Effectiveness of Open Door Undergraduate Research Opportunities

Gabriel Russ
Electrical Engineering
Undergraduate Student
Ohio Northern University
Ada, OH 45810
g-russ@onu.edu

Samuel Roth
Computer Engineering
Undergraduate Student
Ohio Northern University
Ada, OH 45810
s-roth@onu.edu

Benjamin Kerber
Computer Science
Undergraduate Student
Ohio Northern University
Ada, OH 45810
b-kerber@onu.edu

Firas Hassan
Assistant Professor
ECCS Department
Ohio Northern University
Ada, OH 45810
f-hassan@onu.edu

Heath LeBlanc
Assistant Professor
ECCS Department
Ohio Northern University
Ada, OH 45810
h-leblanc@onu.edu

Joel Huff
Electrical Engineering
Undergraduate Student
Ohio Northern University
Ada, OH 45810
j-huff@onu.edu

Abstract

Conducting research as an undergraduate student is an effective way to explore academic interests outside of a traditional classroom setting. In this paper, we detail our experience as undergraduate research assistants at Ohio Northern University. One of the most striking things about the staff at Ohio Northern University is the 'open door' approach that the professors have. When we went to our professors to express our interest in conducting research, they were more than willing to include us in their projects.

Despite not having much experience, undergraduate students at Ohio Northern University are still given major roles in projects they are involved with. This project was fully funded by the university, and called for the development and submission of a thorough bill of materials. Because the project's original design changed part way through the semester, the team was also tasked with developing a secondary design. As the semester came to a close, the team created posters for the 2014 Ohio Northern University Research Colloquium, where the project was presented to others.

Introduction

This paper describes the process that our group went through to assist Ohio Northern University teachers with their existing research projects. Many of the professors in the Engineering department at Ohio Northern carry out independent or group research projects with either student groups or other professors. The students that assist with these projects may be asked directly for assistance, or they may take advantage of the open door policy.

These projects can involve many different aspects of engineering, over a wide range of topics, and sometimes include professors and students from other disciplines of engineering such as mechanical engineers or civil engineers. Project goals depend on the professors, as they may give groups a very detailed goal, or just a basic request and allow the students to come up with a solution on their own.

Students involved in these projects are required to contribute to the project as recommended by the professor. In our group, we were required to create a robot capable of motion using control loops and communication using GPS. Additionally we were asked to create multiple bill of materials with which we were able to work with the school to acquire.

Open Door Policy

One of the great benefits of attending Ohio Northern University is the open door policies many of the engineering professors have. Students who are interested only have to ask a teacher if they need help, and they are able to assist the professor in any projects that they have in progress. All of our members came to be on the project in this way, and we feel that it allows students to improve their knowledge outside of the classroom.

Omnidirectional Motion

Initially, our team was planning to utilize robots featuring omnidirectional wheels. It was believed that this would allow for a wider range of motion, which could be used to test a number of different, complex scenarios.

Figure 1. Mecanum Robot Omnidirectional Wheel

The unique geometry of these wheels allowed the robot to move in any direction without having to complete a traditional turn. The various different ways in which the robot could move were implemented by varying the directions of each of its four wheels. A diagram depicting the algorithm for omnidirectional motion is shown below, in Figure 2.

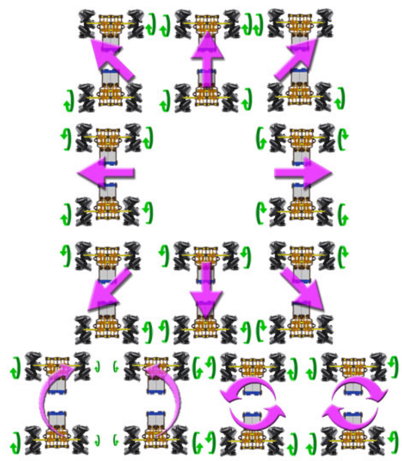

Figure 2: Full Range of Motion

In the above diagram, the small green arrows indicate the direction of motion for each of the wheels. The lack of a green arrow next to a particular wheel indicates that it remains in its current position. The larger, purple arrows indicate the resulting movements made by the robot. The top half of the figure features the eight translations the robot can make. The bottom half of the figure features the turns that the robot is capable - both wide and narrow turns were possible.

The team proceeded to build a single robot featuring these wheels, for the purpose of testing. Considering that the ultimate goal of the project was to deploy a swarm of robots, we had to make sure that a single robot would be able to function as expected. The robot that we built was the DFRobotShop Mecanum Rover 2.0, which is shown in Figure 3.

