Summary Report

Project: Development of LTU Laptop Robot Framework

Chan-Jin Chung

Contents

1. Background

As a directed study in Spring 2002, I suggested and designed basic strategic ideas of LTU laptop robots. After a long search and email/phone inquiries, basic hardware components such as motors, batteries, motor controllers, and robot body were purchased. Carson Reinke and Andrey Shvartsman figured out all the details of hardware and software configurations and developed laptop robot applications. They entered Robofest exhibition division in April 2002. There have been many cases of discontinuing great student's projects, if professors do not take care of them after the completion of the projects and/or their graduation. In order to continue to keep what they have achieved and use them for future classes I needed to the following research and development activities as summer mini-grant project as described in the next section, "2. Jobs done as summer mini-grant project in Summer 2002".

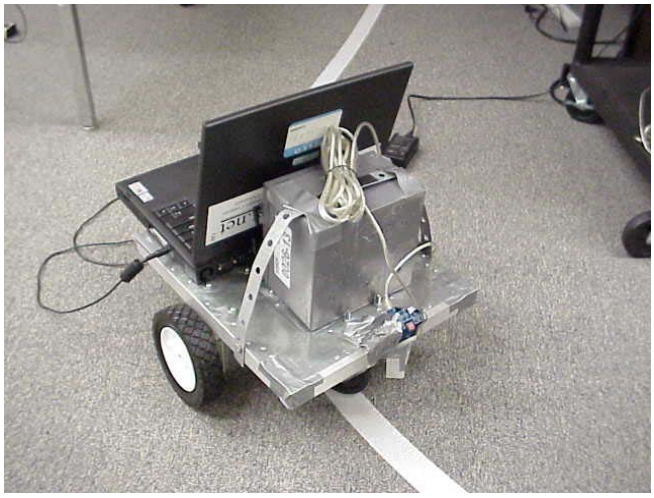


Figure 1. LTU Laptop robot No. 1 hardware built by Carson Reinke

Figure 2. LTU LaptopRobot No. 2 hardware purchased by a company and modified and used by Andrey Shvartsman

2. Jobs done as summer mini-grant project in Summer 2002

- Collected all the hardware and software information related to the robotics projects. Provided web account for Carson and Andrey to post all the info related to the robotics project and verified them. They are:
  - http://mcs.ltu.edu/~andrey/laptop.html
  - http://mcs.ltu.edu/~creinke/robot/

  Also hardcopies of the information can be found in my office. They were later on used to prepare handouts for a class, MCS 5503 Intelligent Systems, in Fall 2002
- Tested kernel mode DLL driver for Windows NT/2000/XP that gives programs access to parallel ports for controlling motors
- Tested Logitech QuickCam SDK 1.0
- Tested Microsoft's Speech SDK and introduced TTS(Text To Speech) functions
- I read their source codes and refined the code for example, comments in the code and removing redundant parts.
- Improved the code by adjusting time values and parameters to act more reliably.
- Modified XML file for new speech commands and TTS.
- Designed basic hardware and software block diagrams as you can see in the later sections 3 and 4 in this report.
- Developed, implemented and tested new functions such as asking the robot to dance, TTS functions, and stopping after locating the target object. These functions were demonstrated during the CAS meeting in August.
- Researched on compiler environment: as a result, I made a conclusion to use MS Visual C++ 6, introductory edition due to MS Speech SDK requirements (Borland's C++ build did not work with Microsoft SDK). After acquiring enough introductory editions (CDs), MS Visual C++ was installed into the laptops in the Robotics lab.
- Research on robot body frame: First I analyzed problems of existing robots. The problems of Carson's robot were (1) too heavy (2) not easily adaptable since it is made of steel, and (3)

