An Evolutionary Approach to Optimal Robot Location in a Soccer Match

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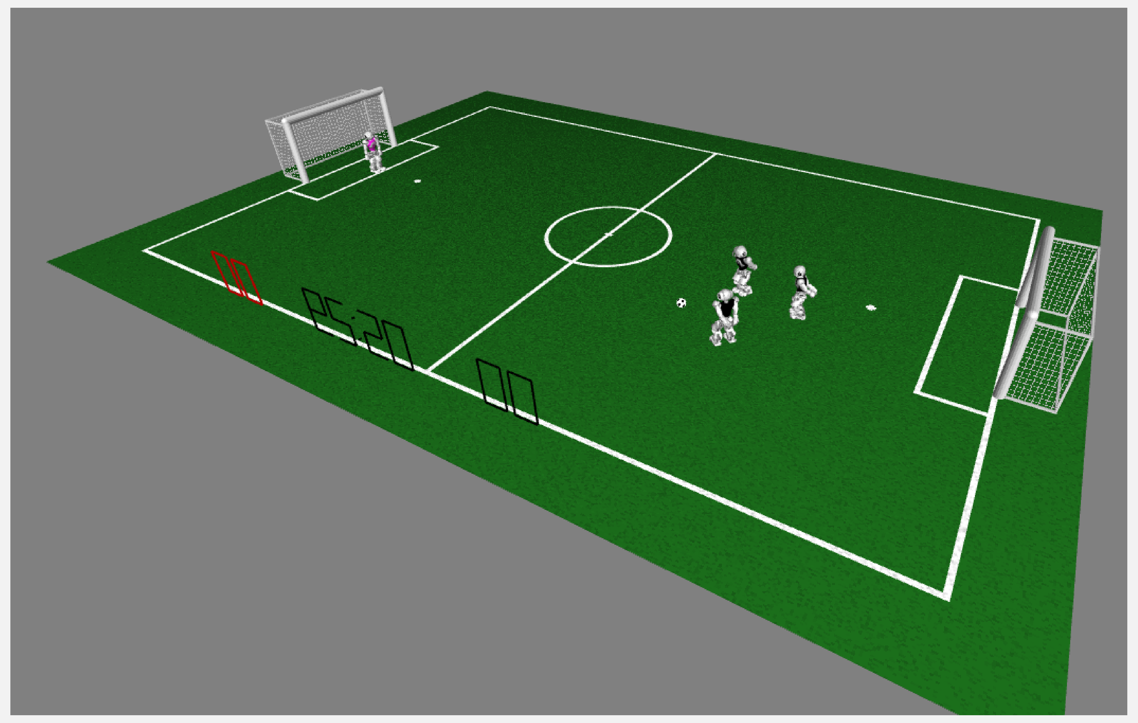
Our Team

The SABANA Herons team is the result of the collaboration between the mechanical engineering and informatics engineering departments of the Universidad de La Sabana. Our team was founded in 2017 and has been gaining experience in different robotics competitions, some in the national context and others internationally. In recent years, the university has been able to participate in various global competition events, such as Shell Eco Marathon Americas (Detroit 2017 and Sonoma 2018), All Japan Sumo Robot Tournament in Japan (December 2017) and RobotChallenge in Mexico (May 2018). Our next goal is to achieve a good participation in Robocup 2019, competing with the university's NAO robot team.

To ensure a good performance in this competition the team has concentrated on the implementation of optimization algorithms to determine the location of robots on the playing field based on static and dynamic game theory [1], on the implementation of heuristic algorithms on the NAO operating system [2] and on the implementation of path planning algorithms.

Algorithms Descriptions

Genetic Locator Algorithm The first algorithm allows to determine the optimal location of the robots on the field based on shared team information and the location of the ball by means of evolutionary algorithms (genetic algorithm).



Path Planner Algorithm The second algorithm is a reformulation of the original B-Human Path Plannig algorithm [3].

Optimization Problem

The optimization problem that each robots solves in real-time to determine the optimal defensive strategy is as follows

$$\begin{aligned} \underset{x_i, y_i}{\text{minimize}} \quad & -A(\vec{X}) + \alpha d(x_i, y_i) + \beta r(x_i, y_i) \\ \text{subject to} \quad & 0 \leq x_i \leq X_{MAX}, \\ & 0 \leq y_i \leq Y_{MAX}. \end{aligned} \tag{1}$$

