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Simulating robot swarms: collaborative transport

Project Specification

DESCRIPTION

As part of my final year project I'm required to solve a specific computing problem. The problem and aim of this project is:

"To simulate a robot swarm moving an object towards a goal, additionally the simulation must allow the user to change parameters such as the number of robots and the shape of the object."

The results of this simulation are to then be compared to the results of the experiment in [1]. These results are synthetic and have been published therefore there should be no ethical issues with using them.

Some constraints are present in the context of this project:

- The robots must be de-centralised, there can be no central controller; robots must organise themselves individually.
- There can be no explicit communication between the robots.
- Obstacles may be present blocking the object from the goal, robots will need to maneuver around these.

I will be using the Occlusion Based Transportation method used in [1] to control the robots. The execution of the algorithm is to be displayed graphically, showing the entire process to a user watching. Additionally a number of parameters should be changeable before the simulation starts.

STATEMENT OF DELIVERABLES

The anticipated documentation of this project is as follows:

- A design documenting how the program is intended to be built.
- An evaluation of the simulation compared to a real-world execution of the algorithm found in [1] and how the introduction of more objects increases running time.
- Documentation on the various test cases used to check if the program is running correctly.
- A dissertation looking at the field of swarm robotics and a review of the successes and failures of the project.

The only anticipated software to be produced is the simulation of the Occlusion based transportation algorithm.

Evaluation of the project will be done using three methods:

- Experimental, this will involve using statistical methods to determine how each of the different parameters will affect the running time of the algorithm.
- Comparison, the simulation will be compared to the results in [1] and any resulting differences will be noted.
- Self, I will review what I think are the strong and weak elements of the project and include how I would go about improving certain areas.

A user evaluation was also considered however without knowledge on swarm robotics the feedback would be mostly irrelevant therefore I have decided to omit this kind of evaluation.

CONDUCT OF PROJECT

PREPARATION

Preparation for the project will include the research into swarm robotics, the occlusion based transportation method and other transportation algorithms such as the group transportation method described in [2].

NetLogo is the programming language being used however with no former experience this will be another research topic using their documentation and tutorials should prepare me for the project.

The use of the test results in [1] raises ethical concerns as this is someone else's work. This work however has been published so there should be no ethical concerns with its use.

DESIGN

The design documentation will include:

- Statistical methods used to determine the effect of different parameters to the simulation.
- UML statechart.
- Interaction chart.
- Class diagrams.
- Pseudo-code for the transportation algorithm.
- Interface design.

IMPLEMENTATION

The project will be using NetLogo which as stated in [3] is "a multi-agent programmable modeling environment". This should facilitate the creation of the simulation as libraries exist to set up the physics of the simulation allowing focus on the movement algorithm.

The program will use regression testing in order to minimise the number of bugs throughout the development cycle. When a major code change is introduced previous test cases will be re-run in order to see if the newly introduced code has caused any problems to appear as a result.

RISK ASSESSMENT

Below are the risks and challenges which have been identified in the project:

- The NetLogo programming language as I haven't used this before. The language uses the Java virtual machine which I have experience with however for libraries exclusive to NetLogo I will have to use the documentation.
- Good timekeeping. This project will be running concurrently with other projects so if there is a setback it will be harder to recover. In order to resolve this I will try to keep a week contingency period for each part of the project.
- Storing the project on one device risks the loss of the project if something goes wrong. To alleviate this I will keep two copies of the project: one on my personal computer and one on the departmental system. This should prevent the loss of any files.

BIBLIOGRAPHY

[1] J. Chen, M. Gauci, W. Li, A. Kolling, R. Groß
Occlusion-Based Cooperative Transport with a Swarm of Miniature Mobile Robots
EEE Transactions on Robotics, Volume: 31 Issue: 2, 2015
[2] D. Milner
Swarm Robotics Algorithms: A Survey
2007
[3] Wilensky, U. 1999. NetLogo.
http://ccl.northwestern.edu/netlogo/.
Center for Connected Learning and Computer-Based Modeling, Northwestern University. Evanston, IL.

Task		Duration
Specification		
	Research	1 w
	Write-up	3 w
Design		
	UML Graph Design	2w
	Pseudo Code Methods	2w
	Interface Design	2w
	Presentation Preparation	1w
Implementation		
	Learn NetLogo	3w
	Setup Simulation Physics	3w
	Setup Arena	4w
	Build Swarm Robot Class	6w
	Testing	5w
	Program Evaluation	3w
	Demonstration Preparation	2w
Interim Report		1 w
Dissertation		
	Project Evaluation	3w
	Write-Up	4w

Timeline: 2017 (OCTOBER W1–W4, NOVEMBER W1–W4, DECEMBER W1–W5), 2018 (JANUARY W1–W4, FEBRUARY W1–W4, MARCH W1–W5, APRIL W1–W4, MAY W1–W4)

Legend: Intended Completion, Contingency