Omni-Drive Robot Platform and Autonomous Pathfinding for First-Year Students

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I. INTRODUCTION

Computer Science and Engineering majors are growing in popularity among students. This thanks to the rapid growth of for example Data Science and AI. Data and robotics have never been so important and prevalent in society as they are now. The University of Michigan is ranked as the number 4 best Engineering school in the United States according to U.S. News [1]. But while the University has a prestigious reputation in Engineering, students often have to wait several years until they can actually get into the designing and building side of robotics. Before they can get to soldering and learning about the works of robotics, they have to go through years of mathematics and theory-heavy classes [2]. When the first two years of a college education start out as dry as this, it can push a lot of very competent students away because this is not what they thought the major would be, or they will simply get too scared and overwhelmed by all the information. In the worst case, they could drop the major. This is particularly a problem with women and people of color in STEM, so the courses will have to contain a lot of guidance and support as well as excite the students to learn more about robotics [3]. The goal of this project is to create courses for First-Year undergraduate students in which they will be taught to build an Omni-Drive robot platform and its autonomous pathfinding. Our idea is to create two courses that first-year students will take simultaneously during their first semester. One of the courses will focus more on the fundamentals of computation and pathfinding algorithms, whereas the other course will focus more on the hardware and design side of robotics. It is important that students who are interested in robotics get to experience and learn about that subject early on so that they can truly pursue their interests. We are living in uncertain times because of COVID-19 and a lot of universities are switching to remote learning. To ensure that the students will always be able to test out their robot we have also worked on creating a simulator. Another problem we are trying to solve with these courses is the underrepresentation of women and students of color in Computer Science and Engineering. We are creating these courses to be fit for anyone, no matter their knowledge of Engineering and Computer Science when they come in as first-year students.

II. BACKGROUND AND RELATED WORK

When we were thinking about the structuring of the courses there were multiple things we needed to keep in mind. Since we want to make these courses inclusive to all students, the courses will need to have a lot of guidance from the Professor and Teaching Assistants. Research has proven that full guidance during instruction is more effective than partial or no guidance [4]. This will result in students feeling more confidant and will hopefully increase retention. Another thing we did to make the courses as inclusive as possible **is** creating the course focused on hardware. Apart from being a great way to properly introduce students to robotics, the course

also serves as a maker space. Studies have shown that maker spaces increase the retention of students in STEM majors and that they can improve the confidence of students when they have to solve a technical problem [3]. Recruitment and retention of underrepresented minorities and women have been a goal for a long time, and according to Morocz et. al., maker spaces could help achieve this goal [3]. Since one of the courses will mainly focus on hardware, we will create our own maker space and form a more welcoming and exciting environment for women and minorities. That STEM classes need to be made more accessible for women and minorities is also reiterated by Guzdial et. al. who state that females and underrepresented minorities need more encouragement than (White and Asian) males in order to be satisfied with the course and to increase the likelihood of them completing a computing or engineering major and pursuing a career in that field [5]. We also want the courses to motivate students and excite them about engineering and robotics in particular. One way to do this is to include a lot of hands-on activities in the curriculum of both courses [6]. In the hardware course, the students will be working with components and building their own omnibot. In the course focused on pathfinding, the students will get a lot of assignments where they will make an actual robot drive using algorithms. Another way to motivate students and help them learn new concepts, according to M. Guzdial and A. Tew, is to teach students concepts that are aligned with their goals, such as their future careers [7].

III. METHODS

In order to make these two courses a success we have been working on the curriculum for both of them. The Hardware centered course will require the students to build their own robot. The first few weeks will be spent working on a differential-drive robot, where the students will be introduced to the basics of robotics. In order to keep the students motivated and interested, we linked the main challenge to an actual robot that is used in a company that everyone knows, Amazon's pallet movers. The students will try to make a robot that does the same as Amazon's pallet moving robots.

