Radio-Controlled Robot Lawnmower

Chong Chen and Jonathan Derr

Department of Engineering Technology and Industrial Studies
Middle Tennessee State University
Murfreesboro, TN 37132

Abstract

This paper presents an engineering technology senior project: radio-controlled robot lawnmower. The lawnmower can go forward and reverse. It can also turn around. The speed of the lawnmower is comparable to a push lawnmower.

This project involved use of the student's knowledge acquired from many major courses, which included Computer Assisted Drafting and Design (CADD), machine shop, strength and materials, electrical circuit analysis, electronics, electrical machines, and instrumentation and controls.

Introduction

At Middle Tennessee State University (MTSU), engineering technology students must take a project course in their senior year. In this course, engineering situations are solved by experimental means. Student must have experimental approach, gather data, interpret results, and prepare a formal technical written report and an oral presentation.

For the electro-mechanical engineering technology students at MTSU, most of their senior projects involve both electrical/electronics work and mechanical work. In the past years, many excellent projects were completed. Some of the projects were presented at professional conferences [1] [2]. Recently, developing a remote controlled robot lawnmower was selected as an electro-mechanical senior project. In this project, a radio-controlled lawnmower was designed, built, and tested. Figure 1 is the picture of the lawnmower.

Mowing lawn is less than fun for many people, especially if they have allergies or physical limitations. A ride mower requires a driver to ride on the mower. To operate a push mower, a person must walk and push behind the machine. Cutting grass is a good exercise, but not a lot of people like to do it in hot humid summer. It has been many people's dream that they can stay in shadow or sit on a porch to operate a lawnmower. The remote controlled lawnmower developed in this project made the wish almost true.

Figure 1. Remote Controlled Lawnmower

The Lawnmower and Its Major Components

The major components of the remote controlled lawnmower include one push mower body, four wheels, two 24-volt DC scooter motors with belt drives for driving the rear wheels, one remote controller and two speed control boards, one 20" blade, one 24 –volt DC motor for driving the blade, and two batteries.

The body of the remote controlled lawnmower is a 20" Murray push mower frame, which is that of currently sold retail units. The remote controlled lawnmower has four wheels, which are standard push mower wheels. Each of the two rear wheels is driven by a 24-volt DC scooter motor through a belt, as shown in Figure 2. The maximum speed of the lawnmower is 6 miles per hour, which is the standard of many self-propelled push mowers on the market and the limit for a good quality of grass cut. The two front wheels are casters, which are connected to the mower's body through two brackets, as shown in Figure 3.

The two motors, which drive the two rear wheels, control the lawnmower's speed and direction. When these two motors run at the same speed, the lawnmower goes straightly forward or reverse, depending on the motor's rotating direction. When the left motor spins forward slower than the right motor does, the lawnmower turns left, and vice versa. Figure 4 shows a rear wheel driving system.

