Stigmergy for Multi-Robot Coverage

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Chapter 1

Requirements

1.1 Project Description

The project is being completed for Professor Karl Tuyls in the department of Computer Science, University of Liverpool, as the primary supervisor. The Project is also applicable for anyone wishing to build an area in which to conduct simulations that utilise the E-Puck platform[1]

Project Aims include building the testing grounds for the robotic simulations as well as showing a demonstration of the arena through the use of the e-Puck hardware platform. With the completion of this project, researchers have the capability of producing a testing ground for their experiments with the e-Puck hardware platform. The demonstrative section aims to show that the arena is capable and performs it's required task.

The initial solution for the project involves using standalone posts, rope and two large pieces of cloth. By using the ropes in a similar manner to a boxing ring, the solution provides flexibility in terms of arena size yet still contains the e-puck robots. Once properly erected, the posts will hold up the large pieces of cloth — one of a darker colour which will be the internal ceiling of the arena, and a piece of fabric which is lighter in colour to serve as the theoretical 'roof' of the structure. The lighter colour will help to reflect most of the external light which would otherwise cover the sectioned area, and the darker colour to absorb light within the structure, as well as absorbing light which manages to pass through the lighter fabric.

This solution allows practitioners to modify the size of the area as there is no permanent link between the posts, thanks to the rope. The dual-layered cover over the area prevents most light from entering the area and should any openings be made within the lower layer of fabric, it would allow visual monitoring with little compromise.

There are multiple research papers on decentralised robots — for patrolling, there is the Edge Ant Walk (EAW) algorithm, which V. Yanovski has worked on [4]. Due to memory limitations, the demonstration will be similar to StiCo[3] as well as the work on HybaCo [2].

1.2 Statement of Deliverables

- Blueprints and Manual for constructing the Robotic Dark Room
- Source code for the program/s used to demonstrate the Dark Room using the e-Puck Hardware Platform

Potential experiments include making sure that the created program/s run successfully on the e-Puck Hardware Platform, the constructed dark room allows the robots to sense light trails left on the glowing floor and that behaviour towards the light trails are encoded into the e-Puck platforms. These experiments can only be carried out once the arena is built.

The main evaluation method will be the programs written to familiarise with the hardware platform. By utilising a program with basic behaviour patterns, improvements to the structure, and algorithms for the main software, can be made.

1.3 Conduct of Project and Plan

Research into Robotic implementations of pheromone-using insects will be the main area of research[4, 3, 2]. Tangentially relevant information includes looking into Auction-based methods of sharing tasks[**Schneider2015**], although this may not be a possibility with the supplied hardware.

Information on the hardware and it's usage will be part of the required data, so that software can be created for the platform. Currently, there will not be any real data, both human and non-human, involved within this project.

The design stage will include potential blueprints for the construction of the dark room, including materials used, dimensions and functional criteria.

This phase will also have a basic outline of the program in pseudo-code that will be written for the implementation stage.

The code will be written in C, and will be compiled for the e-Puck hardware platform. Basic testing will include making sure that the robots can successfully interact with the light trails on the floor, then will move onto checking to see if the coded algorithm works and the benefits of adding more robots into the area at the same time.

The main challenge of the project will be creating the dark room - if this is not built correctly then the entire project fails. Whilst coding an algorithm which mimics an insect's implementation of pheromones, time restraints may limit the complexity or functionality of the program.

Skills that will be developed during the project would be physical handiwork, coding for a platform that is not a workstation as well as a greater understanding of artificial intelligence and it's implementation in a language which is not logic-based, such as Prolog.

1.4 Everything else

Bibliography

[1] Michael Bonani and Francesco Mondada. E-Puck Education Robot. URL: http://www.e-puck.org/.

[2] Bastian Broecker et al. "Hybrid Insect-Inspired Multi-Robot Coverage in Complex Environments". English. In: Towards Autonomous Robotic Systems. Ed. by Clare Dixon and Karl Tuyls. Vol. 9287. Lecture Notes in Computer Science. Springer International Publishing, 2015, pp. 56–68. ISBN: 978-3-319-22415-2. DOI: 10.1007/978-3-319-22416-9_8.

[3] Bijan Ranjbar-Sahraei, Gerhard Weiss, and Ali Nakisaee. "A Multi-robot Coverage Approach Based on Stigmergic Communication". English. In: Multiagent System Technologies Ed. by IngoJ. Timm and Christian Guttmann. Vol. 7598. Lecture Notes in Computer Science. Springer Berlin Heidelberg, 2012, pp. 126–138. ISBN: 978-3-642-33689-8. DOI: 10.1007/978-3-642-33690-4_13.

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