Masters Thesis Report

Bio-mimetic navigation in a dynamic environment

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Declaration

Certificate of Original Authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Student:

Date:

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None of this would be possible without the research community, that has worked on and questioned the state of research for decades. It is on their work that I build upon. I'm grateful to the local research community here that has helped me via discussions, feed back, ideas on my research.

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Preface

This thesis covers the word done during my Masters by research course at the University of Technology, Sydney under the guidance of Dr. Jianguo Wang.

The document is divided into 5 chapters. Chapter 1 introduces my research. It covers a brief summary of navigation and justifies my decision to work on bio-mimetic navigation. Chapter 2 consists of a detailed literature review of the various neuron sets that I worked with. Each chapter detailing a neuron set has two sections - one for the neuroscience review, and another for the computational modelling review. Chapter 3 details the implementation of head direction cells on the ROS platform, and chapter 4 details the addition of grid cells to the system. Finally, I discuss my work in chapter 5. I present my views on the current state of literature, the issues that researchers need to solve when working on a similar project, and what I intend to work on next.

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Abstract

The importance of navigation in robotics cannot be understated. Without being able to correctly and efficiently navigate in an environment, an agent will be unable to carry out any tasks. Animals, even smaller mammals for instance, have sufficiently developed navigation systems that enable them to carry out their daily tasks: forage for food, find shelter, navigate to and fro such sites. It has long been proposed that animals use a type of map for navigation. Unlike maps generated by modern mapping techniques, these maps are topological, and lack precise metric information.

Brain research has found sets of neurons that co-operate to form a navigation system in animals. Such cells: head direction cells, place cells, grid cells; decode specific information about the animal's navigation, a combination of which is sufficient to provide a complete navigation solution.

The aim of my masters research, as detailed in this report, was to study these spatial neurons and their modelling for use in robotic navigation. I have modelled head direction and grid cells, which are important components of the neural path integrator system using the Robot Operating System (ROS) platform. Both models have been validated with real time data collected from the PR2 robot.

I cannot say what I feel in any human sense, Partner Elijah. I can say, however, that the sight of you seems to make my thoughts flow more easily, and the gravitational pull on my body seems to assault my senses with lesser insistence, and that there are other changes I can identify. I imagine what I sense corresponds in a rough way to what it is that you may sense when you feel pleasure.

R. Daneel Olivaw explaining to Elijah Baley that he enjoys his company and is, in a robot sort of way, happy to see him again.
Taken from Isaac Asimov's Robots of Dawn