MARIO: Modular and Extensible Architecture for Computing Visual Statistics in Robocup SPL

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Francesco Laus, Gianluca Di Stefano, Michele Brienza, and Rocchina Romano

https://github.com/unibasteam/MARIO-Modular-and-Extensible-Architecture-for-Computing-Visual-Statistics-in-Robocup-SPL

https://sites.google.com/unibas.it/wolves/robocup/robocup-2022?authuser=0

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- HW Requirements
- Runtime performance

Novel approaches proposed are highlighted in red.

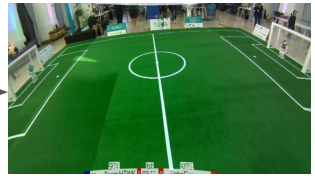
Short Term Goals

CAMERA CALIBRATION

$$K = \begin{bmatrix} f_x & 0 & o_x \\ 0 & f_y & o_y \\ 0 & 0 & 1 \end{bmatrix}$$

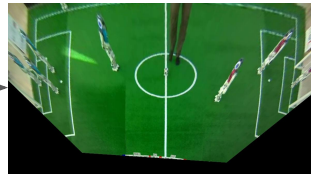
A preliminary camera calibration is performed to remove the camera lens distortion.

BACKGROUND SUBTRACTION



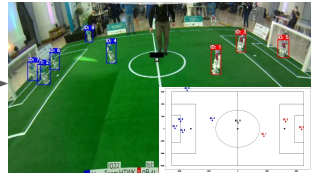
An image subtraction technique combined with a NN model for field's keypoints retrieving is applied.

HOMOGRAPHY



Homography is used to compute a plan view of the field. The entire process is performed automatically.

TRACKING & LOCALIZATION



A combination of YOLOv5 and StrongSORT models is used to track and localize the players and the ball. Tracking data are then projected onto a 2D field view.

K-Means is used to associate the tracking IDs with the Game Controller data

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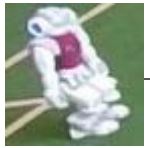
UNIBAS WOLVES RoboCup SPL SOCCER

SPQR TEAM

Novel approaches proposed are highlighted in red.

Long Term Goals



POSE ESTIMATION

A CNN network is used to perform the pose estimation of each robot
A NAO specific dataset has been created specifically for this task.

FALL DETECTION

$$P(y = fallen|x)$$

Based on skeletal information obtained, an Spatial Temporal Graph Convolutional Network (**ST-GCN)** model is used to perform the fall detection.

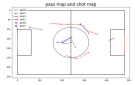
ILLEGAL DEFENDER

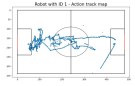
Tracking results are used to check if no more than three players from the same team are in the same penalty area. Their information, with GC data, are stored in a .csv file used for statistics.

DATA ASSOCIATION & STATISTICS

Game data containing player information are stored in a .csv file. The .csv file is used to extract statistics about the game.

GUI





Available statistics: illegal defender, heatmaps, trajectories, ball possession, shots and passes made by robots.

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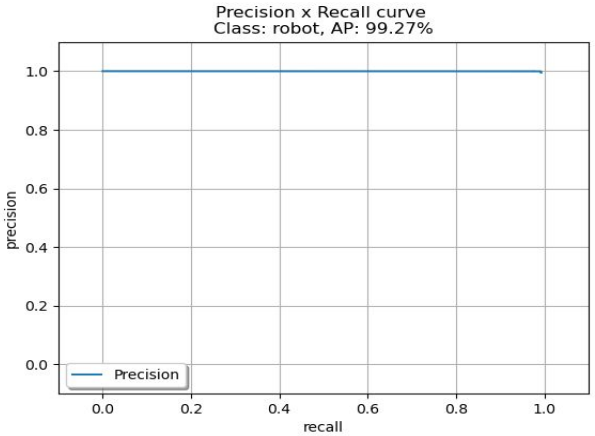
https://www.youtube.com/watch?v=eutyWaQ4-oU

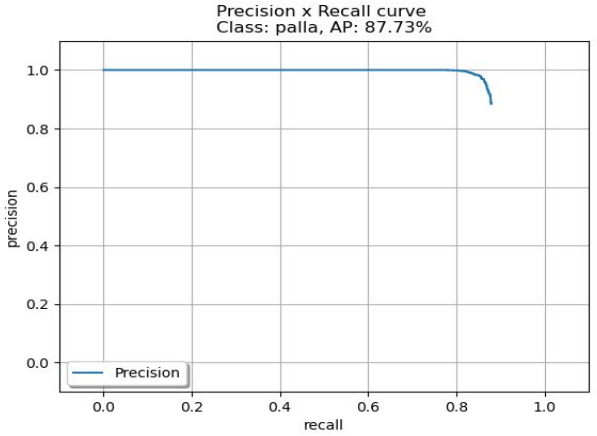
Performance Evaluation

- 35,000 images have been used as data. They are divided in three parts: training (24,000), validation (3,000) and test (8,000). Data are labelled in 2 classes: robot and ball.
- To improve the execution time, we used YOLOv5 model for training the NN.
- The use of YOLOv5 for detection allows a **real-time inference (even on CPU!!!)**



robot

99.27%



ball

87.73%

Runtime Performance

- **LOW PERFORMING HW:**

  CPU: *Intel i3-6006U*

  GPU: *Intel Graphics HD 520*

  RAM: *8 GB*

AVG FPS WITH POSE ESTIMATION: *3*

AVG FPS WITHOUT POSE ESTIMATION: *7*

- **MIDDLE PERFORMING HW:**

  CPU: *Ryzen 7 5700U*

  GPU: *RTX 3050 Mobile 4 GB vRAM*

  RAM: *16 GB*

AVG FPS WITH POSE ESTIMATION: 6

AVG FPS WITHOUT POSE ESTIMATION: 16

- **HIGH PERFORMING HW:**

  CPU: *Intel Xeon W-2135*

  GPU: *Nvidia Quadro P4000 8 GB vRAM*

  RAM: *32 GB*

AVG FPS WITH POSE ESTIMATION: 10

AVG FPS WITHOUT POSE ESTIMATION: 20

Thank you for your attention

Domenico Bloisi

Rocchina Romano

Gianluca Di Stefano

Flavio Biancospino

Cristian Zampino

Francesco Laus

Michele Brienza

Andrea Pennisi