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Robot Soccer Team for RoboCup Humanoid KidSize League

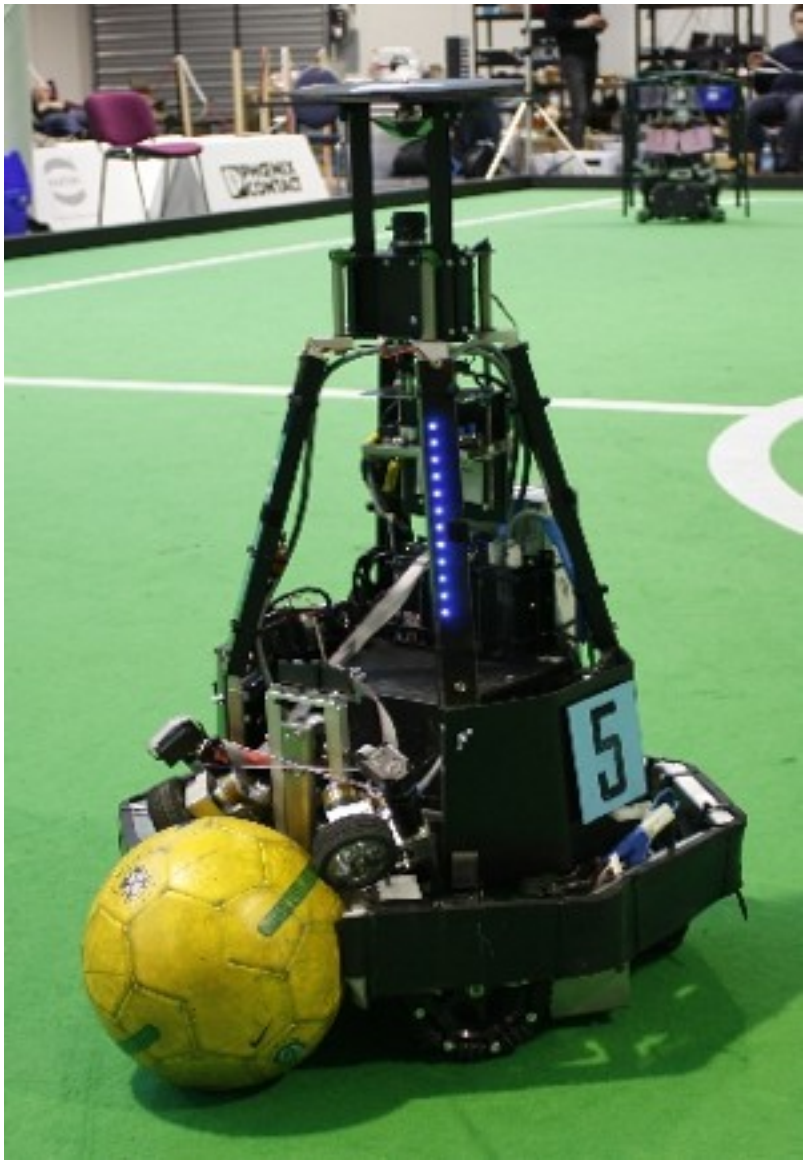
TUSUR University, Tomsk, Russia

RoboCup

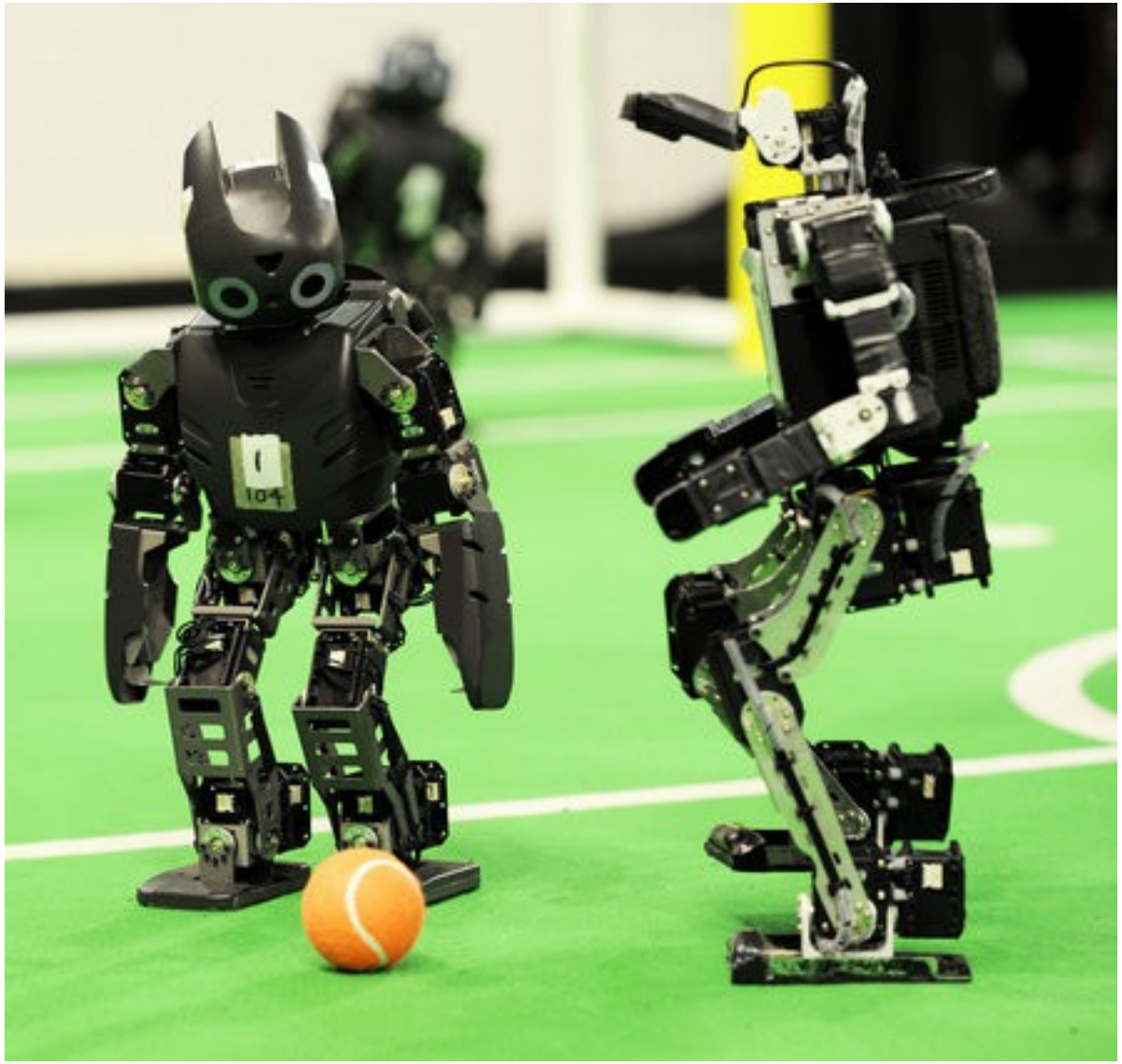
- Noncommercial, science and cultural project. The aim is to promote robotics and AI research, by offering a publicly appealing, but formidable challenge.
- Robot Soccer World Cup
- The official goal: "By the middle of the 21st century, a team of fully autonomous humanoid robot soccer players shall win a soccer game, complying with the official rules of FIFA, against the winner of the most recent World Cup."
- The first RoboCup at 1997, 39 teams, 11 countries
- RoboCup 2016, Leipzig: 400+ teams, 45 countries

RoboCup leagues

- RoboCup Soccer
  - 2D Simulation, 3D Simulation, MiddleSize, Standard Platform, Humanoid
- RoboCup Rescue
- RoboCup @Home
- RoboCup @Work
- RoboCup Junior
  - Soccer, Rescue, Dance



