Cognitive Approach to Robot Spatial Mapping

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1. Background

As an overview of the research, an explanation of the two main concepts evoked in the project topic is necessary. Cognitive science is the study of the nature of intelligence. So the concept of cognitive approach may be seen as bringing reasoning, self learning, intelligence to resolve a particular problem. In artificial intelligence, this approach is concerned with an in-depth study of the fundamentals and mechanisms of intelligence formation, how it evolves into knowledge and how it can be implemented in robotics [1].

The second concept is spatial mapping which implies representing the environment at a particular level of abstraction which in our case is a mathematical model [4]. We are talking about mapping the space into logical information or knowledge that can be understood and utilised by an intelligent robot. A robot uses a number of different sensors to ascertain its surroundings. For example, ultrasonic sounds and laser light emitted respectively from ultrasonic and vision sensors are used to determine the distance between the sensors and an object using the time of flight of the reflection. So, range sensors provide spatial information (size, shape and texture information), depending on their accuracy [3]. Hence, the basic requirement for a map modelling is the sensor information collected during robot navigation.

Now we should be ready to design a map corresponding to a collection of data. Since we want to use these data efficiently, we first consider the concept of data integrity. This is of great concern because it is difficult to deduce or conclude that two different observations refer to the same object. In our world of robot mapping, this difficulty is referred to as the correspondence problem [2]. A method for approaching this problem is noticing that data are collected in a local frame of reference and therefore, must be transformed into the frame of reference used in the map (we call this the global frame of reference). So, it is a matter of answering the questions "Where am I?" and "To which frame of reference is this observation meaningful?", for each record of data. This view of the problem is called self localisation.

These concepts and issues are continually referred to throughout the project.

2. Aim

The end results of the project will the successful design and implementation of an agent able to learn from its environment by gathering new information and recording it in its knowledge-base [5]. So, through some reasoning and common sense, our robot will definitely have the ability to understand its surroundings and generate a map of the objects and their positions. To achieve this level of cognition, a project goal will be to propose and discuss a spatial modelling that will be further interpreted in a programming language.

3. Value to Science

Three main approaches have been used in Artificial Intelligence (AI) during the past few decades. These are structuralism, functionalism and behaviourism. It is true that examining the structure, the behaviour of our society and human beings, how they interact, has brought great improvement in the AI world.

Nevertheless, these approaches are limited when it comes to dealing with intelligence formation, its evolution. With the growth of AI and Robotics recently, the need for self learning and reasoning has become more and more imperative. Also, the robot as a physical agent, interacts with its environment and cannot be efficient if it does not have a proper understanding of that environment. This is an actual problem on which many researchers are

working. In fact, we are working on improving self navigation and self learning of a robot. To achieve this, the concept of cognitive science has been found to be most relevant.

4. Methodology

Spatial cognition in robotics is a wide research area in which many approaches and models have been conceived and used in robot mapping. So a good start will be to understand these different approaches, their limitations and their advantages. Then we will study how they can be modified or improved for a better spatial mapping design. The next step will be to illustrate the obtained approach or model, through implementation. This stage contains both the computational level and the experimental level. The computational level is where I will derive programming techniques that will suitably match our model or representation approach of an environment. Finally, we will conduct experiments, using the sensor data from the NXT and a sample environment.

5. Time Frame

Week 1 to week 3	Getting familiar with the Lego NXT by testing it together with the corresponding software.
Week 4 to week 9	Exploring different cognitive approaches to spatial mapping, their strengths and their weaknesses.
Week 10 to week17	Designing my own model or approach for mapping the desired environment.
Week 18 to week 22	Coding and optimizing the model.
Week 23 to week 26	Experiments, Testing, Debugging.
Week 27To week 30	Project Write up

6. Hardware and Software Required

- The Lego NXT
- The Lego NXT software
- Robot C, which is our platform for interacting(through the NXT software) with the Kit.
- Windows ,Intel® Pentium® processor or compatible, 800 MHz minimum ,Windows XP Professional or Home Edition with Service Pack 2 ,256MB of RAM minimum Up to 300MB of available hard disk space ,XGA display (1024x768) ,1 available USB port ,CD-ROM drive, Compatible Bluetooth adapter (optional)

7. Expected Results

The robot (Lego NXT in this case) will be placed in a sample environment and will be expected to make a map of this environment in a reasonable time. This will be tested by sending a request to the robot to place itself in a specific location of the environment.

8. Possible extensions

- ➢ This research is a first step and can be extended to achieve complete and optimal self navigation with free collision in the real world by a robot.
- ➢ The concept of cognition could be extended to other areas in robotics such as natural language processing.

Animals rely on their senses rather than on their vision. Check similarity with robot

9. Bibliography:

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