Learning Autonomous Systems – an Interdisciplinary Project-Based Experience

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***Abstract*—With the increased influence of automation into every part of our lives, tomorrow's engineers must be capable working with autonomous systems. The explosion of automation and robotics has created a need for a massive increase in engineers who possess the skills necessary to work with twenty-first century systems. Autonomous Systems (MEEM4707) is a new senior/graduate level elective course with goals of: 1) preparing the next generation of skilled engineers, 2) creating new opportunities for learning and well informed career choices, 3) increasing confidence in career options upon graduation, and 4) connecting academic research to the students world. Presented in this paper is the developed curricula, key concepts of the project-based approach, and resources for other educators to implement a similar course at their institution. In the course, we cover the fundamentals of autonomous robots in a hands-on manner through the use of a low-cost mobile robot. Each student builds and programs their own robot, culminating in operation of their autonomous mobile robot in a miniature city environment. The concepts covered in the course are scalable from middle school through graduate school. Evaluation of student learning is completed using pre/post surveys, student progress in the laboratory environment, and conceptual examinations.**

Keywords*—*Project-based learning; Engineering curriculum; Undergraduate/Graduate students; Mobile Robotics; Duckietown

I. Introduction

Global demand for new engineers with knowledge of automation and autonomous systems is growing rapidly. Specifically, it is estimated that the robotics industry is currently growing at a rate of 17% [1]. This rapid growth rate is straining companies recruitment of fresh engineers as the university system has not been able to keep up with demand [2]. Many universities have developed their own autonomous systems courses to support this demand ranging from the project based courses such as those taught at MIT, CMU, and others [3]–[9], simulation based courses [10], to theory based courses such as those at ETH Zurich and MST [11]–[14].

At Michigan Technological University, the Nonlinear and Autonomous Systems Lab has developed MEEM 4707-Autonomous Systems as a course to prepare engineers for emerging career options. Engineers fresh out of undergraduate education are generally skilled in the mathematics and theory associated with their desired careers, but lack hands-on experience. Michigan Tech's senior design and enterprise programs give students opportunities for hands-on experience, however these experiences are typically focused into more traditional mechanical engineering topics such as design, heat transfer, and mechanics with real-world customers. Autonomous Systems gives students the ability to gain hands-on experience with control systems, dynamics, and kinematics in a low-risk and supportive environment. Additionally, the course introduces programming with purpose that improves learning of programming concepts for mechanical engineers by integrating hardware and software.

The Autonomous Systems course is primarily a project-based lab with a conventional lecture component covering core concepts. In this course, students develop skills necessary to understand autonomous systems ranging from fundamentals of programming through to motion control, planning, and navigation. The course text, *Introduction to Autonomous Mobile Robots* by Siegwart, Nourbakhsh, and Scaramuzza [14], is easy to follow, contains the desired high-level content, and encourages self-learning and further exploration by the students. The lab content is developed following a scaffolding approach to lead to a final project modelled on the Duckietown project at MIT [4], [5]. The course content was formed to answer three key questions to introduce mobile robots: 1) Where am I?, 2) Where am I going?, and 3) How do I get there? To answer these questions students learned how to gain a model of the environment; perceive and analyze the environment; find position and situation of the robot within the environment; and plan and execute the robot motion.

This programming intensive course starts with projects that are broken down into small pieces to be accessible to students with no background in computer science. During the semester, these problems grow in magnitude with each week presenting a new core concept. Individual labs and the final project enforce individual hands-on learning as students implement each concept on their own mobile robot and complete every task independently. Growth follows a natural progression that emphasizes problem-solving skills up to vision-based navigation. The project-based approach results in students building, programming, troubleshooting, and testing a fully functional autonomous car capable of navigating through a modeled town. The teaching team supports the individual development of the students own programming style and evaluates performance based on functionality demonstration and online code submission.

The remainder of this paper is organized as follows, Sec. II describes the course content, the final project is described in Sec. III, student surveys and experiences are evaluated in Sec. IV, and conclusions are presented in Sec. V.

II. Course Content

The Autonomous Systems course focused around the 'see-think-act' cycle described in [14]. Course, platform, and labs are used to grow student understanding of the different topics of autonomous systems. In addition to these resources, a teaching team supports conveying the concepts to students.

A. Lecture Content

Early in the semester the course focuses on the 'think' portion by introducing programming to the students. As mechanical engineers, most students in the course had completed no formal programming training so the instruction began with simple codes such as "hello world", blinking an LED, and moving a servo. The Arduino platform is ideal for this application as it is easy to introduce to new students with extremely well documented examples while also supporting expanded functionality with custom codes throughout the semester.

Through the rest of the semester, time was divided between traditional lecture components and hands-on laboratory exercises. The lecture components were meant as a high-level introduction to different components of mobile robotics. Lectures were tied together as pieces of the 'see-think-act' cycle. Content included kinematics, locomotion, perception, vision, planning, localization, and SLAM.