RoboCup Soccer Leagues

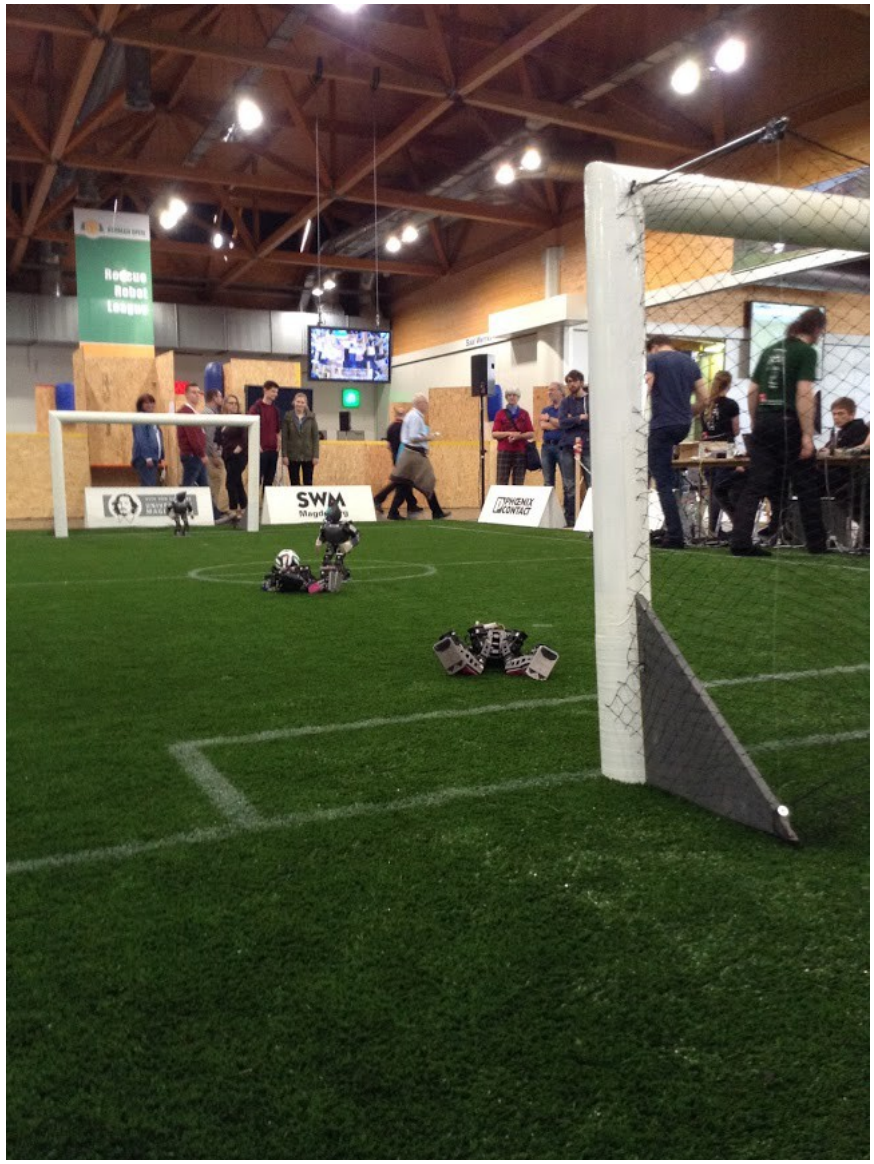


Team Photon

- TUSUR University, Laboratory of Robotics and AI
- Established in 2008
- Specialization:
    - FIRA Cup competition: SimuraSot, MiroSot
    - The Freescale Cup
    - RoboCup:
        - 3D Simulation Soccer (from 2013, RoboCup Japan Open 2013 – I place)
        - Humanoid KidSize Soccer (from 2015)
- Bachelor & master students

