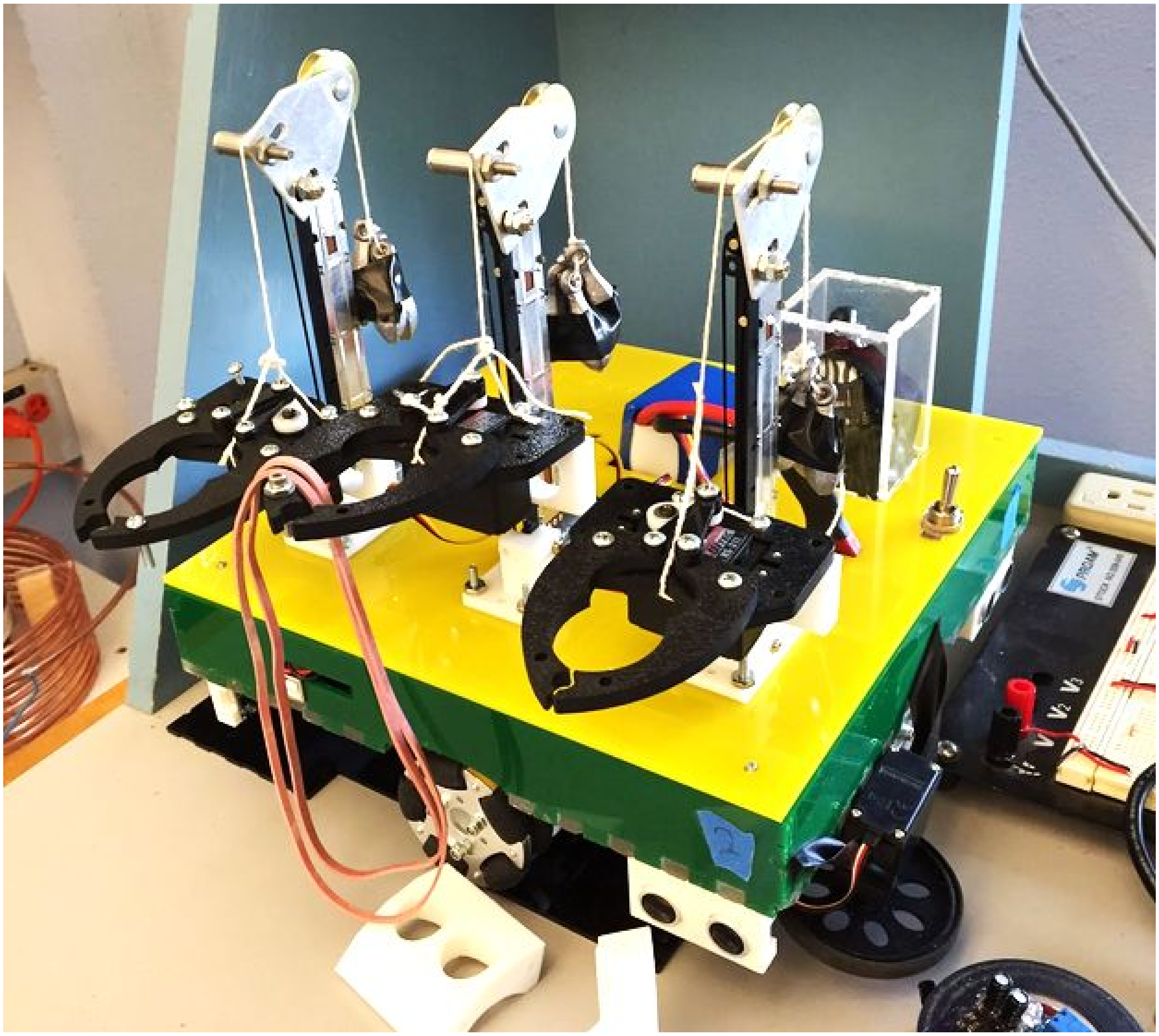

I. Project Title

Roborodentia 2016 - Autonomous Omnidirectional Ring Moving Robot

II. Project Completion Date

April 17, 2016

III. Student(s), Department(s), and Major(s)

Matthew Ng - Computer Engineering
Darius Holmgren - Computer Engineering
Mytch Johnson - Electrical Engineering

IV. Faculty Advisor and Department

John Seng - Computer Science

V. Cooperating Industry, Agency, Non-Profit, or University Organization(s)

Robotics Club and Roborodentia Club

VI. Executive Summary

Our team created an autonomous omnidirectional driving robot that was capable of small micro adjustments to accurately follow the black guide line using four motors. This omnidirectional robot used a linear potentiometer to raise and lower the grabbing mechanism. The grabbing mechanism was a claw with 3D printed extensions which increased the amount of rings that could be picked up in a single motion. We expect this methodology of quick driving and streamlined movements would be a deciding factor in scoring points for our team.

