

Fayetteville State University's Outreach Report for the Students of West Over High School



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As part of our requirements for participating in the NASA Swarmathon competition, we chose to engage the students at Westover High School right here in Fayetteville, North Carolina with a presentation and demonstration of our work. To be more specific, these are students from the Academy of Engineering and other students who could attend the event. Our purpose was **not** only to increase interest in both computer science and robotics but to also see what activities they have been doing at their school with robotics too!



Swarmathon Outreach (Left to Right): Bruce Osnoe, Sam Ndiwe, Michael Backus, James Fisher

We met Ms. Jeannie Johnson at the door near the media center. She is the director for the Academy of Engineering at Westover High School. She also leads a group of students who have been participating in a "First Robotics" competition for some years now. As requested as part of this paper, we mentally noted the number and kinds of students in attendance. We had about 40 students in attendance which included a majority from underrepresented groups. Less than half of them were from the engineering academy on campus so we are hoping to have captured their interest in robotics and computer science after witnessing our presentation.

Our presentation consisted of about 20 minutes of PowerPoint slides which was then followed by a simulation and physical demo of the rovers. Michael started off by speaking about swarm robotics in general, which included the method's history and value to solving many different complex problems. Swarm robotics is about replicating the efficient swarming behavior of flocks of birds, colonies of ants, hives of bees, schools of fish, etc, and we wanted the students to know that each individual performs simple tasks yet work together. Ants are a great case study since they have limited communication abilities, but do communicate via trails of chemicals that are known as pheromones. We also wanted the students to understand that using swarm robotics was useful for the sustainability of future space exploration endeavors, such as building a base on the moon or traveling to Mars. With swarm robotics, we could send many different rovers out to search for the right rocks with the right minerals to retrieve and convert to water, fuel, and oxygen- which brings us to the NASA Swarmathon.

Next, Bruce continued our speech. His topic encompassed the hardware and software of the swarmies. He spoke of the different sensors the rovers had- an IMU, a GPS, an Intel NUC mini- computer, the sonar sensors up front, and so on. He also talked about the software that the Robot Operating System ran on, which is Ubuntu Linux 14.04. He explained the concept of

"dead reckoning" and the issues present in odometry, that is, trying to figure out exactly where the rover is based on how much the wheels have turned.

Sam went next and he spoke about uninformed and informed search, or more precisely, the idea of goal states and improved search patterns. However, he did not want to talk in detail about heuristic or cost functions nor did he want to mention A* search. Instead, he did a brilliant move to talk about how that we are "all robots... trying to reach our goal state." He went on about how that our "goal state" could be anything, whether it's to traverse the hallway to lunch or to become successful in the future. He said that without any information- good mentors, counselors and others around us- then we would be performing an "uninformed search" for our goal and that we may not arrive there in time or efficiently. However, Sam said that with the right data and information around us, that we could do an "informed" search and therefore reach our goal state much quicker. It was an excellent speech and the students definitely found it amusing.



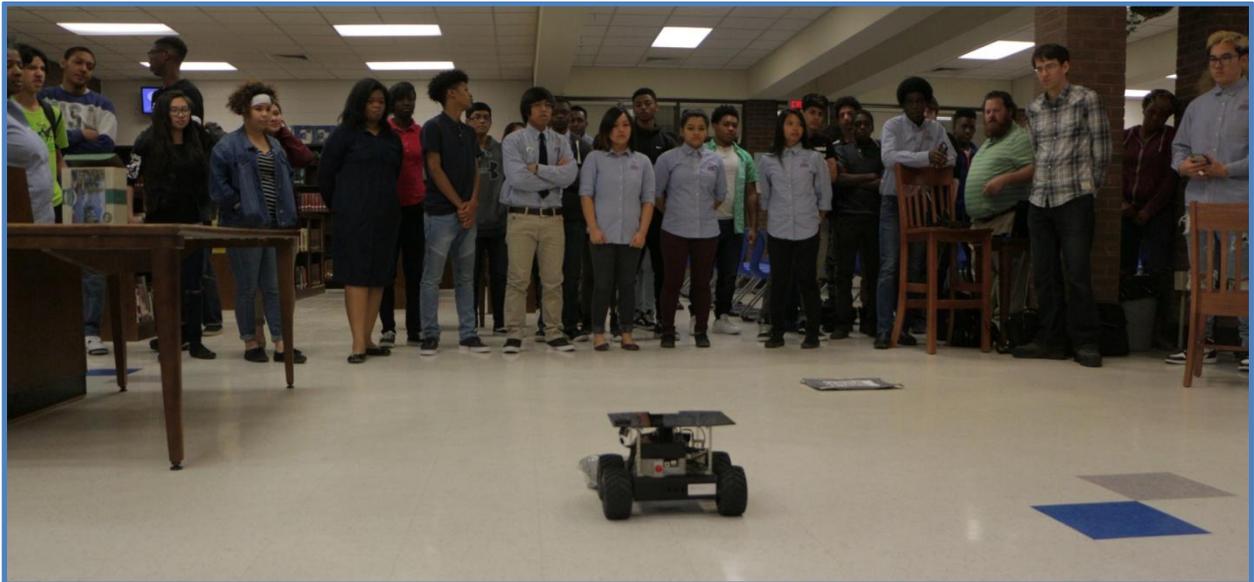
Presenting "Swarm Robotics" to the Westover High School students

