Cal State LA Swarm Robotics

Swarmathon Outreach Report

Spring 2016

California State University Los Angeles

Team Roster in Appendix A

Faculty Advisor: Dr. Nancy Warter-Perez

Dr. Warter-Perez certifies that she has read this report prior to submission.

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***Abstract*—As partial fulfillment of the requirements for the NASA sponsored Swarmathon competition, the Cal State LA Swarm Robotics Team completed the initial stage of our outreach project by interacting with students in middle school and high school classrooms in our local community of East Los Angeles, which primarily serves minority students. The classroom visits comprised of presentations by several of our team members, both a simulation and physical demonstration of our rover, a hands-on activity, and a student questionnaire. We plan on continuing our outreach efforts by further developing our current relationships as well as getting involved in a budding program that encourages middle school girls to get involved in STEM fields.**

Swarm robotics; robotics competition; STEM education; community outreach; youth outreach.

I. Introduction

The members of the Cal State LA Swarm Robotics team have a multitude of ideas when it comes to the outreach portion of our Swarmathon project - the goals of our continual outreach efforts are ambitious and we plan on spending many additional hours aside from the time we have already spent visiting classrooms throughout East LA to share our passion for the engineering field and robotics, in hopes that we will spark passion and inspire young students to do the same. In consideration of the limited time we had for outreach while we were figuring out and implementing our search algorithm, we spread our goals out between a short-term outreach project and a long-term project. The majority of this paper will discuss the activities and outcome of our short-term outreach project, but we will conclude with our future plans.

For our preliminary outreach, we decided to limit our focus on awareness of opportunities in the engineering field, challenging the conventional image of an engineer, self-reflection on attributes that an engineer may encompass, and of course, the engineering emergence in evolutionary swarm robotics and our role in the Swarmathon competition.

II. Recipient Group Background

We utilized existing connections we had in the community from a previous project, IMPACT LA (Improving Minority Partnerships and Access through Computer Information Systems and Engineering (CISE)-Related Teaching in Los Angeles, http://impactla.calstatela.edu/), to access one charter and four Los Angeles Unified School District (LAUSD) classrooms at two high schools and one middle school. In small groups of 3-4, we visited two engineering classrooms at Lincoln High School that recently competed in their first robotics competition at the Ventura Regional, hosted by First Inspires (http://www.firstinspires.org/), a physics classroom at the STEM Academy of Boyle Heights High School, and two sixth grade math and science classrooms at Stevenson Middle School. All are minority serving public schools in our community of East Los Angeles. Four out of five classrooms were composed of 100% minority students and all schools were considered 4th-quartile schools. Of the STEM Academy of Boyle Heights High School students, 80% were Latino, 12% were Asian, and 8% were from other various minority backgrounds.

The average classroom size was 25.2 students. In the science and math classrooms visited at the middle schools, there were approximately an even amount of girls and boys. However, in the high school physics and engineering courses, there was a notable decrease of girls in the classrooms, as girls only made up 16% of the students. In comparison, an English classroom that we briefly visited at the same high school, had an even distribution of 10^{th} grade boys and girls. Though the presentation to the English class was much shorter due to limited time, student engagement was very high, especially from the girls in the class.

III. Team Participation

We assembled a small team to speak at each classroom - each member who participated in the outreach project had an opportunity to share their personal stories and interests in the engineering field, giving the students an opportunity to hear from different points of view. A PowerPoint presentation was prepared for all classroom visits, along with a simulation demonstration of the rovers using Gazebo, a physical demonstration of one of the rovers, and a student questionnaire.

Halfway through our outreach efforts, we recognized the value that an activity may have, so we introduced a pen-and-paper egg hunt game to elicit student engagement and to get the students thinking about search algorithm patterns before we gave our presentation. We also used feedback from our first outreach visits to reconstruct the questionnaire to step away from a pre-survey/post-survey model to a single questionnaire model (see Appendix B). The reason for this change was that we wanted to shift our goal from measuring the influence of our presentation to the goal of using the questionnaire as a critical thinking exercise on the part of the students, a change that reflected our presentation goals more accurately. The questionnaire results that we will be referring to in the remainder of this paper is comprised of answers from 57 sixth graders from two math and science classrooms. We have excluded the initial questionnaire responses.