where

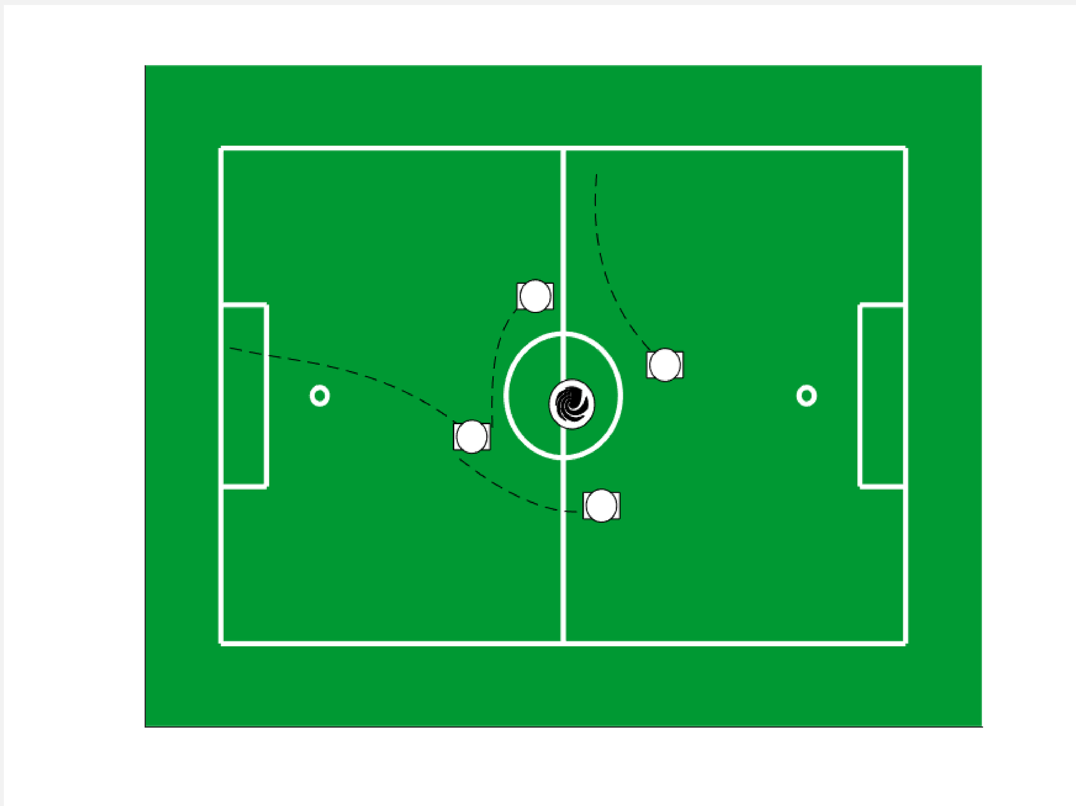
$$A(\vec{X}) = \frac{1}{2} \left| \sum_{k=1}^{n} \det \begin{pmatrix} x_k & x_{k+1} \\ y_k & y_{k+1} \end{pmatrix} \right| \tag{2}$$

and

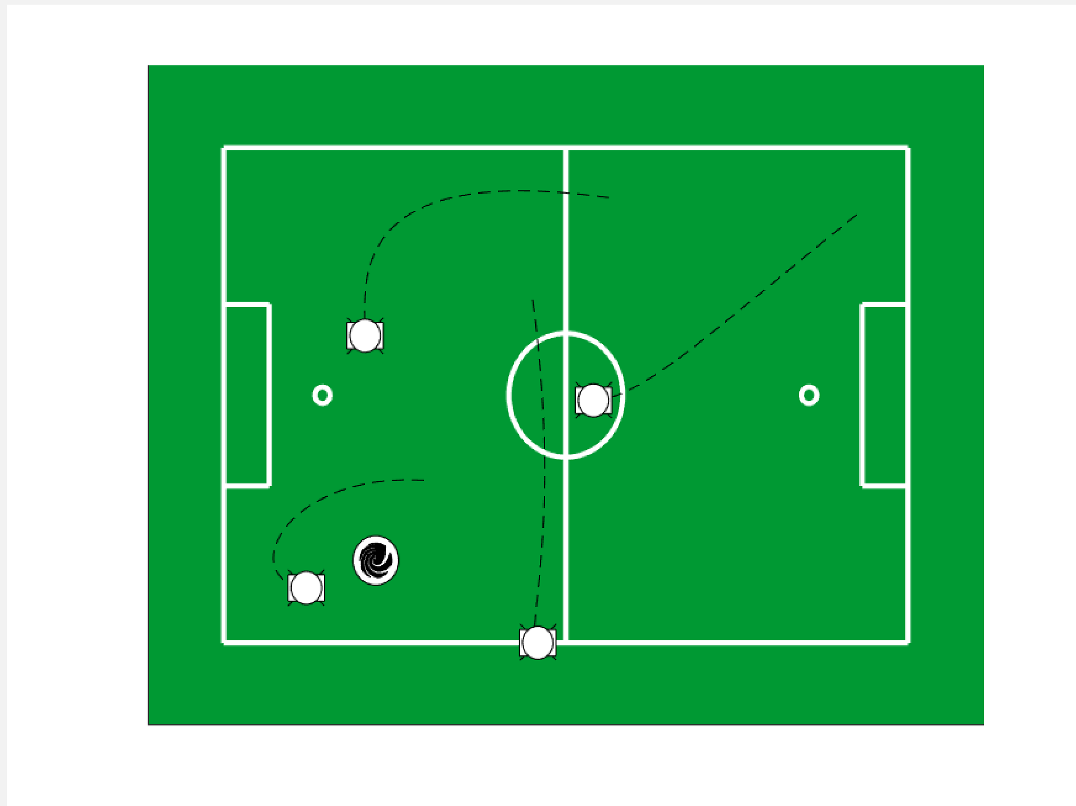
$$\begin{aligned} d(x_i, y_i) &= (x_i - x_b)^2 + (y_i - y_b)^2 \\ r(x_i, y_i) &= (x_i - \frac{X_{MAX}}{2})^2 + (y_i - \frac{Y_{MAX}}{2})^2 \end{aligned} \tag{3}$$

For this optimization problem, α and β are tunning parameters.

Important Result



(a) Optimal Solution



(b) Sub-Optimal Solution

Figure: Trajectories following the proposed algorithm

Conclusion

SABANA Herons team has presented an algorithm that can determine the optimal location of a set of NAO robots on a playing field and be used in a game of Robocup SPL. Tt can be shown that this algorithm can be implemented in real time on the robots given the short time required for its execution (about 50ms). It has also been shown that given the nature of the algorithm presented, it can be modeled through game theory, which broadens the horizon of study, because it can be spoken of a much deeper optimality, i.e., the Nash equilibrium, than only determining the minimum of a convex function.

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