

Executive summary

2022 MSD Autonomous Referee System

The Autonomous Referee (Autoref) project is a part of the EngD program in Mechatronic Systems Design, aimed at designing an autonomous referee for soccer robots. The project has been ongoing since 2016, with MSD trainees making contributions every year. The previous Autoref designs were based on cameras equipped with autonomous drones to use as referees in the RoboCup Middle Size League (MSL). However, the 2020 MSD team removed the requirement of quadcopter drones as the basis for the autonomous refereeing system and emphasized continuity as a key stakeholder concern in system architecture and 2021 MSD team used robot players as "referees" to collect data for the decision-making algorithm.

The focus of the 2022 MSD team was to design an algorithm for checking set piece violations during corner kicks, free kicks, and penalty kicks in the RoboCup Middle Size League (MSL). The project involved using one of the security cameras to capture a video recording of a corner kick procedure and validating the developed algorithm. An object detection algorithm was run in the video recording to detect the ball and players from different teams. A bird's eye transformation was applied to calculate distances between objects. By using the distances, the corner kick procedure was checked, and a signal was sent to the referee depending on the players' positions. A dataset containing robot and ball images was collected, and YOLO detection algorithm was used to detect objects. By dividing the input image or video into a grid of cells and predicting the object class and bounding box for each cell, the YOLO algorithm finds objects in photos and videos.

The project's key milestone was defining the corner kick set piece procedures and checking for any violations according to the defined rules. According to corner kick set piece, two possible scenarios were defined, attacking team scenario and defending team scenario, to validate the results. As a result, we have identified some steps. First, the human referee gives a "corner kick" signal. Next, the robot of the attacking team that is taking the corner kick is positioned at the ball. Then, all other players of attacking team can stay anywhere on the field outside a circle with a radius of 2m around the ball until the ball is in play. The defending players can stay anywhere on the field outside a circle with a radius of 3m around the ball until the ball is in play. The project resulted in a successful implementation of the algorithm for checking set piece violations during corner kicks in Robocup Middle Size League (MSL).

Throughout this project, the team carried out project management, feasibility analysis, requirements engineering, system architecture, algorithm design and implementation, and testing activities. A design-decision matrix was created after the feasibility analysis to decide which technology to use for data gathering. During the project, the team implemented an object detection algorithm on a recorded video of TechUnited turtles to detect the ball and players from different teams and performed an eye bird transformation to calculate the distances for checking violations.

Finally, a "Readme" file in GitHub was created to explain the project and containing links to access all 2022 MSD deliverables. The project's deliverables include , a technical architecture document, a project management plan, feasibility analysis report, developed software and a LinkedIn post. The Autoref project is ongoing, and future MSD teams will continue to work on improving the autonomous referee for soccer robots.