UChile Robotics Team Developments

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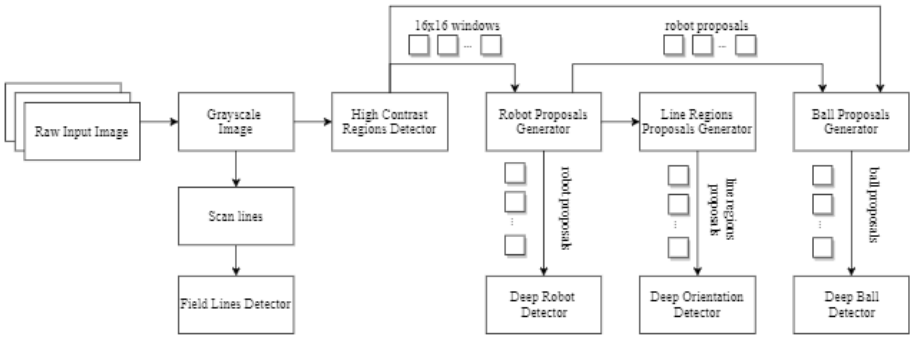
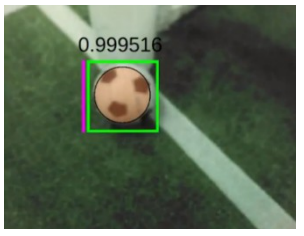
Team Description

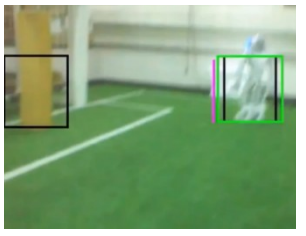
UChile Robotics Team (UChileRT) is a joint effort of the Advanced Mining Technology Center (AMTC) and the Department of Electrical Engineering of the Universidad de Chile in order to foster research in mobile robotics, computer vision and learning algorithms.

New Vision System



The main feature of our framework is that it manages to detect the ball, other players, their orientations, and key features of the field without using any color information: all the processing is performed on grayscale images. This is done by following a cascade methodology that combines classical approaches widely used in pattern recognition and modern CNN-based classifiers.

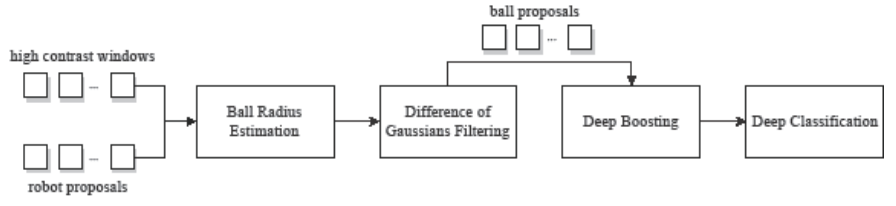




Ball detector

Being able to accurately detect the ball is critical to play properly in SPL matches. We developed a new ball perceptor, which follows the paradigm of proposal generation and subsequent classification using convolutional neural networks. Our new perceptor uses a proposal generator inspired on the ball hypotheses provider created by HTWK team, however, in our approach no color information is used.

To perform the ball detection, the proposals are fed to a cascade of two CNNs which classifies them as ball or non-ball. The first CNN performs boosting in order to both limit the proposals' number to a maximum of five, and sort them based on their confidence. The second CNN performs the binary classification task, meaning that it processes the filtered hypotheses to detect the ball.



Ball Detector Results		
Accuracy	**Proposals Recall**	**Avg. Execution Time**
97.1%	99.3%	3.58ms

Robot detector

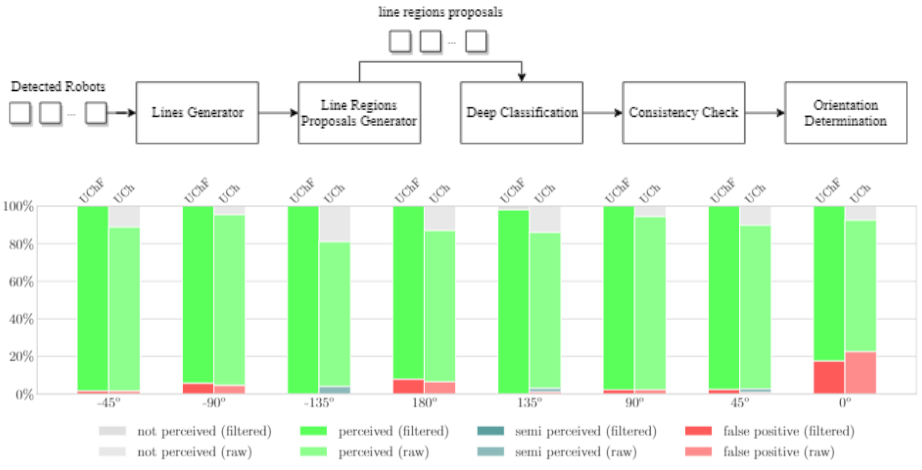
Robot detection is a critical capability of robotic soccer players as it enables the players to avoid obstacles and implement complex strategies. Traditional heuristic robot perceptors achieve excellent results in controlled environments. However, the static color segmentation used by this kind of perceptors performs poorly under challenging light conditions, detecting players on shadows and spotlights. Our new robot detector algorithm uses heuristic based proposal generators, which are then classified by a single input channel CNN.

Robot Detector Results		
Accuracy	**Proposals Recall**	**Avg. Execution Time**
94.9%	97.2%	1.9ms

Orientation Determination

Knowing the orientations of other players provides more information about the state of the game, allowing better strategy planning. In this context, we propose a visual orientation determination system, which makes use of CNNs in order to achieve a good prediction accuracy

Firstly, the system analyzes the camera image robot to determining the lower silhouette of each opponent robot, utilizing image processing techniques and geometric models. In second order, taken the lower silhouette points, we calculate a line model in field coordinates by using a voting methodology akin to the RANSAC algorithm. Then, using a CNN, we classify the previous lines, in order to estimate the orientation of the observed robot. Finally, a circular median filter is applied to the resulting orientation, achieving a better estimation.



Dynamic experiment results. Graph shows a performance comparison between raw (UCh) and filtered (UChF) estimations for our orientation detector.

Search Ball

Our new ball search algorithm follows active vision principles. Together, the robots maximize the field coverage by visually exploring it in a coordinated manner, giving priority to the areas that have not been seen. In order to do this, the field is virtually divided in four areas which are assigned to each player (excluding the goalie). Each robot then calculates its euclidean distance to the four field areas, and then a joint decision is performed in order to minimize the global sum of the distances between robots and areas.