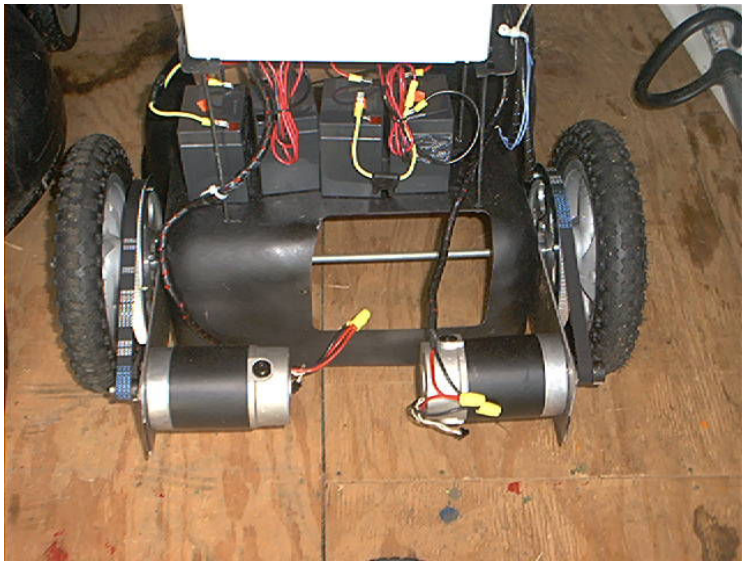

Figure 2. Mower's rear wheels

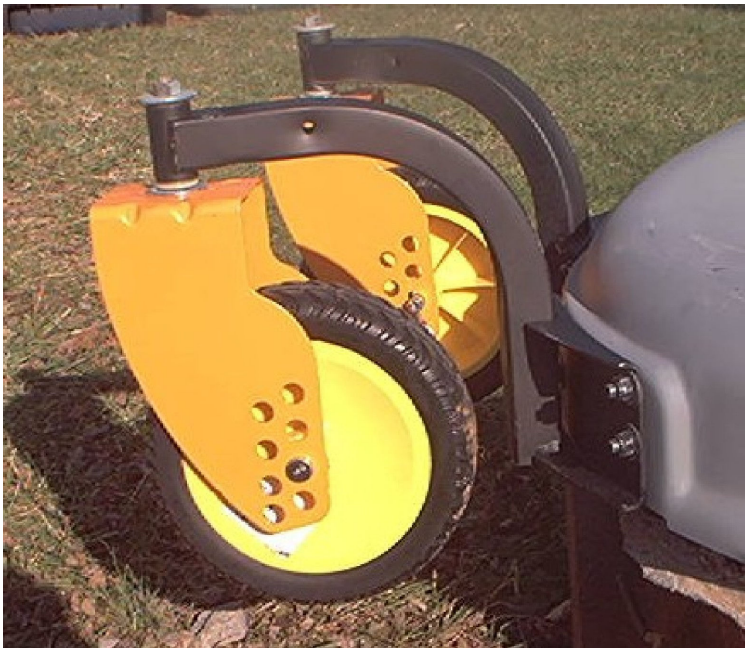

Figure 3. Mower's front wheels

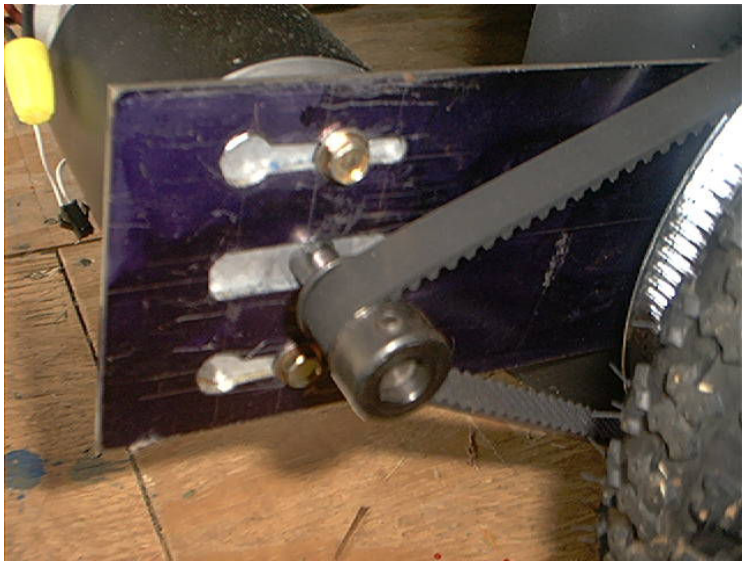

Figure 4. Rear wheel driving system

A radio frequency remote controller and two control boards are used for controlling the two motors driving the rear wheels. The remote controller, which includes a transmitter and a receiver, is a HITEC 4-channel radio. The control boards, which are shown in figure 5, have the following major properties [3]:

- applied voltage: 12 volt to 36 volts;
- 35 amperes of maximum continuous current;
- ramped forward and reverse speed acceleration;
- PWM output, continuously variable speed from stop to full forward or reverse.

