NASA Swarmathon

"Swarming Eagles"

http://www.coppincs.com/nasaswarmathon

Virtual Competition Team Technical Report

Swarming Eagles Team Members:

- Orville Keize
- Olubusayo Ladelokun
- Javon Summers
- Anil Yadav
- Rufus Smallwood
- Byron McCarthy
- Chimdi Eze
- Gabriel Franca
- Jerry Mahammitt
- Keena Samuels
- Rodney Carter
- Shamar Reeder
- Antonio Harrell
- Victor Onyenze
- Iyoha Irabor
- Anderson Burgess

Academic Supervisor

Dr. Leshell Hatley, Ph.D

I certify that I have reviewed this report before submission.

Abstract

The NASA Swarmathon is a competition that makes it possible for Historically Black Universities and Colleges (HBCUS), Tribal Colleges, and Hispanic Serving Institutions to learn about robotics and participate in real-world problem solving. Why *Swarm* you ask? Well, the name originates from how some animals look for food in swarms (collections) in order to survive. The goal of this annual competition is to replicate those same actions into search algorithms so physical and virtual robots will be a success at finding *april tags,* which simulates finding water or other resources on Mars. This great opportunity is hosted by the Moses Biological Computation Laboratory and the Swarm Robotics Research Group at the University of New Mexico and is sponsored by NASA's Minority University Research & Education Program. This report provides the procedures that the students of Coppin State University took in order to succeed in the NASA Swarmathon Competition.

1. Introduction

Coppin State University's 2017 NASA Swarmathon Virtual Competition Team

"***Good Afternoon Class, we're joining the NASA Swarmathon Competition!***" That was the first thing that we heard as a class when we walked into the door on the first day of class this semester. The first thought that ran through most of our minds was "what is that?" We've never been involved in a serious competition like this before, but we could tell that each one of us was

eager to learn. The idea of learning new languages such as C++ or Python or Gazebo created a passion.. Throughout this technical report you will read of our challenges, what we enjoyed, and topics we learned along the way.

2. Methods

Coppin State University's 2017 NASA Swarmathon Virtual Competition Team

2.1 Experiments: Trial and Error

The first and most basic step we took was to understand the what the competition was about, what knowledge we needed in order to compete, and the dynamics of our entire team. We soon realized we had a great deal to learn. We knew that carrying a pretense that every member of the team was an expert in certain languages was the surest way to go down a wrong path. There were various resources already available for the teams to view / analyze and see what additions could be made to increase the productivity of the roaming rovers. We used our meeting periods, which were class periods that occurred twice a week, to update each other on our level of understanding of these concepts.

Initially various concepts were foreign to us, in terms of languages and operating systems (i.e. Ubuntu). However, understanding that computer science, from the beginning, has always been a sector of discovery and learning, we were encouraged to delve into the concepts with joy and anxiety. Our initial brainstorm led the team to believe that python and C++ languages were the routes to proceed with. Later, we abandoned Python and proceeded full time with the C++ language. The majority of the team knew only a small to medium fraction of the C++ programming language. Therefore, this meant that we had to ramp our knowledge of the language to a higher level. Time was of the essence! The C++ language is a vast and deep

language, therefore the total understanding of it would take months. Our strategy was going for important and useful knowledge rather than learning everything associated with the language. As previously mentioned, the python language was dropped due to information received by a member of the team on the competition's forum and slack pages. It was revealed that python language proved a little slower for a team that competed last year. After a meeting of the entire team, we concluded that it was in the best interest to fully focus on the C++ language. Other concepts that started as an enigma for some was Ubuntu and ROS (Robot Operating System). Both Ubuntu and ROS were unfamiliar to most members of the team until our participation in this competition. After a few weeks of struggling with laptops that had specifications that did not match those needed for the competition, we ultimately borrowed laptops with matching specs from our school's IT department and from our Academic Supervisor, Dr. Hatley. Making several attempts to install both Ubuntu and ROS on these laptops helped our understanding of each. During our attempts, the NASA Swarmathon website proved to a be a very resourceful tool that helped a long way. From the webinars to the forums, some questions that was presented by the team could be answered from the website.

2.2 Feel the Fear and Do It Anyway

The tasks that the competition required were not easy and there were many things that we did not get to accomplish. We ultimately realized that procrastination was a major reason that hindered us from ultimately achieving the goal that was set in the beginning. It seems many team members may have been a bit anxious because of the vast amounts of knowledge and skill we had to acquire and use in a short period of time. This contributed to an initial lack of confidence and maybe even a bit of fear. Nonetheless, in comparison to where the team was in the beginning, the team has now increased knowledge as well as experience over a few programming languages, systems, and environments. A lot of members of the team have gained something that they can take with them pass this competition whether it was coding, tactics, methods, working with the environment, or in general; new terms.