RoboCup Humanoid KidSize Soccer league rules

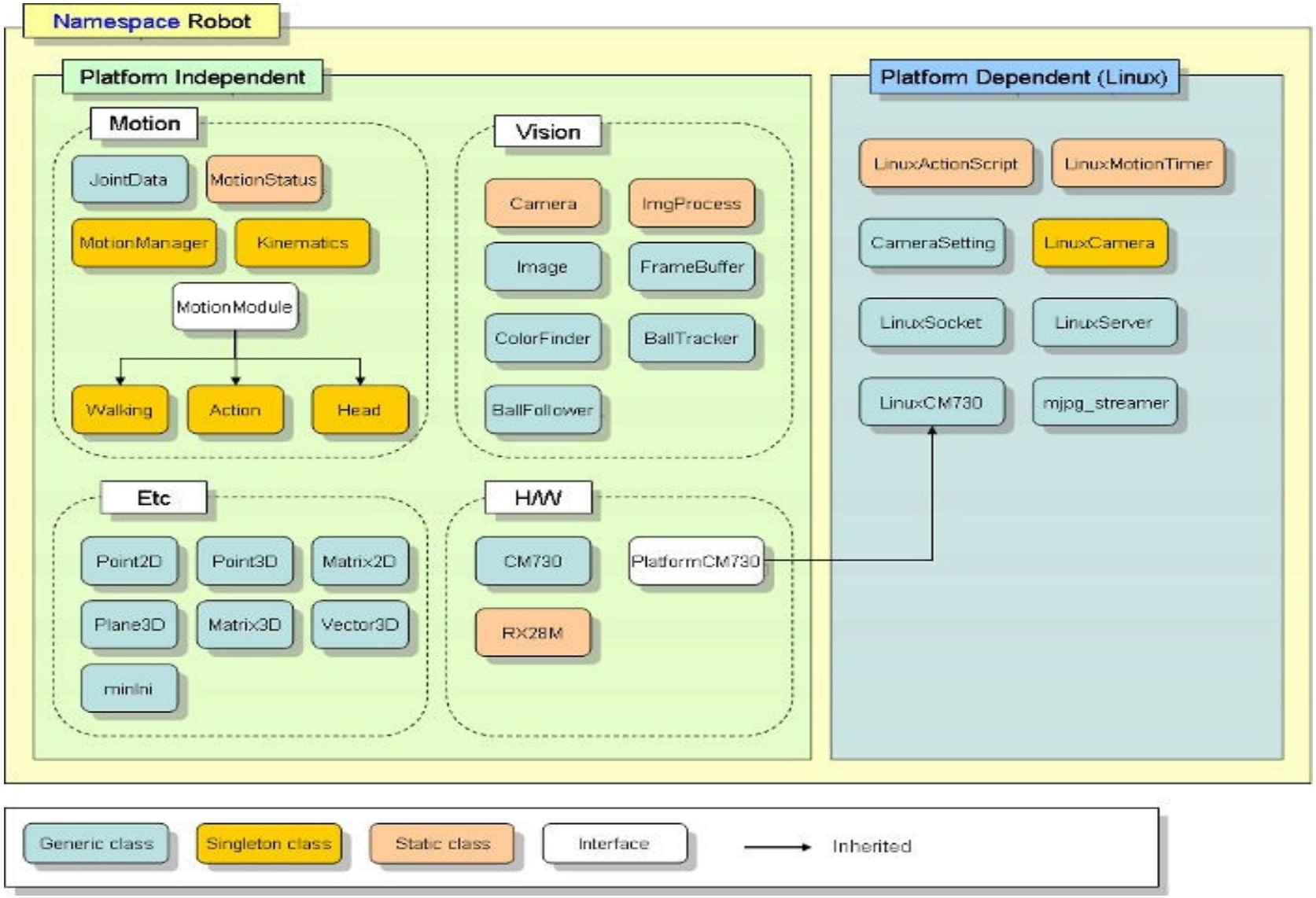
- Before 2015
  - Field size: 4*6m
  - Ball: 8cm, red color
  - Goal posts color: blue and yellow
- From 2015:
  - Field size: 6*9m
  - Field surface: green, artificial grass, height 3 cm
  - Goal posts color: white
  - Ball: FIFA Size 1, 50% white color