In the course, 30% of the overall grade is from lecture content, 30% from weekly labs, and 40% is from the final project. The grading focus on lab and final project is reflected in student time as they had to develop applicable skills and also forced the lecture content to remain as a high level overview. The twice-weekly lectures are built on the content from the book [14]. The course schedule is shown in Table I.

B. Teaching team

The course content consists of lectures and laboratory hours. The theory of autonomous systems are taught during lecture hours by the course instructor and guest lecturers. The lab hours are divided between three graduate teaching assistants (two PhD students and one research engineer) experienced in autonomous systems and robotics. Due to the heavy hands-on and programming content of the course, students were divided into three groups. During the normal lab session all three teacher assistants (TAs) were present to guide students through the lab activities. Each week an extra lab session was added to the teaching plan to provide one-to-one interactions. Each TA was assigned to a specific group of students for the extra lab session. This combination was selected for three reasons; students can use more individual time with TAs for troubleshooting, TAs can remember each students coding style and troubleshoot their code more effectively; and students can use three different teachers with different programming skills.

Week	Lecture Description	Lab Description
1	Intro	Programming Basics
2	Programming Basics	Motor Control & Feedback Control
3	Locomotion	Hardware Debugging
4	Mobile Kinematics	Timing-based robot control
5	Mobile Kinematics	
6	Perception	Ultrasonic Obstacle Avoidance
7	Perception	Line Following
8	Vision	Spring Break Challenge
9	Planning	Vision
10	SLAM/Localization	Ball Following
11	Duckietown	Duckietown
12	Planning	Duckietown
13	Duckietown	Duckietown
14	Duckietown	Duckietown

TABLE I: Course progression in Autonomous Systems

C. Students

A total of 36 students enrolled in the autonomous system course in the Spring of 2017. The class was a combination of 26 undergraduate and 10 graduate students. Most of the undergraduate students were at senior level. Eight of the undergraduate students had job offers from companies prior entering the course.

D. Platform Overview

The platform used for the Autonomous Systems course is a low-cost, Arduino-based, wheeled vehicle that is sold as a kit. We used the Elegoo Smart Robot Car kit available on Amazon for approximately $70 USD as well as a Pixy camera also available on Amazon for approximately $70 USD. Total cost per student was less than $140 USD due to bulk order and education discounts. The low-cost enabled each student to receive their own kit which they were able to customize and keep at the end of the semester. Because each student had their own car, every student had to develop their own controllers and demonstrate their vehicles performance. Several groups worldwide have developed their own low cost platforms [15]–[18]. While these platforms are valuable, a commercially available kit vehicle that is available at low-cost is more accessible for implementation.

The robot car kit (Fig. 1) consists of all the required hardware for a basic autonomous vehicle. It has an Arduino microprocessor, L298N dual h-bridge motor driver, four DC motors, a chassis, three line following sensors, and an ultrasonic sensor. With this kit students were able to progress from no knowledge of Arduino and minimal circuit experience to an autonomous robot that travels through a model town.

In week eight of the semester, students received a Pixy camera. The Pixy is a low-cost computer vision system designed to operate with Arduino. It performs all the vision processing onboard; enabling the Arduino, and the students, to focus more on navigation and algorithm development. Students were free to mount the Pixy wherever they felt appropriate so as the semester progressed vehicles became customized with students taking a wide variety of approaches. At the end of the semester no two vehicles were the same and some students took modifications to an extreme by implementing additional sensor capabilities, dual controllers, and novel camera mounting locations.

E. Lab Development

Weekly labs in the Autonomous Systems course are used to develop student skills both in hands-on implementation as well as theoretical understanding. This course assumes that students have preliminary knowledge of controls but have not had any formal programming instruction. Based on this assumption, early lab sessions are focused on fundamentals and rapidly

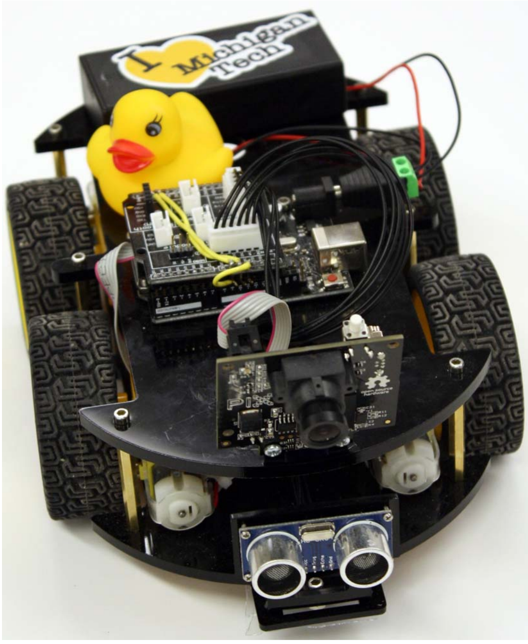

Fig. 1: The Elegoo Smart Robot Car kit is a low-cost platform at $70 USD. It has an Arduino microprocessor, L298N dual h-bridge motor driver, four DC motors, a chassis, three line following sensors, an ultrasonic sensor. A Pixy camera was added to the car at the price of $60 USD.

expand to integrate higher-level programming. The weekly labs are presented in Table I.