the height is too low. The problems of Andrey's robot were (1) it was not our own design since the body was purchased from a company zagoros.com. (2) it was too small to place our laptop on the shelf of the body, and (3) the cost was too high. So I had to re-design our own robot hardware platform in summer. The first thing to do was to find right material for the shelves. I spent a lot of time in hardware shops looking for best materials for the robot body and shelves. It must be durable and light. Experimented different materials for constructing the body. Plastic panel found by Andrey was tested and it was used to build the third robot as seen in Figure 3. However, the price of the plastic panel was too expensive. Finally I found a hardwood material (plywood) and it was experimented. It was adopted as the material for the standard laptop robot body, since the board was cheap, light, and strong enough to hold batteries and a laptop. The boards were cut by myself and now the fourth robot using the hardwood board is in the robotics lab since the summer. See figure 4.

- Attached IR light sensors facing downward through the data acquisition board. Andey assisted this part.
- Researched more on different motors and motor control boards. The problems of the current motors purchased from zagoros.com were (1) speed was slow (2) speed cannot be controlled by hardware and (3) torque is not powerful enough for practical applications.
- Designed laptop robot game, "LaptopBot Tennis".
- Demonstrated robots in August during CAS meeting: for the meeting I brought two robots to the meeting. For the official demo, I was using the hardware robot built by Carson, but the software I was using was improved by myself. For example, the dancing function was new. As another example, the Carson's robot did not have the function to stop in front of the colored ball. TTS function was new to the robot, too. I was planning to show the new functions using another robot built in summer, but I was not given enough time to demonstrate two robots on that day.