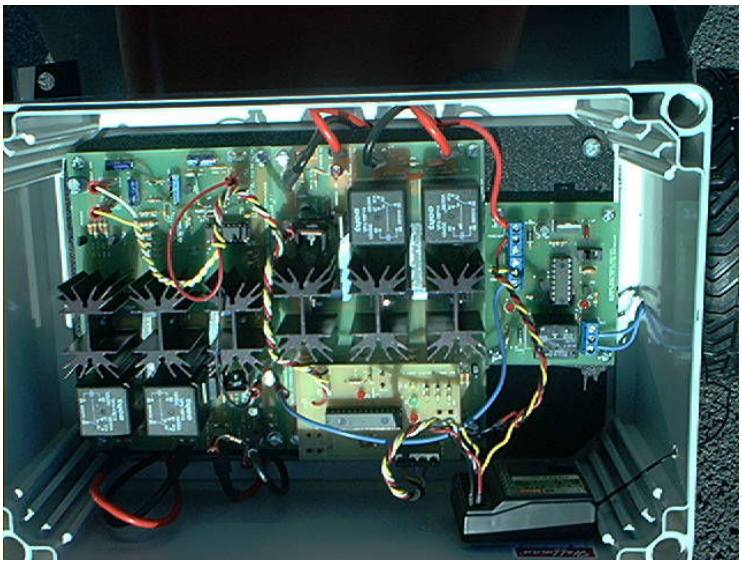

Figure 5. Driving motor speed control board

The blade used in the lawnmower is a regular blade that can be found in a 20" Murray push mower. The blade is driven directly by a 24 volt DC motor. This cutter-motor has a on/off switch remotely controlled by the operator. Two 12volt /17 ampere-hour lead acid batteries are used as the lawnmower's power supply. They are connected in series to offer 24 volts of DC power to the motors, control boards, and radio receiver of the lawnmower.

In Figure 1, the control boards locate in the waterproof Hoffman square enclosure on the top of the mower. The batteries are right below the enclosure. The cutter-motor is above the blade and below the top cover. The top-view of the cutter-motor is given in figure 6. Figure 7 is the block diagram of the motor controls.

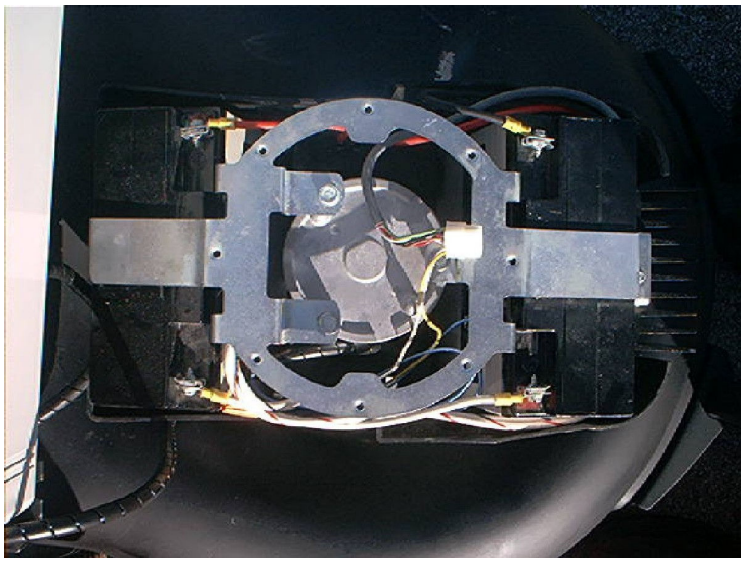

Figure 6. Top-view of the cutter-motor (without cover)

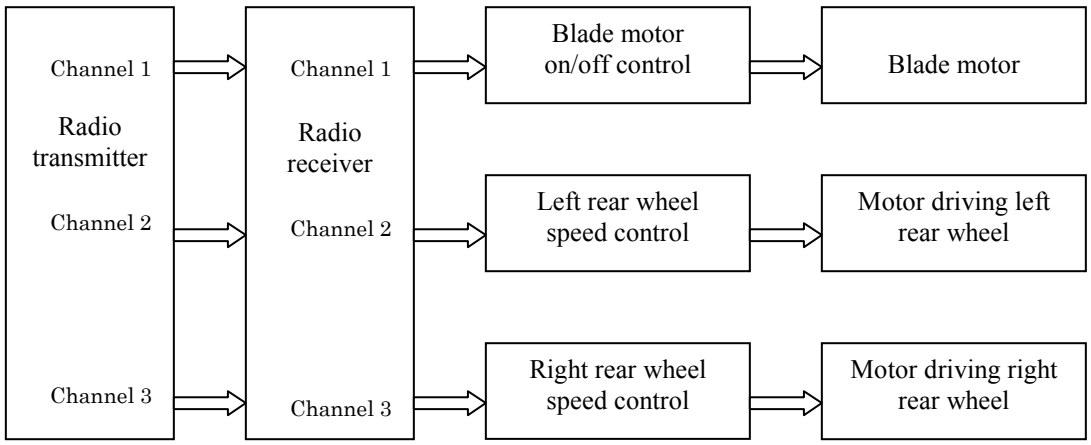

Figure 7 Control block diagram

Testing

The remote controlled lawnmower has been tested for blade and speed control. It can run forward and reverse. It can also turn left and right. The lawnmower's speed may reach the speed of a self-propelled push mower. One technical problem encountered was the system grounding. Due to this problem, a speed control board was burned out and several fuses were blown. After the grounding problem was solved, the system run fine. Like a remote controlled car, the remote controlled lawnmower running route greatly depends on the operator's skill. An unskilled operator may take much more time to cut a lawn than a skilled operator does. This problem can be resolved, when a microcontroller is used with a programmed route control.

