Research Internship

Integrated multi-objective task allocation for multi-robot systems

LINEACT cesi

Context

Nowadays, manufacturers are facing more and more challenges due to the highly volatile market. This is a problematic matter since it could create large fluctuations in product demand, in addition to an inexorably merciless market share competition. To ensure its competitiveness in such a context, a company needs to establish and coordinate several organizational, decisional and operational tools to ensure efficiency and high flexibility of its manufacturing system. Multi-robot systems integration is one of the solutions adopted in industry that can provide several advantages like robustness and flexibility to the manufacturing process. To fully benefit from this solution, the robots must be supervised smartly in order to allow an efficient cooperation between them while performing common or separate missions. Several decision making problems emanates regarding production planning, resources allocation and tasks scheduling.

In this context, the CoRot project is working on multi-robot task allocation (MRTA) problems, that is, defining the best possible assignment of robots to each task. It enables also to find the sequence of the tasks for each robot to minimize the total task completion time [Li2017, Padmanabhan2018, Zaidi2019].

Mission

Multi-robot teamwork management is a complex problem consisting of task division, task allocation, coordination, and communication. It is only through cooperative task performance that the superiority of robot groups can be demonstrated. Regardless of the type of cooperation, the goal of the team must be transformed into tasks to be allocated to the individual robots [Baghaei2016]. In this frame, we propose a research internship of 6 months. This internship will focus on two main problems related to multi-robot task allocation (MRTA) problem: how to distribute tasks among robots, and how to coordinate their actions in order to successfully accomplish the assigned tasks. We consider robots that can execute only one task at a time on a hand; and tasks that are requiring only one robot to perform them on the other hand. The trainee's role will focus on the development of new algorithms that deal with the MRTA problems and allow to supervise robots while executing operations in a self organized and adaptive way. In order to consider realistic and accurate situation, we need to develop a virtual version of the workshop and model the behaviour the each part to cope with the real world. 3D simulation and representation will improve the quality of supervision allow to make dynamic decisions.

This internship research will cover the following points:

- State of the art regarding developed algorithms for MRTA problems

- MRTA problem formulation accordingly to CoRot project objectives: input/output data, objective functions, constraints, criteria, …
- Development of a virtual environment representing the CESI's CoRoT use case.
- Development and Implementation of self-organisation algorithm and reconfiguration behaviour.

References

[Baghaei 2016] Baghaei, K.R. and Agah, A. Multi-agent task allocation for robot soccer, 2016.

[Li2017] Li, D., Fan, Q., and Dai, X. Research status of multi-robot systems task allocation and uncertainty treatment. In Journal of Physics: Conference Series, volume 887, 012081, 2017.

[Padmanabhan2018] Padmanabhan Panchu, K., Rajmohan, M., Sundar, R., and Baskaran, R. Multi-objective optimisation of multi-robot task allocation with precedence constraints. Defence Science Journal, 68(2), 2018.

[Zaidi2019] L Zaidi, B Bettayeb, M Sahnoun. Task allocation based on shared resource constraint for multi-robot systems in manufacturing industry, 9th IFAC Conference on Manufacturing Modelling, Management and Control, 2019.

Required profile

- Last year of M.Eng. or M.Sc. in Industrial Engineering, Mechatronics, Robotics, etc. ;
- Technical skills: robotics, optimization, algorithmic, programming (Python, Matlab, C++);
- A good level of oral and written English;
- Autonomy, communication, power of proposal.

Internship conditions

- Location: LINEACT CESI, Rouen, France
- Duration and date: 5 to 6 months, starting first semester 2020
- Remuneration: According to CESI's standard grid

Scientific supervisors

Lazher ZAIDI (lzaidi@cesi.fr)
Belgacem BETTAYEB (bbettayeb@cesi.fr)
M'hammed SAHNOUN (msahnoun@cesi.fr)