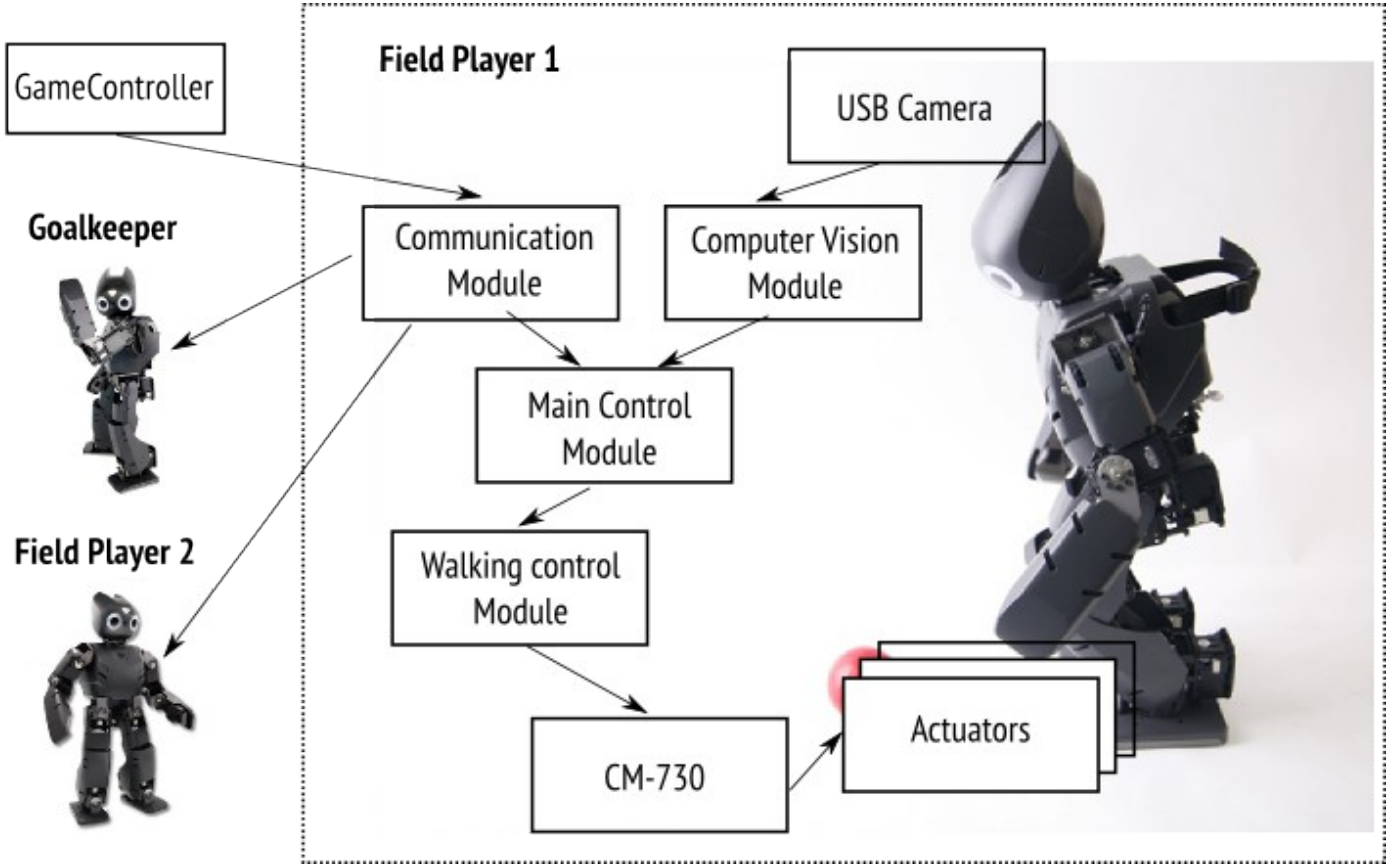
Robot hadware

- Robotis DARWin-OP:
  - Height: 45,5 cm
  - 20 DOF
  - 20*Dynamixel MX-28 actuators
  - USB Camera
  - Gyroscope, accelerometer
  - Intel Atom Z530
  - Ubuntu Linux
  - DARWin-OP Framework

DARWin OP Framework



General architecture



- Team: 3 robots: 1 goalkeeper and 2 field players
- Communication with GameController for RoboCup Humanoid Leagues
- Programming languages: C++ and bash scripting language