VII. Major Accomplishments

Omnidirectional movement/sliding/IR detention

Our drivetrain was the accomplishment we were most proud of. The way we could quickly speed around the course and track the black line was faster than any other group. Since our robot was designed to use omniwheels, it was able to avoid having to directly follow the black line. The robot was programmed to turn while waiting for the black line. Once the line was detected, our robot would straighten itself out and begin to follow the line again.

Using linear potentiometers to raise and drop the rings

This was the most challenging part of the robot. We knew how to drive a robot chassis but have always had a difficult time in getting a robot to lift something. The linear potentiometer was able to do that for us. Unfortunately we found that the linear potentiometer motor wasn't strong enough to lift the claw and the rings combined weight. We grabbed some fishing weights and created a counterbalance that would help the linear potentiometers carry the rings. Even though the weights helped counterbalance the claw and rings, it still strained linear potentiometer too much. We ended up overloading and breaking at least one linear potentiometer in the process.

4th place overall

This was our third time participating in Roborodentia. Our freshman year we barely qualified and was eliminated rather quickly. Last year we qualified easily and scored in the top 40% of points. This year we hit fourth place. This was the highest so far. Each year we've learned from mistakes so when this next competition comes around we be gearing up and aiming to take that first place spot.

VIII. Expenditure of Funds

Supplier	Quantity	Part	Unit Price	Total Price
Wheels/Motors				
RobotShop	4			

IX. Impact on Student Learning

Matthew's Response

I was introduced to roborodentia from my CPE 123 professor John Seng freshman year and he said even though it was a difficult competition, it was a great learning experience. He wasn't wrong at all. A lot of the problems that we've run into with mechanical, electrical, and computer design were great learning experiences that impacted our future designs when we create robots. There are many aspects that cannot be taught in a class. Some of these learning experiences include:

- Finding WD40 between two sliding panels actually creates surface tension and makes it harder to slide the two panels
- A digital IR sensor requires chargeup of a capacitor and a timer to count the response whereas an analog IR sensor will instantly pick up the correct shade.
    - A digital IR sensor can be changed to an analog IR sensor by removing the capacitor, surface mount soldering a resistor in its place and shorting a connection.
- WD40 on wheels make the robot lose traction
- Ultrasonic Sonars have a difficult time receiving accurate data so filters must be used
- Encoders on motors can sometimes be inaccurate using omniwheels and different voltage ranges
- Linear potentiometers are not good for strength applications but can slide quickly and easily

I would definitely recommend anyone who has a small interest in robotics to compete in this competition. It is a great way to learn by doing.

Darius' Response

One thing majorly lacking in my academic education is a chance to learn the skills related to the application of my major skills. Having the hands on experience of Roborodentia as an opportunity to grow my skills in the areas of mechanical engineering, software engineering, as well as general team building skills was invaluable. Working on a project from conception to competition is the best way to learn.

Designing the chassis required a holistic knowledge of what the plan was for our bot. Aside from the obvious constraints of size and price, there were more dynamic design decisions to factor in such as the weight and strength of the material being positively correlated leading to an optimization problem. We wanted our frame to be strong so that it would not crack due to collision or bow with the weight of the other components. Having to discuss these factors and reach a consensus with a team is an important skill to have for any task that requires teamwork. Other design decisions such as the size of the torque requirement of the motors, the grasping strength of the claws, and the weight lifting capability of the sliding potentiometer had mathematically derivable minimum requirements that we could solve before making purchases.

Every piece of the robotics puzzle was equally important as far as getting a working product as well as a learning tool. Participating in Roborodentia for the past three years has been one of the most thrilling and growth inducing experiences in my time at Cal Poly. I cannot wait to do it again next year.

Mytch's Response

Every year that I have participated in Roborodentia I have gained new skills and refined the skill that were taught to me at Cal Poly. It is a truly unique experience to invest your academic knowledge and real world skills into a project of this type. The most beneficial skills that this year's competition taught me were related to project planning and leadership. In previous Roborodentia competitions, our team only had a vague plan and timeline for our project. This year, we decided to create a gantt chart of our entire project timeline and stick to it. Because of our planning, we rarely fell behind schedule and we always knew what needed to be worked on. Additionally, our team designated group work time for each week. This way our team was always working with each other at the some time. If an unexpected problem arose, we could all work together to solve it. These team management skills were key to our ability to finish our robot on time and placing where we did.

While team skills were very important to our success this year, there were a number of technical skills that I learned as well. The most important technical skill I learned was the ability to design a system level power framework. There were a variety of subsystems that needed power such as microcontrollers, DC motors, and servos. In order to have an autonomous robot that functions the same way even as your battery drains, it was important to maintain a well regulated power system. I had to learn the basics of DC-DC regulation using LDO and Buck converters. I had never learned about proper DC-DC converter design and implementation prior to learning it myself for Roborodentia. Through the aid of a few power electronics professors and self learning, I was able to properly regulated the necessary subsystems for our robots. These design skill will be useful for any application that has subsystems with a variety of power and power level requirements.