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A Web-Based Teleoperative Mobile Robotic System

Master of Engineering

in

Information Engineering

at

Massey University,

Albany, Auckland, New Zealand

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April 2006

ABSTRACT

With the rapid development of internet technology, it becomes real that human beings can access, modify and control a remote hardware device via internet connection. Such remote operations can replace the human to be present at a dangerous or unreachable place or can make as many as possible users to access the hardware in different places at a low cost.

The thesis research was aimed at developing a web based mobile robot control framework for education purpose. It should be composed of a mobile robot, Http server, dynamic user interface and video server. With it users can view and control the real robot via a normal web browser and can choose to run either simulation or the real robot. This is done by setting up operational parameters via a friendly GUI (graphic user interface). Users also can upload and compile their own C code to control the robot and get back the running results.

The main objectives of this thesis research are hardware upgrading for Nomadic Super Scout mobile robot and web based php programming. For the first objective, the onboard PC was replaced by a laptop that is remotely placed and connected to the robot control system via Bluetooth wireless. The Nserver for robot simulation was set up in the Linux operating environment. For the second objective, the software programming was focused on building a web control platform which should be user friendly. An Apache server was developed where PHP program was used for the user interface. The main advantage of using PHP is that it does not need to install or download any software or script to get access to the remote robot via a normal web browser on any operation like windows or Linux.

The web-based mobile robot system was tested using two different cases. One case demonstrated how the user specifies a set of motion parameters of the robot that is programmed to perform a wall-following behaviour. The other

demonstrated how the user uploads a collision avoidance program to run the robot that is placed among obstacles. Both case studies were performed in real environments and the results proved the success of the developed web-based robotic system.

ACKNOWLEDGEMENTS

I would like to express my deep gratitude and thank to my supervisors Dr Peter Xu and Dr Mahammad A.Rashid for their constant supervision. Dr Peter Xu has provided me with all the resources I needed for this research. He has also given me the ideas to solve the problems I met in this project. Dr Rashid has taught me the attitude and method of the research.

I would like to thank ones who were involved and shared their time with me during the course of the project. Finally I will give my think to my family.

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Chapter 1 Introduction

1.1 Goal and Outline of the Thesis

The goal of this thesis research was to develop a web-based control platform by which every user can use normal web browser to access and control the Nomadic Super Scout robot at Massey University. One could either run the provided sample program by specifying a set of motion parameters or write and upload a program in C code to operate the robot via GUI. The robot movement status such as coordinators, sensor data, and images could be viewed and stored for further analysis.

This platform could be run at any computer operation system. Remote user might log onto the robot via any popular web browser over internet. It would not need to download or install any program or plug-in to control the robot.

This platform would serve as a test-bed for any one who is interested in the mobile robot. One could upload a program to and compile it on the server, do the testing runs and get back the running results in a file or displayed on the web browser.

This project can also help students who are interested in mobile robotics to learn the new technology and improve their problem solving skills. Making the Super Scout online will reduce the barrier to use the robot. It can meet different levels users' requirements. For an entry level user who just wants to be familiar with mobile robot, he or she can log onto the web and run sample programs to get the first hands-on experience. For those who are already familiar with this mobile robot system, they can write their program that use the sensing facilities to perform intelligent action, upload to and compile at the web to get the program started running. This can be achieved by any popular web browser over internet.

1.2 Upgrading the Robot Computer Hardware

The mobile robot to be used in this project is Nomadic Super Scout. It was out of order at the time the project began. It took about eight minutes to reboot its Linux system and the hard disk did not work properly.

Firstly, the main onboard PC was upgraded. Nomadic Super Scout communication, motion control and sensing are managed by an industrial PC mounted internally. The PC has a 233MHZ CPU, 32MB RAM and 10G hard disk. Actually this system should be able to run Linux system smoothly but why it takes so long to get Linux started? The hard disk is a bottleneck. This hard disk with a PCI adaptor card is inserted into the PCI slot instead of using the IDE slot directly. The reason it was designed like this may be to maximize the battery running time. If a standard PC hard disk is used, it would significantly reduce the robot running time with only two 12 Volt 17 amp lead-acid batteries.

A laptop computer is intended to replace the onboard computer. It will communicate with the robot controller wirelessly. The advantage of using a wireless laptop is that it is portable and the on-board batteries will be used by the robot only. Consequently the robot would run for a longer time between charging intervals.

What follows is to install a proper version of Linux on the laptop, setup the Linux environment suitable for the Super Scout, install the robot control software in the Linux operating system and connect the laptop to the robot controller. This is the most essential part of the hardware improvement.

1.3 Software Programming

Once the robot runs well, the efforts will go to build up a server based on Linux operating system for TeleScout system.

- Develop a Linux HTTP server which can communicate with the robot server;
- Build an image server for broadcasting the video stream;

- Develop a user interface which connects user with the robot host;
- Resolve security issues such as only a single user can run the robot;
- Provide a facility for users to upload and compile their own C code to control the robot and monitor its motion.
- Compile error messages if any, visualise the robot motion and generate a results report

In the thesis the design and implementation of the web-based mobile robot system, TeleScout system will be presented. The rest of the thesis is organised as follows.

An overview of previous and related work in web-based or telerobotics is given in Chapter 2. Chapter 3 describes the improvement of the robot control hardware and the setup for TeleScout system. The HTTP server setup and the development of the user interface are presented in Chapter 4. Chapter 5 gives two case studies. Chapter 6 concludes the thesis with open research issues.