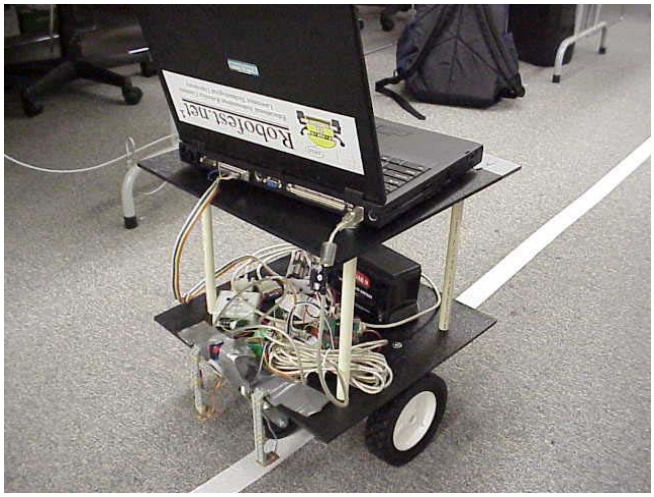


Figure 3. LTU laptop robot No. 3 built in Summer 2002 as mini-grant project

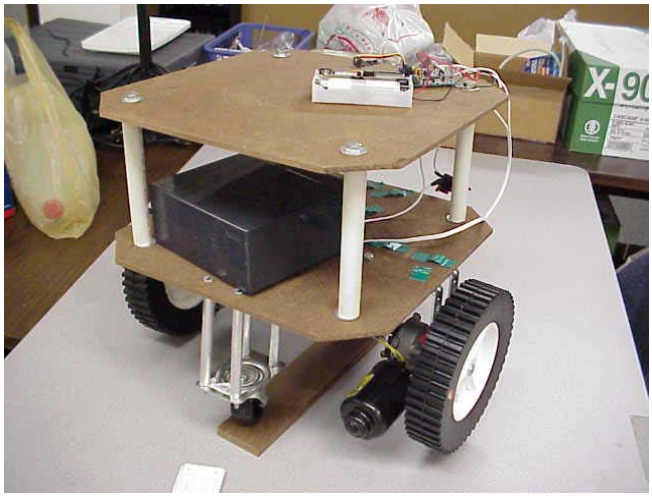
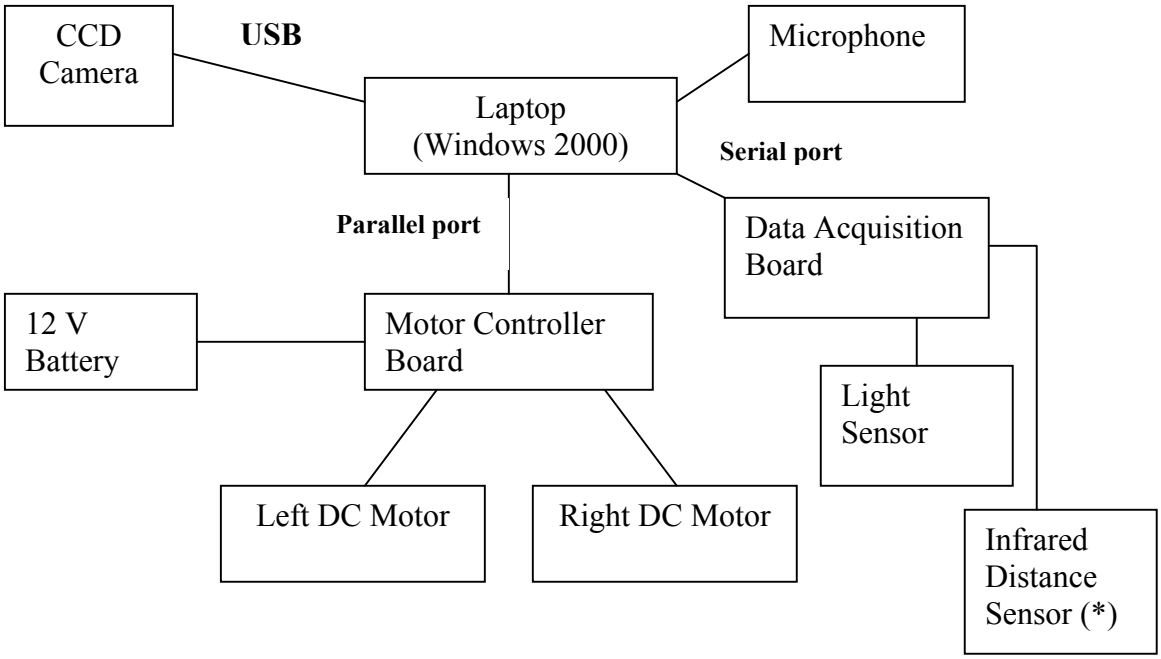
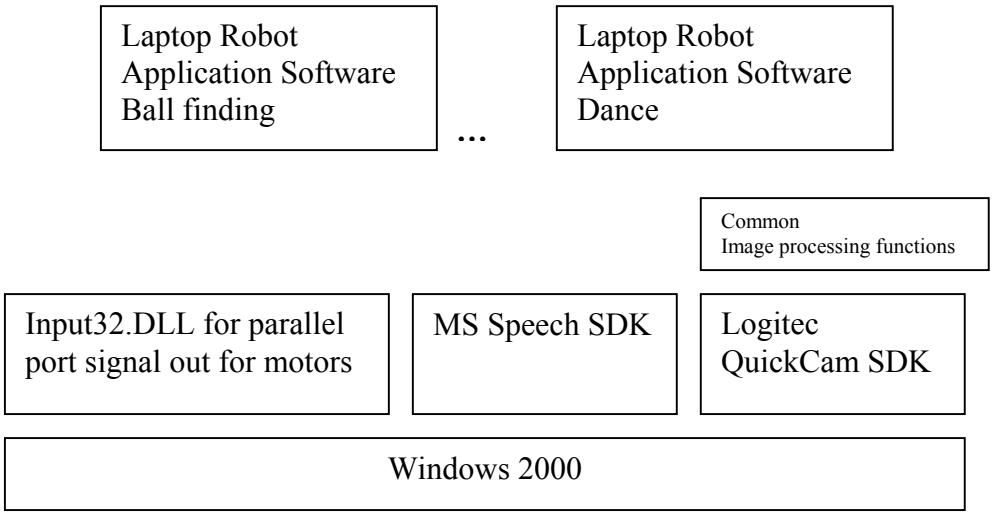


Figure 4. LTU laptop robot No. 4 started to be built since Summer 2002. Completed in 2003.