Walking control module

- Omnidirectional adaptive movements on playing field + performing pre-programming movements (Actions)
- Low level - DARwIn OP Framework
- Walking controller:
  - Tuning robot gait parameters
  - High level functions: Move forward, Follow the ball, Turn on the spot...
- Actions:
  - Kick the ball
  - Get up after fall
  - Goal protection (for goalkeeper)

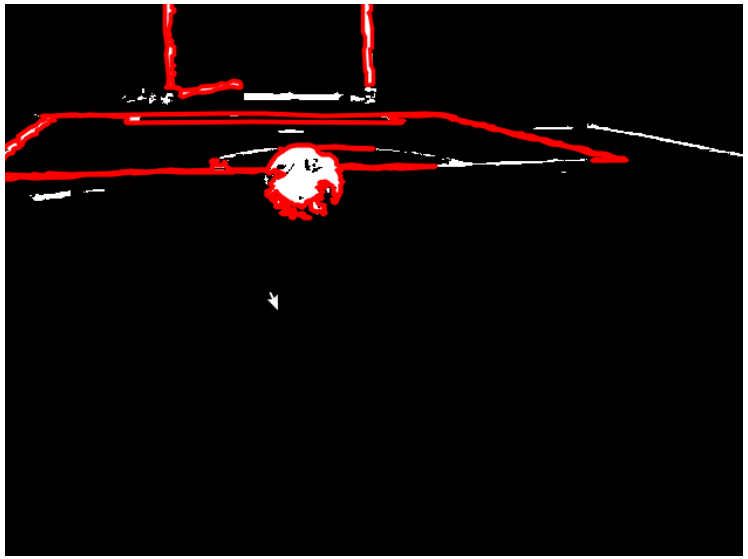
Computer vision module

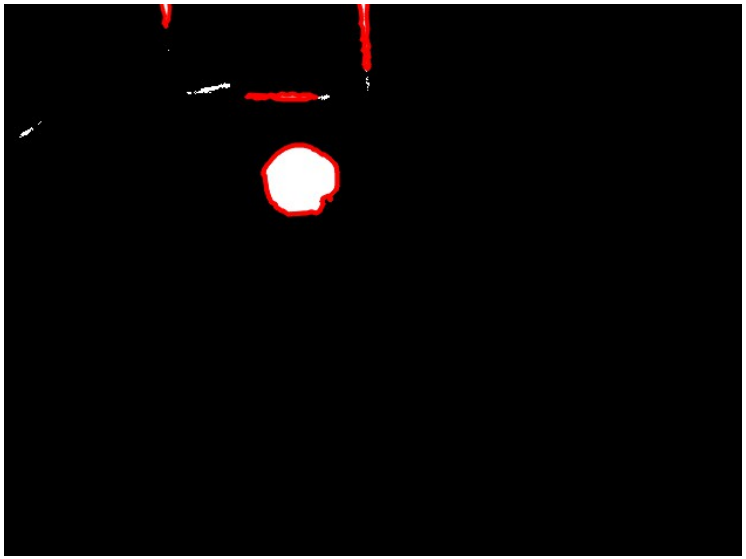
- Search the FIFA Size 1 ball with 50% white color
- Search the goal
- Compute distance to ball, ball speed and moving direction
- Framerate: no less than 10 frames/s

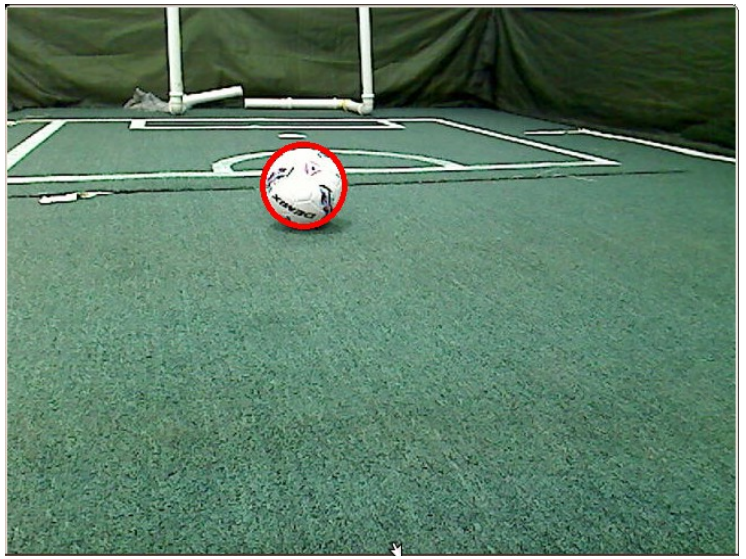
FIFA Size 1 ball detection

- OpenCV library used
- RGB->HSV conversion
- Image binarization
- Blurring image (to get rid of small objects)
- Searching contours similar to circle
- Select the larger round object on the field