Figure 3. DFRobotShop Mecanum Rover 2.0

GPS Module

To improve the accuracy of the robot, it was decided that a GPS module would be utilized. This would allow for the robot to maintain accurate positioning for itself and in relation to to other units. The GPS modules were added to the overall bill of materials, and purchased from seeed studio. The GPS module recieved a GPS signal from satellites and output a simple data string, shown in Table 1

$GPGGA	String Identifier
170834	Time
4124.8963,N	Latitude
08151.6838,W	Longitude
1	Fix Quality
7	# Satellites
1.4	Horizontal Dilution of Precision
240.2, M	Altitude
*7E	Checksum

Table 1: GPS Data String

We created a program to run on the arduino microcontroller, which allowed the string to be processed into just the position data, which was reported to the robot's controller. To test the GPS, one of our group members brought the GPS module on a 2 hour drive from campus to Sandusky, OH. The program was modified to output the number of satellites that the module was receiving, and the drive was chosen due to the fact that it contained a wide range of terrain, from open plains to hills and trees, even going under bridges and around sharp turns.

The duration was also useful as it would allow us to ensure that the quality of the receiver did not degrade over time. To make sure that the receiver was accurate, the output was imported into google maps and checked against the existing map. The test was very positive, as the map result was very close to existing maps, usually varying by less than a meter.

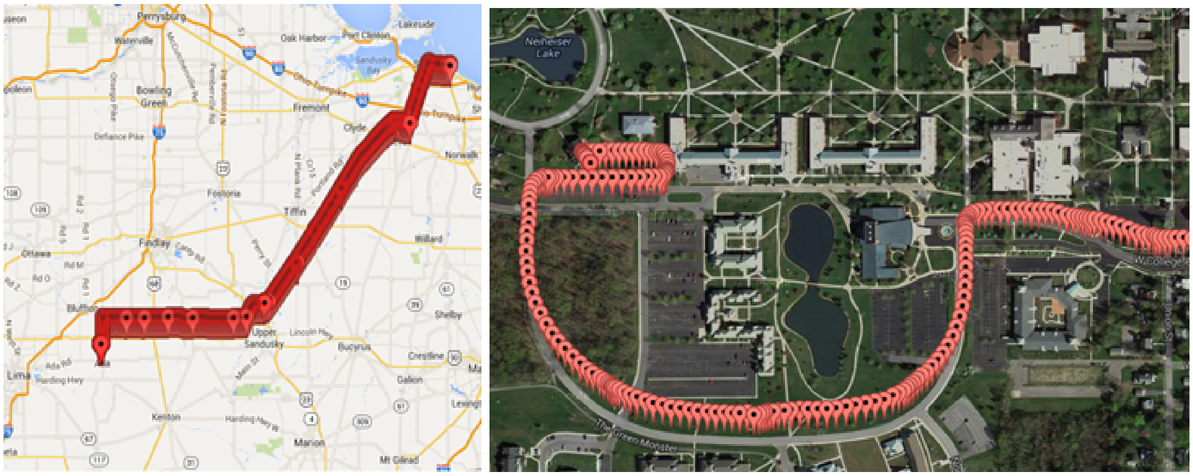

Figure 4: GPS Tracking

The GPS module itself also performed well, with the number of satellites connected to remaining fairly high for the duration of the trip. The module was still able to remain accurate with the lower satellite count, which was caused by the GPS module falling out of position without being noticed.

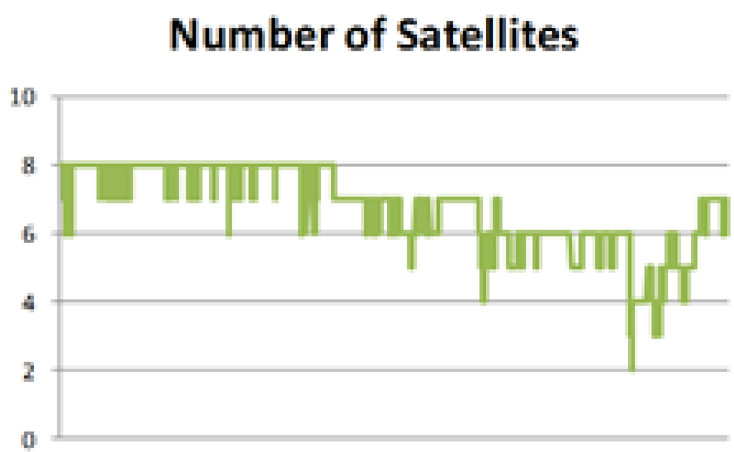

Figure 5: Satellite Connections over time

Results

As the semester began to end, the team created a presentation aid to help in the presentation of our project. These presentations were held at Ohio Northern's Macintosh Center, and provided a chance for the team to show other professors and students the outcome of the project. This poster included information on all the parts of the project, and was created by all the members of the project. The professors helped us by giving us advice on ways to improve the readability and layout of the poster. The poster is shown below in figure 6.