James went last and spoke about some of the specifics of how we made the swarmies do what they were supposed to do. James went through some of the details about how we set up the rover's code to search until they've found a tag, to scan it, then to also get the location of the tags not picked up yet near the scanned tag and to place them and their location into their "memory." After that, this information was broadcasted so that all of the rovers could see the locations of discovered tags. The rovers then, by working together, de-queued tags off of the queue as they went to the cluster of tags together until there were no more tags available. After the simulation demo, James set up a live demo where the students gathered around a large circle.

The students watched as the rover went searching for a target. Since we only had one cluster of targets, James eventually took manual control of the rover and lead it to the source. After gathering the target, the students watched as the rover went back to the base and returned it for collection. We had issues, such as the GPS not performing as well indoors and the camera having a little too much motion blur because of being indoors, but the rover continued picking up targets. This was followed by a lot of "free" conversation back and forth between the students, their leaders such as Ms. Johnson, and ourselves. They had a lot of questions, questions that ranged from "what are the requirements to participate in this competition in the future" all the

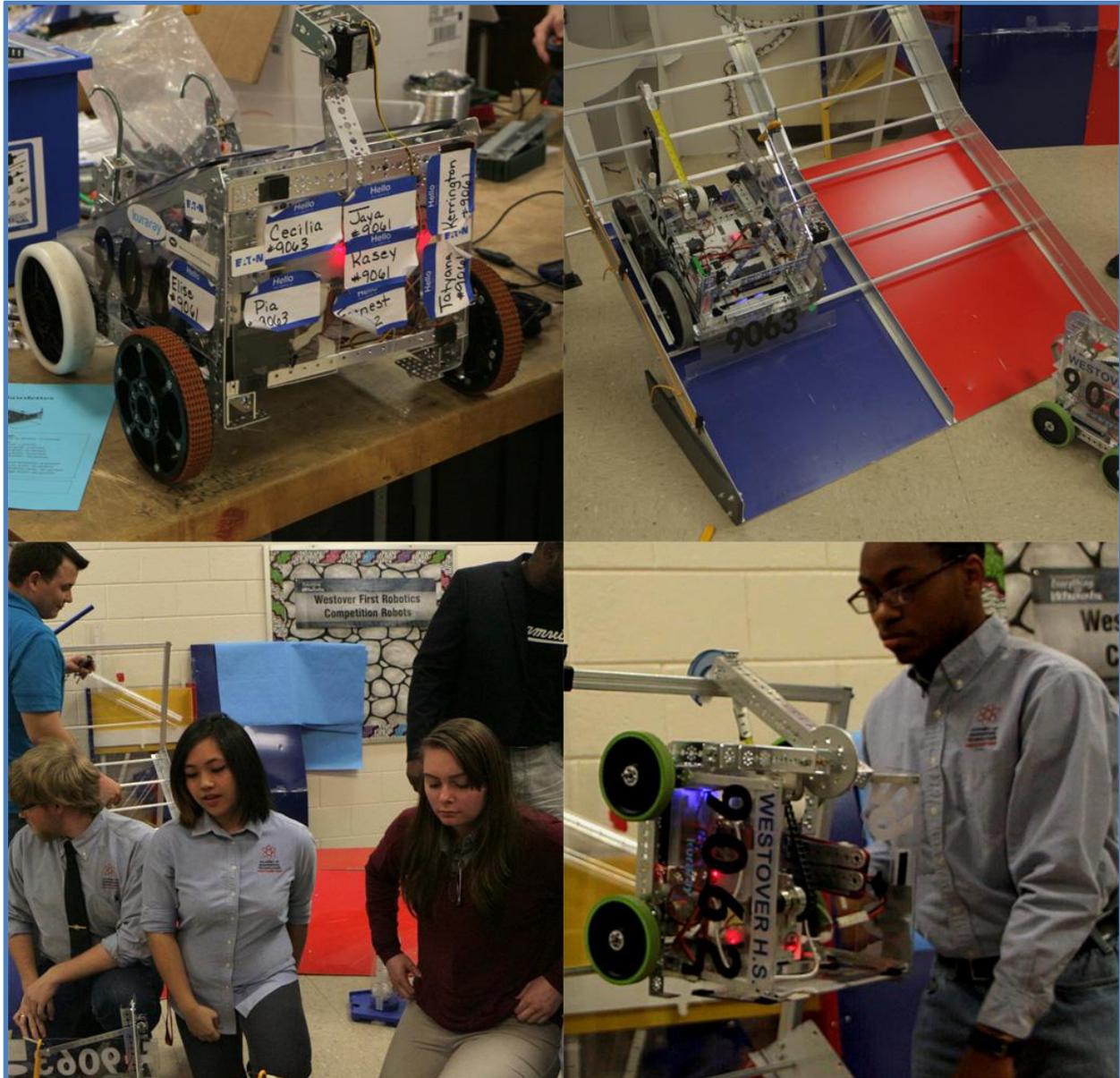
way to "what is the most difficult course in computer science?" We had a good time answering all of these questions and were very happy to see how inspired the students were about robotics, CS, and competitions like this... which is where Michael mentioned the Netlogo programming language and the future Swarmathon competition for high schools. The slides were still up which included about 4 pictures from the modules presented on the Swarmathon website. Michael informed them that they will be able to do some of the same things we were doing all while they learn the basic programming concepts such as conditional structures. He showed them how that their simulated robots, known as turtles, have similar features: search, retrieve, scan, etc. Module 5 was the best part, best, which included a tutorial on creating a similar parking lot setup like we have in our virtual simulator. Some students were already going to Fayetteville State University as their college while others showed interest in the Netlogo competition. For the students who wanted to know more about computer science and how our experience was while seeking the degree, we let them know that the math required for the actual programming and assignments wasn't very high, but that the computer science degree exposes and helps you learn about many different concepts- from data structures, algorithms and their running time, to the differences and similarities among programming languages, to very different programming paradigms such as functional programming. One student asked us what they can do now to prepare for a degree in computer programming. We replied by informing them to make sure that they pay more attention than they think they should in trigonometry and to also get a few books on Python or Java and begin reading those!