3. Hardware Block Diagram



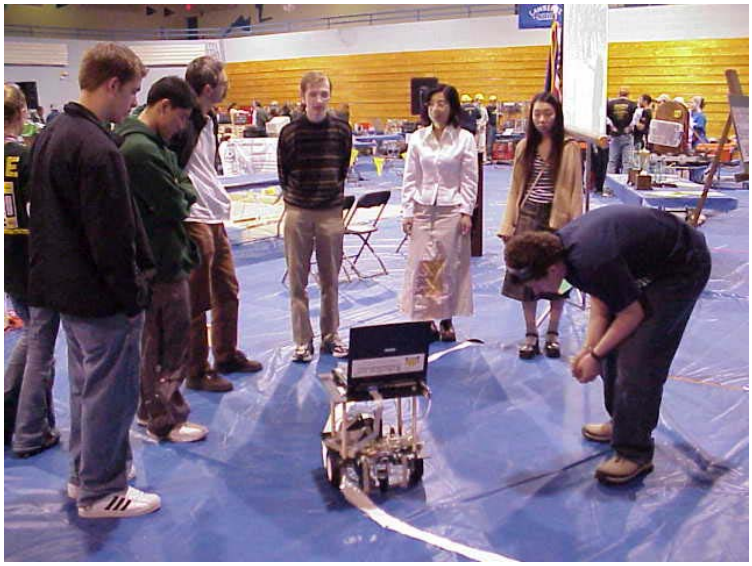
4. Software Block Diagram



5. How the robots were used in classes in Fall 2002

In MCS 5503 Intelligent Systems class, five students were given Laptop robot documentations organized in summer to start with. Their task was to develop software to drive the robot to follow a line in a dynamic environment. As a class project, they demonstrated three robots in the gym when we had OCCRA robot tournament in December 2002. Many audiences including our President Dr. Chambers watched the demo. Every robot was completing the mission to follow a line when the line contained a lot of noise due to the light and surface condition in the gym. See Figure 5 and 6.

Rita, Santosh, Eva, David, and Josh


Laptop Robot Demo during OCCRA tournament, Dec 7, 2002

6. How the robots will be used in future classes

Currently in Spring 2003 in Advanced Topics In Intelligent Systems class, the robots are being used for two purposes: (1) Robofest LaptopBot race and (2) IGVC (International Ground Vehicle Competition) in May 2003. However, the robots are under big modifications, since IGVC requires carrying 25lb payloads. Planned to be used for High school teams for Robofest from 2004.

7. Self-evaluation

The objective in the mini-grant proposal was

> *To develop standard hardware and software framework with professional manuals for constructing autonomous Laptop robots. The user is ready to program the robot by simply plugging in LTU laptops to the standard framework.*

All has been achieved except the professional manuals. The reason I discontinued the development of the professional manual for the robot No. 3 as follows:

- The choice of C++ programming language as the default language was questionable. In that case I had to be dependent on Microsoft technologies such as speech and compilers.
- Since I had decided to use Java instead of C++ in the late August in 2002, there was no reason to continue developing the professional manual based on C++ for the robot developers.
- The professional manual was planned for the product for sale, for example, to future High school teams to Robofest. There was no problem for LTU students to do the work with just design documents and source code instead of professional manuals.
- Hardware changes occurred in summer due to the IGVC involvement. Since IGVC robot requires strong motors, the change of motors was obvious and there was no reason to continue the documentation of the No. 3 robot.

Anyway, currently I am working on Java version manuals for the standard Laptop robots. New motors and motor control boards have not been decided yet.