In order to make our presentations as engaging as possible, we solicited responses from students during the presentation about the history of engineering, current roles of engineers in society, direct day-to-day impacts of engineering in their lives, as well as current and future applications of robotics in fields including, but not limited to, medical, aerospace, construction, transportation, and environmental.

A key point in our outreach efforts was to demonstrate that engineering is a diverse and broad field with endless opportunities, therefore, it is likely that the students can find at least one type of engineering that relates to their interests. For this purpose, our presentations were not limited to swarm robotics, but branched into introducing a wide range of engineering fields. Since our team itself consists of students of various backgrounds, majors, and specializations, the students were able to learn and ask questions about how engineering can be split into numerous branches of study.

When asked if there was something more they wanted to learn more about after the presentation, Figure 1 shows that 82% replied that they did. 49% of those students wanted to learn more about what specific engineers in different fields do, the most frequent field of interest being software engineering, followed by electrical engineering, mechanical engineering, chemical engineering, and civil engineering.

	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	NA
I like the feeling of solving a problem.	40	10	5	0	2	0
I like to imagine creating new things.	50	5	0	1	1	0
Anybody can be an engineer.	33	14	4	3	2	1
If given the chance to, I want to program a robot.	37	11	4	2	0	3
I'm good at working in a team.	28	22	4	0	2	1
I like building and fixing things.	40	10	3	2	1	1
I'm curious about how something works when you take it apart.	43	9	2	0	3	0
I can be an engineer if I want to be.	46	6	4	0	1	0

Figure 1 Accumulated Survey Results From 57 Middle School Students

As students pursuing STEM fields ourselves, our team understands the possible confusion or misunderstanding middle or high school students may have about engineering. Engineering is often depicted as an intimidating career path, especially to underrepresented minorities in STEM such as women and ethnic minorities. We aimed to challenge the conventional image of an engineer by using our own team as an example of diversity in STEM, with hopes of serving as role models to students in our community. With this, we hoped to convey the fact that there is not one narrow set of qualities that defines an engineer, but that engineers can come from all different types of backgrounds.

Through this outreach project, our team also strove to clarify any misconceptions of engineering, and highlight the benefits of this rewarding field. Mostly, we wanted students to feel that engineering is a very possible future for them, not an obscure, unreachable goal.

At the conclusion of our presentations, over half of the students (82%) agreed with the statements that anybody can be an engineer. Even more students (89%) reported that they themselves could be an engineer if they wanted to be. Of course, without a more in-depth longitudinal study, it is impossible to attribute these results to our presentation alone. However, these results make us optimistic that STEM careers are being viewed as attainable by future generations of students.

In order to gain the students' interest in swarm robotics, the team demonstrated a simulation of the robots on Gazebo before demonstrating how the simulation could translate to a physical robot (Figure 2). Having a physical robot with us was a crucial visual aid and learning tool. Needless to say, it was also the source of the most excitement in our classrooms. At the end of demonstration, 84% of students said that given an opportunity to program a robot, they would be interested in doing so.

Figure 2 Gazebo Simulation Demonstration

IV. Outreach Activity and Student Engagement

The complex task of developing a search algorithm was illustrated by having students develop their own search patterns. Provided with a grid and starting point, students were asked to draw a pattern that spanned 16 blocks, did not overlap, and did not cross diagonally. The goal was for them to "search a garden and find as many eggs as possible", an analogous scenario to searching for resources (see Appendix C). Students then objectively compared how many "eggs" they found when we provided them with the coordinates of their egg locations, and were asked to evaluate how many they found, how many they came close to finding, and how many were not at all close to their chosen paths. This activity served as an excellent transition into talking about swarm robotics and the challenges we faced as a team to implement the best search algorithm when there are a team of robots working together.

We wanted to provide a positive outlook on engineering by acknowledging the challenges that comes with the career, and also providing solutions with first-hand examples of how we went about solving some of the issues we came across while participating in the Swarmathon challenge. We highlighted a few specific examples of the analytical processes we used to troubleshoot, with the purpose of introducing students to some real world applications of critical thinking in problem solving.