By now, our swarmie had picked up quite a few tags and it was time for students to go to their second period class. Ms. Johnson wanted to show us what her students from the Academy of Engineering have been working on- their very own "First Robotics" competition. She escorted us and some of her engineering students to their own shop where they work on their robots.



Students formed a circle around the rover as it collected tags!

Our first impression of their shop was, "we didn't have anything like this at our high school!" They had a lot of tools and a complete library of pre-built metal/CNC parts to build their robots based on certain specifications. Their competitions change year to year from what we can recall, and this time their goal was to have their robots go up a surface then carefully latch their way to the top.



Students from Westover's Academy of Engineering show us their robots!

They had three robots that they had built for this year's competition. Ms. Johnson gave us more details and explained how other than the robots being within a certain size and weight, they were free on how they could build them. They could chose any wheels that they wanted or make their own. One student showed us a 3d printed wheel he created, and another showed us how they had used common household items such as tape measures for the robot she made. They used

game controllers and their phones to control their robots. We asked if they were to autonomous during any part of their competition and they said yes- but only for the first 30 seconds or so. Then the students could take control and work on getting them up the platform. We also asked them how much code was involved, and they said that there wasn't too much for these robots. We all joked and wondered if next time they could outreach to us! They had really, really impressive work especially for high schools in this area.

This brings us to our outreach activities for 2017 and 2018. We are planning to follow up and expand our efforts starting next year to include everything we did here plus more. We will contact other local high schools that have an engineering program and an interest in robotics. We will visit at least two different high schools each year, whereby students from Fayetteville State University who are participating in the NASA Swarmathon competition will give a presentation on swarm robotics. Like we did at Westover High School, we will give demos of our swarmie robots in the virtual world and the physical world. Additional information and material on ROS, or the Robot Operating System will be given out for those interested in getting started with CS and robotics. We will discuss how ROS is an open-source yet robust robotics platform which has existing support for a wide range of robot designs and even how the user can extend it to support other designs and features as necessary.

Another form of outreach will be done also through open house, which happens at least one day in a semester at Fayetteville State University, typically Saturday. Similar activities done at the high schools will also take place at open house events. The audiences will primarily be composed of prospective university freshmen and their parents or guardians. The content will be adjusted to emphasize less on specific technology and more on the impact of swarm robotics and robots in general for both the future and NASA's missions. We will keep tabs on when the Netlogo Swarmathon Programming Competition will be running and encourage and mentor students from high schools who are interested in participating. Along with all of these activities and extended outreach, most importantly, we will speak about how students in the United States are encouraged to study Computer Science and other areas of STEM, which includes Science, Technology, Engineering, and Mathematics, due to its benefits to our nation's economy, society, and individual human capital.