotational velocity $\bar{\omega}_0$
- Inverse problem; from desired target to initial inputs
- Model the effects of shooting lever and ball handling on the ball
- Use model to achieve correct desired $\bar{V}_0$ and $\bar{\omega}_0$

Shooting with effect

Results so far

- Estimating path of ball for n bounces as a function of initial velocity $\bar{V}_0$ and initial rotational velocity $\bar{\omega}_0$
- Inverse problem; from desired target to initial inputs
- Model the effects of shooting lever and ball handling on the ball
- Use model to achieve correct desired $\bar{V}_0$ and $\bar{\omega}_0$

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Faster gameplay

Current strategy implementation

- Role-based strategy
- Fixed behavior implemented in role
- Behavior change requires role switch

Limitations

- Tasks/action coupled to role
- "State" is not preserved during role switching

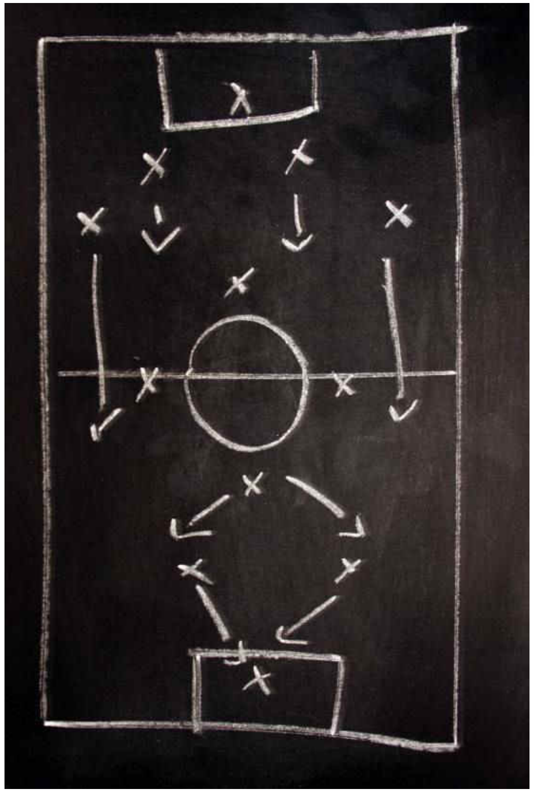
Faster gameplay

New implementation

- No behavior implemented in roles
- All actions can be shared between roles
- Sequences of actions

Improvement enables

- Faster gameplay
- Easier passing with multiple robots
- Longer planning horizon



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Thank you