In order to further challenge the students, we built upon the in-class activity given by asking the question of whether or not having multiple robots would help or hurt a situation involving the exploration of an unknown area. Students had many creative answers and by the end of our presentation, when asked to give reasons why having multiple robots search together may be beneficial, common themes were:

- "It's better to have many robots on one task because if one breaks down, there will be more that could continue."
- "If one robot finds something the rest go help that robot."
- "They work as a team and can cover more ground."
- "If you only have one robot doing the work by itself, it will take long for it to do its task."

V. Impact of Outreach

Our outreach project emphasized the current possibilities of robotics as well as future possibilities. By completing a simple activity of creating a search pattern on paper, the students were engaging in an engineering process not unlike the one our Swarmathon team did. With this, the students can feel more confident in their capabilities to further pursue an education and a career in STEM. By introducing the students to engineering, it allows them to have an initial positive view of engineering and computer science. Also, since our team consisted of both engineering and computer science college students, the younger students were able to hear a positive view of their experiences as members of the STEM community.

From the accumulated results of the questionnaire we distributed at the end of the presentations, we are pleased to see curiosity in considering a career in STEM. It is encouraging to see that an overwhelmingly large percentage of the students we visited have confidence that an engineering career is within their reach.

VI. Planned Outreach for the Future

For our outreach extension, we plan on expanding upon our existing core goals of exploring opportunities in the engineering field, challenging the idea of what an engineer looks like, self-identifying qualities and attributes that may be helpful in any engineering field, and discussing areas of future growth for robotics, with an emphasis on swarm robotics.

The schools we partnered with all have budding engineering programs. After discussion with the teachers, they seem keen on establishing a relationship with Cal State LA students so that their classes can have exposure to the engineering field with noted applications. We want to make a bigger impact than we were able to have in the short duration of time we were given for the competition, so we plan on extending the span of our project with the goal of being able to expand our current activity portion to be just a small part in a series of activities that conclude in developing applied programming skills. We will be using the relationships we created with the schools and teachers from our outreach efforts thus far to come up with project plans that best suit each classrooms' individual interests, needs and time constraints.

We also had the chance to speak with a teacher who is working on a program called Girls Build LA. This program seeks to encourage middle school girls not only to pursue STEM related fields, but to show them how successful women are in the field. The goal is to interview both college women and women in established STEM careers so that young girls have role models to look up to. With that in mind, we seek to encourage the women in our departments to participate in this project as part of our outreach.

Appendix A- Team Roster

First Name	Last Name	Major
Christoph	Anderson	CS
Aram	Atamian	EE
Sergio	Castillo	EE
Saul	Castro	CS
Jason	Green	EE
Holly	Griffiths	ME
Layla	Habahbeh	CS
Ray	Han	CS
Abner	Hernandez	EE
Donna	Hernandez	EE
Ceasar	Jimenez	CS
Kyle	Kinsey	EE
Jose	Lemuz	EE
Brian	Martinez	EE
Mariah	Martinez	CS
David	Rojas	EE
Jonathan	Sahagun	CS
Josh	Saunders	EE
David	Trejos	EE
Jonathan	Valladares	EE

Appendix B- Student Survey

Date: ______________________________ Class: ______________________________

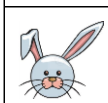
Teacher: ____________________________ Grade: ______________________________

What is something that robots can do better than humans (besides the robot dance)?	
Why is it better to have many robots working on a task than just one robot?	
What does an electrical engineer do?	
What does a software engineer do?	
Did you learn anything new today during the presentation? If so, what?	
Is there something you want to learn *more* about? If so, what?	

	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree
I like the feeling of solving a problem.	1	2	3	4	5
I like to imagine creating new things.	1	2	3	4	5
Anybody can be an engineer.	1	2	3	4	5
If given the chance to, I want to program a robot.	1	2	3	4	5
I'm good at working in a team.	1	2	3	4	5
I like building and fixing things.	1	2	3	4	5
I'm curious about how something works when you take it apart.	1	2	3	4	5
I can be an engineer if I want to be.	1	2	3	4	5

Appendix C- Student Activity

Find the Eggs. Draw one continuous line.
Your rabbit can only move 16 blocks!

	1	2	3	4	6	7	8	9	10	11	12
A											
B											
C											
D											
E											
F											
G											
H											
I											
J											
K											

Found Eggs: _______