Student Participations

The student, who worked on the remote controlled lawnmower project, has been employed by manufacturing industry for several years. He has a lot of experience in machining, testing, and assembling. The remote controlled lawnmower project met his interest and technical background. With the instructor's advising, the student completed the following work:

- designing the lawnmower;
- selecting and obtaining the major components through purchasing or donations;
- fabricating most of the minor components by himself;
- machining the mower body for the holes and cuttings that are necessary;
- assembling the lawnmower and installing the electrical component;
- testing the lawnmower;
- documenting the progress.

After several months of work and a couple of control board problems, the lawnmower run as expected. This project used the knowledge learnt from many required electro-mechanical engineering technology courses. These courses included CADD, machine shop, strength and materials, circuits, digital electronics, analog electronics, electrical machines, and instrumentation and controls.

Project Evaluation

Like other senior projects, the remote controlled lawnmower project is evaluated in the following areas:

- Research and originality
- Project topic and challenge
- Design
- Independence
- Project appearance
- Project progress
- Demonstration & presentation
- Written report.

After registering senior project course, a student must do research and find a project that he or she wants to work on. The project must been approved by the instructor for ensuring it is a proper one in the aspects of contents, technical level, time consuming, cost, and equipment needed. The research work and project originality are counted for the project assessment.

In project topic and challenge area, challenge and difficulty of the project are evaluated. A harder project gets more points.

It is a common sense that a new developed product should be better in one or more of the areas of reliability, cost, operating convenience, and efficiency. This is considered in the project design section. As a project involving of learning, student is encouraged to use updated technology and products in the work.

When a student works on his/her project, instructor supervising and assistance are available. However, as a senior, the student should have the ability to identify problems, conduct troubleshoot, and make corrections. The student may get help from the instructor, but the instructor is not a project partner. The student has to complete the project independently. Unreasonable requests for instructor assistance may result less points.

For passing the senior project course, a project must work properly as stated in its project proposal. However, a successful project may have different appearances. For example, in a project with circuits, the circuits can be connected very neatly, or it can be like a bowl of spaghetti. The project appearance is counted as a part of the evaluation. Student is required to make the project look as professional as possible.

Completing work on time is one of the most important things for a business or a professional to be successful. However, progress management is a problem for many students in an independent study class. In the senior project course, student is required to follow the schedule, which is planed and included in the student project proposal. The project progress is monitored and counted toward the final grade.

A student must present his/her project after the project is done. When a product is generated in a project, a demonstration is required to show the product works properly. The presentation and demonstration must be done in professional way. After that, a written report must be turned in. The report is checked for contents, format, grammar, and spelling.

Conclusions

A senior project in engineering technology major gives student an opportunity to practice the knowledge learnt in other courses. The project may allow student to get experience from a real industry problem. In the remote controlled lawnmower project, the student involved in mechanical and electrical design, machining, assembling, wiring, and troubleshooting. Although the student had many years of industrial working experience, he still learnt a lot from this project. He is thinking about to develop the lawnmower into a commercial product that has a micro-controller and sensors.

References

[1] Chong Chen, *An Automated Inspection System*, ASEE Annual Conference, June 18-21, 2000, St. Louis.

[2] B.S. Sridhara, *Curriculum Integration of Engineering Technology Courses with the Solar Car Project at Middle Tennessee State University*, ASEE Annual Conference, June 28 – July 1, 1998, Seattle.

[3] www.diverseelectronicservices.com

Biography

Dr. Chong Chen is a professor in the Department of Engineering Technology and Industrial Studies, Middle Tennessee State University. He received his B.S. degree from Hebei Institute of Technology in China, M.S. degree from Tianjin University in China, and Ph.D. degree from the University of Kentucky, all in Electrical Engineering. Dr. Chen is a Professional Engineer registered in the State of Tennessee.

Mr. Jonathan Derr is a senior student in the Department of Engineering Technology and Industrial Studies, Middle Tennessee State University. He works as a testing technician with Nissan North American Incorporation in Smyrna, Tennessee.