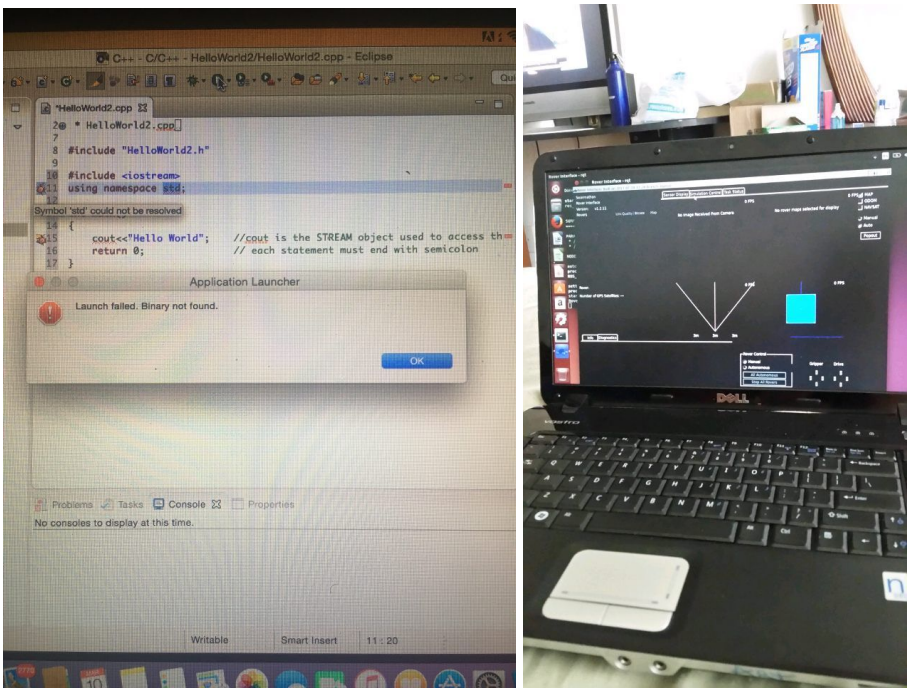
Progressing through the semester, we had a belief that we could fish out new knowledge from the computer science field. This competition has enhanced our skills as computer scientists. Our will to learn about new things has been better off since starting the competition. The fear that we had at the beginning of the semester was eradicated through the hard work and persistency we had all semester all long. We have learned a lot. We have understood the importance of how new programs can be implemented into today's questions research for the future.

2.3 What We Accomplished

This was our team's first time getting accustomed to working with the virtual "Swarmie" robots. The team learned that the Swarmies could interact with the environment and move around using tactics/algorithms such as the "Search and Collect" method where multiple robots search like a lawnmower for what is needed while one robot stays ready to collect the april tags. As time progressed, we made a lot of adjustments to help us become more productive over the final weeks for the competition. First thing we plan on doing is to gain an understanding of the various topics (ROS, C++, Gazebo, etc.) Gradually, we started running the Gazebo environment and studied how the swarm rovers performed random search to retrieve tags. Understanding the environment was a difficult task in itself as nobody on the team had prior knowledge of Gazebo,

so we had to start from the very basics. It would have been almost impossible to work if the entire team would not collaborate; thus, teamwork was very crucial. To achieve this, we used agile and scrum methodology. We updated our backlog twice a week to keep track of the progress. For the most part, the time was utilized to debug the source codes that we already had. It was such huge task to accomplish, especially when seen in context that students had other classes to focus on too. Nevertheless, by the end of the first month, each group had prepared a presentation for the rest of the class.

Our biggest challenge was to understand functions of various ROS libraries. The proper understanding of the Robotic Operating System was a gem that if fully explored to a greater height, could prove to be priceless. However, time restraint curtailed any further knowledge search we could do pertaining to ROS. Algorithms can be fun when built from the scratch, as you build you can add or subtract. For this competition, we edited resources that were already available rather than build from nothing. Writing algorithms can be a great learning and challenging experience. It allows us to incorporate some of the knowledge that we have learned over the years in the computer science program. Although it can be slightly frustrating because of the constant trial and error, algorithm building is very enjoyable and fascinating aspect that we would have loved to really get into.



Screenshots from laptops of team members asking for help and testing Gazebo.

2.4 Advice for Next Year's Team & Areas of Improvement

The competition this year was a true test of our team's ability to stick together through times of frustration and submission while also a test of each individual member's work ethic and character. Looking back and reflecting on these past few months together, we acknowledge that their are some things that we would of done differently if the opportunity presented itself again.

First off, one thing that we would definitely seek to improve for next year's competition is our lack of urgency. Procrastination really plagued our team a lot this semester and ultimately kept us from accomplishing a few things which could of potentially put us in a much better position for the competition. For the teams participating next year we would advise the team be prepared for a very hard and insightful semester. This project pushed us to the limits and you should be prepared for that too. We came into this thinking this would be a simple easy task using our prior experience programming with java. But we learned the hard way this project requires a lot of time and time management is KEY. Trying to balance this project and other courses took a toll on our group. There were times when we wanted to give up, but we fought through it as best we could.. For us, trying to learn Ubuntu, ROS, and C++ in a very short time was difficult. Hopefully next year's team won't be as bad and will fight through like our team did.

Coppin State University's 2017 NASA Swarmathon Virtual Competition Team

2.4 Results: Next Steps and Work-in-Progress

With all that we learned this semester and the many powerpoint presentations we gave each other on many topics, we have decided to make an app that would help others. The design and development of this app is underway and we look forward to sharing it with other teams next year.

3. Conclusion

Us competing this year was definitely a great experience. As a class we learned each other's strength and weaknesses but we weren't the best at leveraging everyone's strengths. The students at Coppin State University would love to continue our participation in NASA's Swarmathon years to come and we thank NASA and UNM for allowing us to partake in this opportunity.