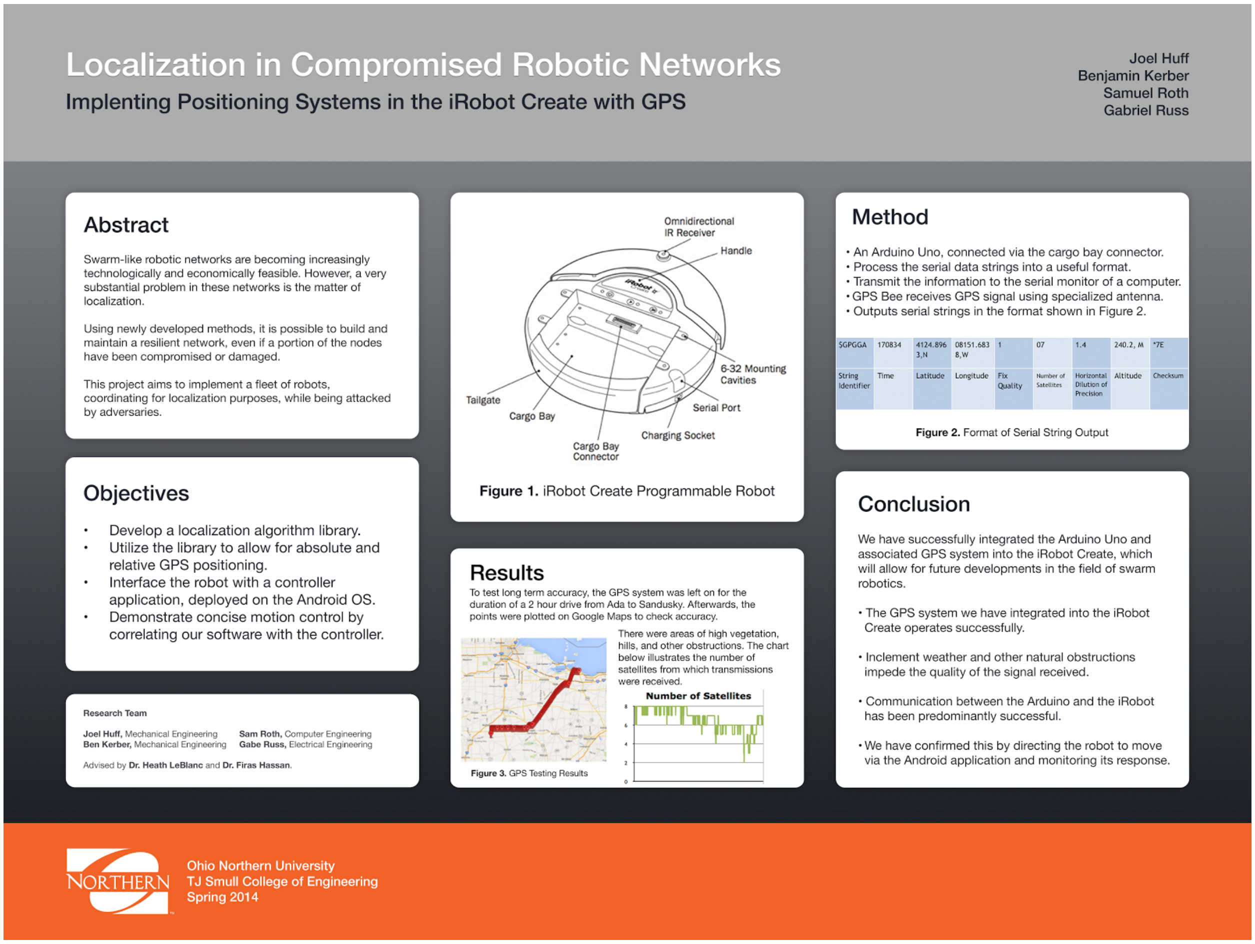

Figure 6: Presentation Poster

Reflecting

Overall our group felt that working with the professors was a rewarding experience. Not only did we have the opportunity to work with multiple professors in order to complete an independent project, but we were able to gain a great deal of knowledge by working on the project.

One of our group members was a freshman electrical engineer, who had barely had any programming or design experience before, however through working on the project he learned how to design and program efficiently.
The other three members of the group had not had much experience programming navigation algorithms before, and this project gave them the chance to improve their programming abilities. As the navigation algorithms were refined, we were able to visibly see the improvements that were made as the control of the robot was made easier, the robot was able to move faster, and more advanced maneuvers were possible.

Application with Independent Study

Due to class requirements and the busy schedules of the two professors involved, the project was not continued into the 2014-2015 school year with the entire group. However, one of the group members was able to use the knowledge gained through working on the project and apply it to their senior design project. This project involved

Conclusion

The main result of our collaborative project was a series of navigation algorithms for robots, as well as a GPS navigation system to provide feedback for the robot in question. However the group was also able to gain a great deal of knowledge and experience from the design process. This experience would be extremely difficult to get just sitting in a classroom, and our group felt that it was the most important and beneficial part of the project. This project allowed us to gain valuable design experience while assisting professors in their research.