Project Proposal - Group 30

Clean Waters

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ABSTRACT

We are proposing a problem where a group of intelligent drones of two different types detect and clean oil spills on the ocean. One type of drone will focus on scanning the environment while the other will clean the polluted tiles. The main problem lies in cleaning the polluted tiles as efficiently and as quickly as possible, while dealing with the spreading of the pollution. We intend to solve this problem by using both reactive and deliberative architectures, which will allow us to compare the results between them.

1 INTRODUCTION

1.1 Motivation

As ocean pollution becomes a more and more endangering threat to life on Earth, a team of scientists came together to develop a project that would try to minimize the negative effects of this activity.

1.2 Problem Definition

Cleaning the ocean of pollution brings a complex challenge, by employing several variables, that will cooperate towards a common goal: fully cleaning the ocean from pollution.

1.3 Relevance

We believe that the complexity of this problem, as much as its end goal, is extremely relevant in the current days, as the environmental crisis is becoming more and more alarming, requiring decisive action and scientific discoveries that will help us mitigate humanity's ecological footprint.

1.4 Objectives

Our solution will consist of a simulation of an ocean environment, in which there will be oil spills. As the oil propagates in the ocean tiles, there will be two types of agents: **Scanners** (that move through air to find polluted areas) and **Cleaners** (that move through water and will clean the polluted ocean tiles). These agents will communicate between each other, in order to get a maximized understanding of the scenario and to arrange which drones clean which tiles, in order to maximize the amount of tiles cleaned and minimize the amount of trips and distance covered. If the oil occupies half of the ocean tiles or there are no drones left (due to battery discharge), the simulation ends. The main objective of the project is to develop a **Multi-agent System** where agents have to cooperate to clean as much oil as possible, as fast as possible, while minimizing the amount of trips required.

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2 APPROACH

2.1 Environment

The environment is the high sea, with oil spills that will propagate through the water. There are charging stations for the environment.

2.1.1 Representation.

The environment will be represented by a **NxN** matrix with N given as input parameter once the system starts. Each agent has a (x,y) coordinate pair. Each movement within the environment costs energy.

2.1.2 Properties.

The environment is going to be **inaccessible** since the agents won't have complete, accurate and up-to-date information about the whole environment. **Non-deterministic** since both types of agents will have some probability to stop working. It is **dynamic** as the sea changes as the agents act on it. The environment is also **discrete** because there's a finite amount of perceptions and actions the agents will sense and make. Finally, it is **non-episodic** because the world cannot be divided into a series of episodes independent from each other as the collected pollution will influence the future.

2.2 Agents

We plan on having two types of agents, each with their own internal model with information about the environment and each agent's state. With variables that will support the features described in this section.

2.2.1 Scanners.

Sensor.

- Have a large field of view to sense oil spills in the sea
- Receive messages from Cleaners
- Detect the agent's amount of battery

Actuator.

- Send message to Cleaners
- Move in a random manner
- Charge battery

2.2.2 Cleaners.

Sensor.

- Have a small field of view to sense oil spills in the sea
- Receive messages from sensors
- Detect the agent's amount of battery

Actuator.

- Send message to Cleaners
- Move in the direction of the oil spills
- Clean oil spills
- Charge battery

2.3 System Architecture

In this context, we propose three different architectures.

2.3.1 *Random Agents.*

In this architecture, we will only have Cleaners that move **randomly** throughout the environment looking for oil to clean.

2.3.2 *Reactive Agents.*

When using Reactive Agents, we expect that the agents can communicate between themselves. Therefore, we will use reactive agents with a **subsumption architecture**. The Scanners move randomly throughout the environment and, when they find oil to clean, they broadcast that information to the Cleaners. The Cleaners that are waiting in the station, when they receive a message from the Scanners, will move to the oil spilled.

2.3.3 *Hybrid Agents.*

Hybrid Agents will have, other than a reactive behaviour, a deliberative behaviour which will confer the agents the ability to learn. This will allow for a real time response combined with goal oriented behaviour. On that account, Cleaners will have a **single-minded commitment** i.e., they will only change their current action when they finish the action or realize that it's impossible to finish. This will be possible due to the fact that both agents will have an internal state that saves all known oil spills.

3 EMPIRICAL EVALUATION

We plan on testing the performance of each architecture with a set of different parameters:

- Number of Cleaners;
- Number of Scanners;
- Quantity of spilled oil.

To evaluate each scenario, we defined the following set of metrics (averages):

- Number of successful/failed attempts;
- Number of steps taken by the agents;
- Number of alive Cleaners if successful;
- Time spent cleaning all the oil if successful;
- Number of recharges;