ROKEL: The Interactively Learning and Navigating Robot of the Knowledge Engineering Laboratory at Otago

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Abstract

This paper outlines the ROKEL (Intelligent Robot of the Knowledge Engineering Laboratory, University of Otago) project. ROKEL is an intelligent navigation and communication system installed on a Pioneer DX mobile robot platform. Evolving connectionist systems are employed for both spoken command recognition adaptive navigation.

1 Introduction

The Pioneer 2DX family (see figure.1) are produced as hardware by ActivMedia Robotics, LLC.

Figure.1 ROKEL is built with the use of Pioneer 2 DX robot hardware platform

The robot has a sonar array of ultrasound sensors fixed in the front of the robot's deck. It includes eight transducers that provide object detection and range information for features recognition, as well as navigation around obstacles. The sonar positions are fixed in the array: one at each side, and six facing outward at 20 degree intervals providing more than 180 degrees of nearly seamless sensing. The sonar firing rate is 25 Hz and sensitivity ranges from 10 cm to more than five meters.

The robot's built-in micro-controller uses a 20 MHz Siemens 88C166 microprocessor which can be connected with either an onboard computer, or a notebook computer for transmitting information and commands, and it also can be connected with a desktop computer by using a radio modem that provides an operation range of 110 meters (indoors) or 300 meters (outdoors).

An on-line digital camera or video camera can be attached to the robot for on-line object recognition and tracking.

2 Adaptive navigation based on measurement of sonars using EFuNNs

Evolving Fuzzy Neural Networks (EFuNNs) are hybrid learning systems [1,2]. EFuNNs can create and update their rule nodes dynamically, and can extract fuzzy rules. Several simulators of EFuNN are made available on the WWW: http://divcom.otago.ac.nz/infosci/kel/CBIIS.html

The ROKEL project develops adaptive navigation using EFuNNs. The navigation is based on the following principles:

- The robot can create a map of the environment.
- The robot can perform commands such as 'get to the second door on your left hand', 'go ahead for about two meters and then turn right and find a corner', 'send this book to Kim and go back', etc.

- It can update the map dynamically if the environment changes, for instance, when a table has changed its position.

3 Adaptive Speech Interaction

ROKEL is designed to recognise spoken commands (e.g. the eight words and phrases listed in table 1).

Find Corner	Right
Find Door	ROKEL
Go	Stop
Left	Return

Table 1: *List of words and phrases*

3.1 Word Recognition

Learning and evolution are two fundamental forms of adaptation. The ECOS paradigm [1,2] is based on adaptive learning rather than on evolutionary optimisation. It is used here for the development of the word recognition system.

We want to be able to minimise the size of the neural network which can achieve good generalisation capability. EFuNNs are able to expand and contract themselves during the training process.

Preliminary experiments show EFuNN's capabilities in both learning and generalisation. In addition, one distinct feature of EFuNNs is their adaptability to a dynamic environment.

4 User Interface

The GUI of ROKEL was developed in Borland C++ Builder environment as a client of Saphira.

Saphira is a robotics application development environment developed at SRI (Stanford Research Institute) for the Pioneer mobile robot platforms. ROKEL as a client application, connects to a robot server with the basic components for robotics sensing and navigation: drive motors and wheels, position encoders, and sensors. The server handles the low-level details of robot sensor and drive management, sends information, and responds to Saphira commands called by ROKEL.

The user is able to control the robot using two different modes. In manual control mode, the user controls the robot by command buttons. In speech mode, the user controls the robot via speech (see figure 2). The robot in return

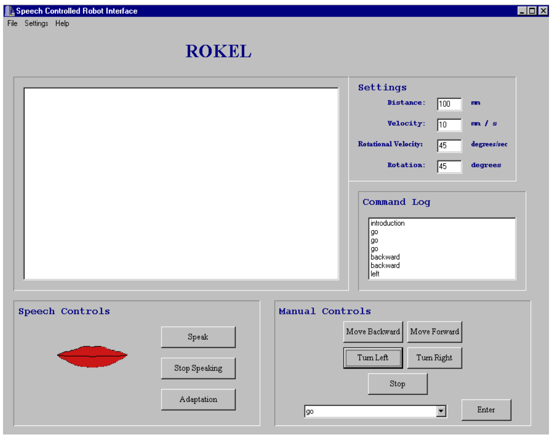

Figure2: *The ROKEL's user interface*

responds to these commands by executing the commands and saying a phrase of acknowledgment using Microsoft text to speech synthesizer.

Every command has a number of responses associated with it. The user is able to either add, edit, or delete these responses (see figure 3).

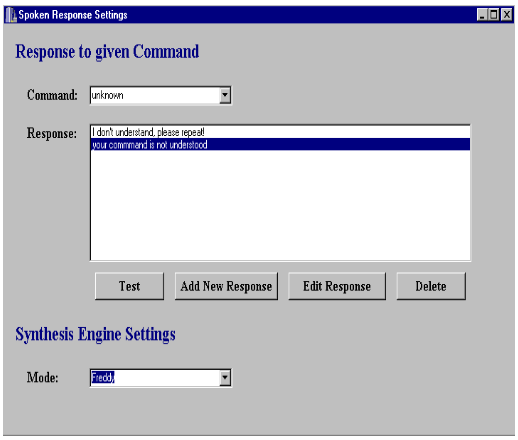

Figure 3: *ROKEL's response setting dialog*

5 Future Work

Several major issues will be addressed in future research:

- The navigation system we are currently working on is only based on the sonar sensors. We have planned to develop another navigation system based on both sonar and video sensors.
- The ROKEL speech recognition system should be able to adapt to new speakers (with the same or different accents) .
- The speech recognition vocabulary will be expanded.

6 Acknowledgement

We would like to acknowledge Lance Elder for the initial design of ROKEL's GUI as part of his INFO411 course requirements. The ROKEL project has been partially funded by the University of Otago Emerging Research Theme "Connectionist-based Information Systems", by the Department of Information Science, and by the grant UOO808 "Connectionist–based Intelligent Information Systems" funded by the New Zealand Foundation for Research, Science and Technology.

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