Ball detection







Goal detection

Histograms of oriented gradients method used

Capture image from camera

Image binarization

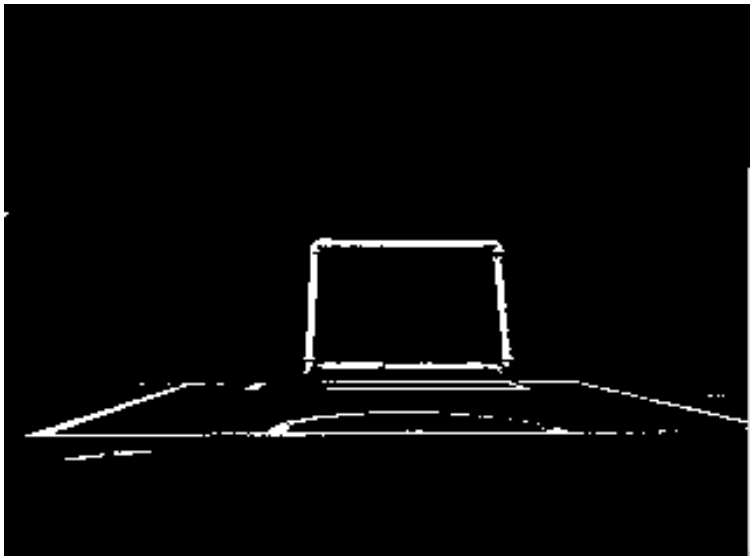
Binarized image is divided into 640 v-stripes

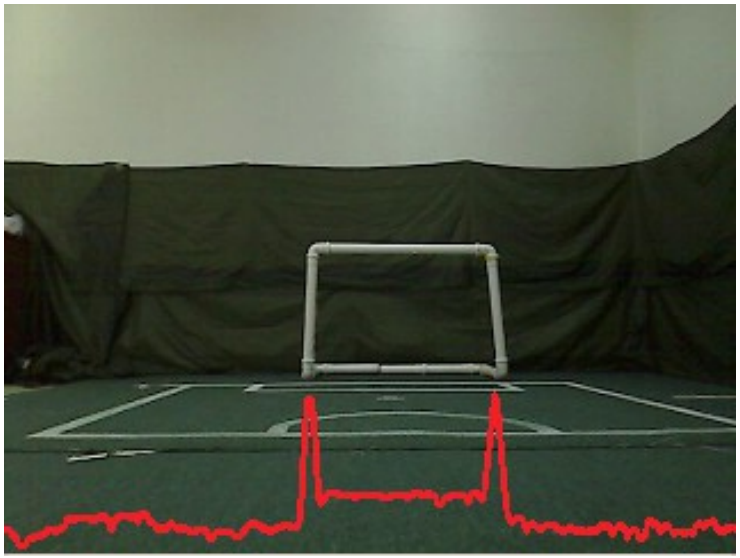
Histogram created on the number of white pixels in each v-stripe

