Recent Articles and Conference Papers

Robot Club Toulon - University of Toulon, France

January 2024

1 2023

1. H. A. Pham, V. Gies and T. Soriano (2023). Decision-making strategy for multi-agents using a probabilistic approach: application in soccer robotics. In IEEE 12th International Conference on Control, Automation and Information Sciences (ICCAIS), Hanoi, Vietnam, 2023, pp. 298-303, doi: 10.1109/ICCAIS59597.2023.10382302.

   Abstract: The efficient coordination of soccer robots is a complex topic because there are numerous possible scenarios in the game, and the state of the robots can change rapidly. It requires the robot to be able to analyze and make decisions in a short time. In this article, we first use Dec-POMDP to describe the actions and states of the soccer robot team. Secondly, we introduce a probabilistic approach so that the robots can quickly make decisions corresponding to specific situations. More specifically, we present a method for calculating and evaluating the expected points corresponding to each particular action for each robot. The robots then choose the actions with the highest expected points. Finally, we have developed a simulator based on the digital twin approach to verify the proposed strategies on simulation models and implement these strategies rapidly on real robots.

2. Soriano, T., Pham, H.A, & Gies, V. (2023). Design of the dynamic behavior of soccer robots based on the Dec-POMDP framework. In IEEE 14th France-Japan and 12th Europe-Asia Congress on Mechatronics, Japan (**Best Paper Award–Finalist**).

   Abstract: A soccer robot is a complex team sport that requires coordinated decision-making and execution from multiple robots. The Dec-POMDP approach provides a natural framework for modeling and optimizing the decision-making processes of a robot soccer team, as it allows for the representation of uncertainty and coordination among multiple robots. In this paper, we describe a model for a robot soccer team and study a specification of team behavior based on Dec-POMDP specialization. Our results show that the approach can effectively model and optimize the decision-making processes of a soccer team, leading to improved team performance.

3. Moussa, H., Gies, V., Soriano, T. (2023). Ultra-Fast Lidar Scene Analysis Using Convolutional Neural Network. In: Eguchi, A., Lau, N., Paetzel-Prüsmann, M., Wanichanon, T. (eds) RoboCup 2022:. RoboCup 2022. Lecture Notes in Computer Science, vol 13561. Springer, Cham. https://doi.org/10.1007/978-3-031-28469-4_5

   Abstract: This work introduces an ultra-fast object detection method named FLA-CNN for detecting objects in a scene from a planar LIDAR signal using convolutional Neural Networks (CNN). Compared with recent methods using CNN on 2D/3D lidar scene representation, detection uses the raw 1D lidar distance signal instead of its projection on a 2D space, but

it still uses convolutional neural networks. The algorithm has been successfully tested for RoboCup scene analysis in Middle Size League, detecting goal posts, field boundary corners, and other robots. Compared with state-of-the-art techniques based on CNN, such as using Yolo-V3 for analyzing Lidar maps, FLA-CNN is 2000 times more efficient with a higher Average Precision (AP), leading to a computation time of allowing it to be implemented in a standard CPU or Digital Signal Processor (DSP) in ultra-low-power embedded systems.

2 2020

1. Gies, V.; Soriano, T.; Marzetti, S.; Barchasz, V.; Barthelemy, H.; Glotin, H.; Hugel, V. Optimisation of Energy Transfer in Reluctance Coil Guns: Application to Soccer Ball Launchers. Appl. Sci. 2020, 10, 3137. https://doi.org/10.3390/app10093137

   Abstract Reluctance coil guns are electromagnetic launchers with a good energy ratio transmitted to actuator volume, making them a good choice for propelling objects with a limited actuator space. In this paper, we focus on an application that is launching real-size soccer balls with a size-constrained robot. As the size of the actuator cannot be increased, kicking strength can only be improved by enhancing electrical to mechanical energy conversion compared to existing systems. For this, we propose modifying its inner structure, splitting the coil and the energy storage capacitor into several ones, and triggering the coils successively to propagate the magnetic force to improve efficiency. This article first presents a model of reluctance electromagnetic coil guns using coupled electromagnetic, electrical, and mechanical models. Four different coil gun structures are then simulated, concluding that splitting the kicking coil into two half-size ones is the best trade-off for optimizing energy transfer while maintaining an acceptable system complexity and controllability. This optimization results in robust enhancement and increases by 104% of the energy conversion compared to a reference launcher used. This result has been validated experimentally on our RoboCup robots. This paper also proves that splitting the coil into a higher number of coils is not an interesting trade-off. Beyond the results of the chosen case study, this paper presents an optimization technique based on mixed mechanic, electric, and electromagnetic modeling that can be applied to any reluctance coil gun.

3 2019

1. Gies, V.; Soriano, T. Modeling and Optimization of an Indirect Coil Gun for Launching Non-Magnetic Projectiles. Actuators 2019, 8, 39. https://doi.org/10.3390/act8020039

   Abstract: This article focuses on indirect coil guns used for launching non-magnetic objects. A mechatronic model, coupling electrical, mechanical, and electromagnetic models, is proposed. This model is applied to optimizing a kicking system used on limited-size robots for propelling actual soccer balls at the RoboCup. Working with an existing coil gun, we show that fine-tuning its setup, especially the initial position and the length of the non-magnetic plunger extension, leads to an increase in the ball speed of 30% compared to previous results.