The pathfinding course will be mainly focused on pathfinding algorithms and teaching the students the principles of computing. The first few weeks will be spent going over the basic technical concepts of computing with regards to the language the class will be using. In order to keep the students engaged from the first class, we had the idea of a lab in which the students get to move robots around to show them what they can eventually make the robot do. We thought of multiple assignments and lab exercises throughout the semester where they can implement different algorithms, such as Dijkstra's and A-Star, on their robot to make it move around.

To make the courses we are creating as engaging and accessible as possible, we created a robot simulator using LCM. This simulator can map the floor of a classroom and can be used by the students to test their algorithms. The simulator is also a great alternative for in-class sessions with robots. Because of the pandemic the world is enduring right now, the importance of remote learning has become prevalent.

Having a simulator that can sketch the robot's movements and the room it is in is of great importance.

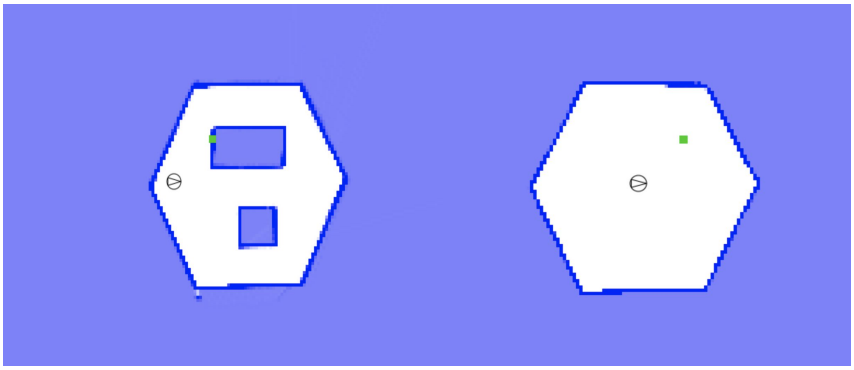

Fig. 1: two maps created with the robot simulator using LCM

IV. CONCLUSION

In this work, we wanted to show robotics courses for first-year undergraduate students who go into pathfinding and Omni-drive platform building which enables students to pursue their interest in robotics from their first year on. It will allow students to learn about the designing and building of robots and the pathfinding algorithms they use without having to go through years of math and theory-heavy classes first. These courses will be constructed in such a way that they are inclusive to everyone and will aim to increase recruitment and retention of students, specifically that of females and underrepresented minorities. We also created a robot simulator which not only makes it easier for students to test out their code but also enables students to work with their robots even when the course is taught remotely.

VI. REFERENCES

[1]*How Does University of Michigan--Ann Arbor Rank Among America's Best Engineering Schools?* www.usnews.com/best-graduate-schools/top-engineering-schools/university-of-michigan-ann-arbor-02088.

[2]Barrett, Thomas, et al. "A Review of University Maker Spaces." *2015 ASEE Annual Conference and Exposition Proceedings*, 14 June 2015, doi:10.18260/p.23442.

[3]Morocz, Ricardo, et al. "University Maker Spaces: Discovery, Optimization and Measurement of Impacts." *2015 ASEE Annual Conference and Exposition Proceedings*, 14 June 2015, doi:10.18260/p.24967.

[4] Clark, Richard E., et al. "Putting Students on the Path to Learning - The Case for Fully Guided Instruction." *American Educator*, 2012, pp. 6–11.

[5] Guzdial, Mark, et al. "A Statewide Survey on Computing Education Pathways and Influences." *Proceedings of the Ninth Annual International Conference on International Computing Education Research - ICER '12*, 9 Sept. 2012, doi:10.1145/2361276.2361304.

[6]Mcgill, Monica M. "Learning to Program with Personal Robots." *ACM Transactions on Computing Education*, vol. 12, no. 1, Mar. 2012, pp. 1–32., doi:10.1145/2133797.2133801.

[7] Guzdial, Mark, and Allison Elliott Tew. "Imagineering Inauthentic Legitimate Peripheral Participation." *Proceedings of the 2006 International Workshop on Computing Education Research - ICER '06*, 9 Sept. 2006, pp. 51–58., doi:10.1145/1151588.115159