Finding two peaks – goal post

Finding center of the goal and robot position relative to goal

Goal detection



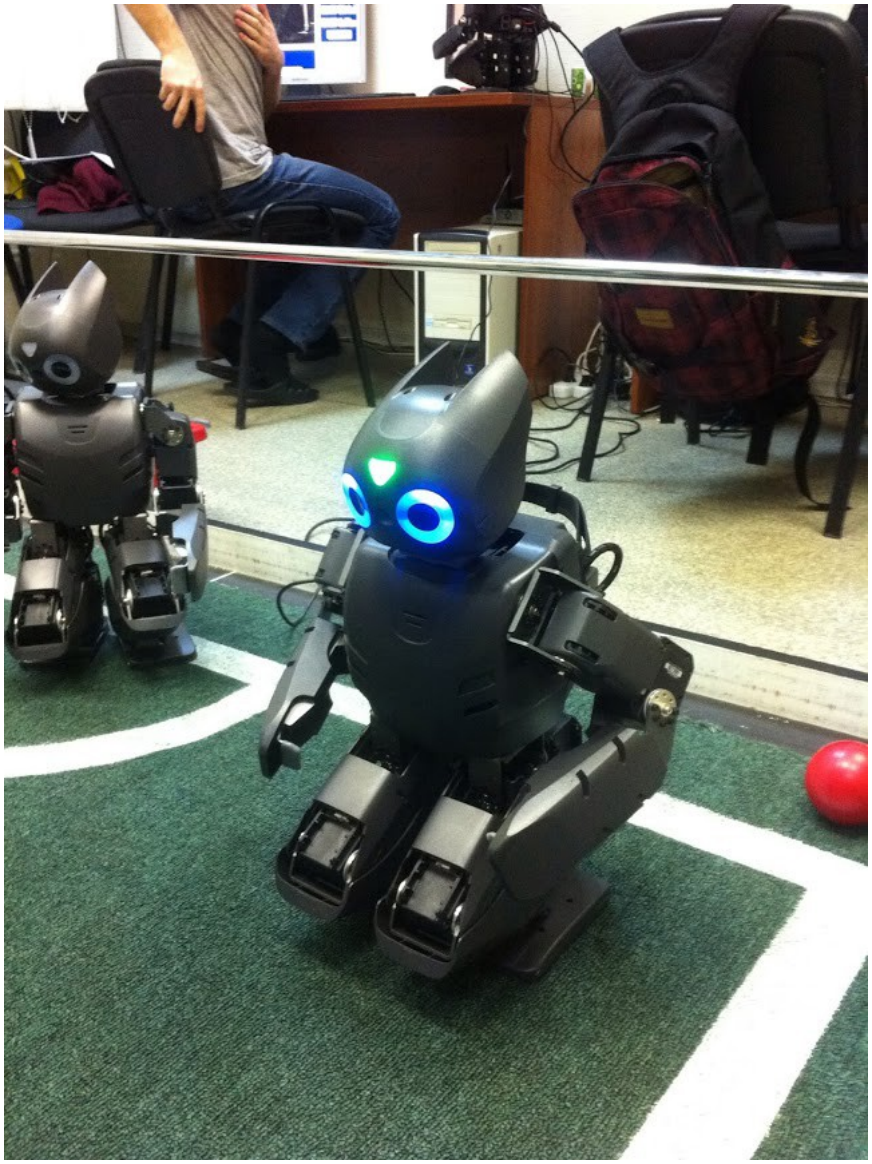


Communication module

- Communication with RoboCup Humanoid Soccer GameController
  - Open source software
  - Broadcast packets over UDP
  - Information about current state of the game (INITIAL, READY, SET, PLAYING, FINISHED)
  - Obtain packets, send replies and set states for behaviour of the robot
- Interaction between team players
  - Broadcast UDP packets
  - Information about self (estimated position on field, direction, distance to ball, distance to goal)
  - Basic coordination of robot activitites
  - Information from goalkeeper help us to determine on which half of the field ball

Main control module

- Event-oriented programming
- Set of states:
  - FINDBALL
  - BALLFOLLOW
  - FINDGOAL
  - KICKBALL
  - STANDUP
- Event markers: “signal from GC”, “the robot has fallen”, “ball in the strike zone”, etc.
- Robot eyes color — for indication current state



Experiments

- Laboratory of robotics room
- Field tests: RoboCup German Open 2015, Magdeburg, 24-26.04.2015
- Fine tuning of walking parameters, vision modules
- We won II place in KidSize league!

Conclusions

- As a result we have developed software for team Photon of RoboCup Humanoid KidSize league
- We have made laboratory and field test of developed software
- Team Photon took II place at RoboCup German Open 2015

Thank you for attention!

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