In the programming basics lab, students are introduced to fundamentals of programming in Arduino. Concepts such as digital vs. analog control, using functions to optimize code, and using a microcontroller are introduced. In week two, students develop two functions that are used for the rest of the semester, one is a motor driver function that controls the toggles for the h-bridge motor controller, the other is a function to drive and measure the ultrasonic sensor for range finding. Week three involves assembling and performing hardware debugging. In week four, students drive along certain predefined paths such as a square pattern using entirely timing based control. The students quickly realize that controlling robots without the use of feedback is challenging and unpredictable. The ultrasonic obstacle avoidance lab was then completed with students developing controllers to drive their vehicles around in an obstacle field and avoid collisions. Basic line following was then introduced to require students to develop controller memory and multiple control states. The Pixy camera was later introduced with a full lab on basic use prior to integration with the robotic system in the ball following lab. The final four weeks of the semester were dedicated to the final project as it is a very intensive, cumulative assessment of student learning and independent thinking.

The lab progression was designed such that at the beginning of the course labs were well-defined with strict learning goals, recommended processes, and rigid success metrics. Through the semester, the labs became less structured compared to the rigid "recipe" style labs that the students are accustomed to. This initially caused some issues for students, however students rapidly adapted, and towards the end of the course students were appreciative of the unstructured nature with several students commenting that the unstructured approach is much more similar to what they will actually see following graduation.

Critical to the lab development process was the teaching team support and instructional style used in lab. In an effort to encourage individual learning, the labs were structured such that at the beginning of each lab, a brief overview of expectations was covered and then students were to work individually to complete the lab. The three member teaching team supported the 36 students with troubleshooting and problem-solving. With the teaching team, students rarely had to wait long for support and they were able to receive help from multiple perspectives. The small student:teacher ratio also enabled more personalized support as each student developed their own programming style. In addition to the mandatory lab hours, the teaching team supported an additional one day per week of supported lab time that students could use for work time. Through the semester each TA had roughly a 5 hour per week workload for the course.

III. Final Project Overview

The final project for the Autonomous Systems course is 40% of the final course grade and represents four weeks of continuous work for the students. In this project, students develop an autonomous car that has to navigate around a small scale town populated by rubber duckies (Fig. 2) built on standard interlocking foam tiles. The town consists primarily of straight road segments, turning road segments, and intersections controlled with stop lights. This layout is based on the Duckietown project at MIT [4], [5].

To provide the opportunity to implement the concepts learned in lectures, six challenge obstacles were incorporated into the car's path through the town. At least four of the obstacles must be navigated by the student's car to receive full credit allowing students to customize their course. The six obstacles are as follows:

1) Pedestrian zone
2) Off-road segment
3) Dead end
4) Stop sign
5) Gate
6) Garage

1) The *pedestrian zone* is located on one of the straight tiles. It consists of a series of duckies that are crossing the road. The car must differentiate between the marking lines and the duckies, recognize that there are pedestrians in the road, and wait for the pedestrians to clear the road surface. Once the vehicle has stopped the duckies are manually removed from the road surface to enable unimpeded motion. Fig. 2 shows the pedestrian obstacle. This challenge ensures that the vision systems are calibrated correctly as the Duckies and the road lines are only slightly different color. Any improper calibration of the vision system result in injured duckies.

2) The *off-road segment* consists of two tiles covered in pebbles that must be driven over, larger rocks that must be avoided, and a small ramp that must be negotiated. Fig. 3

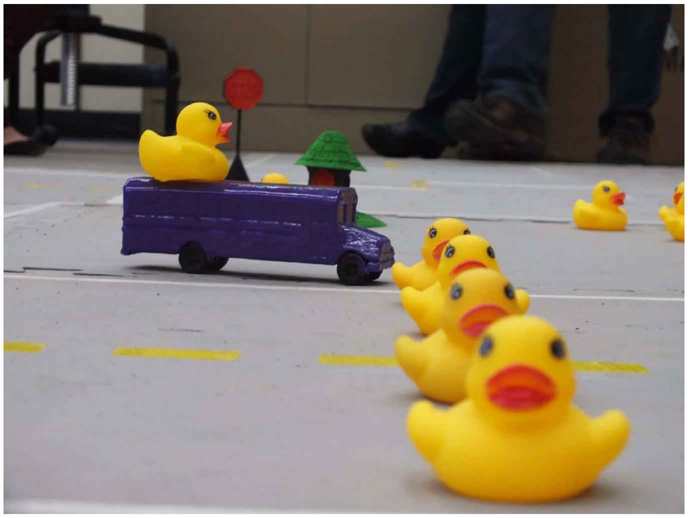

Fig. 2: Duckies in Duckietown represent pedestrians that must be avoided by the vehicles. The duckies theme is chosen to align with the original Duckietown at MIT [5].

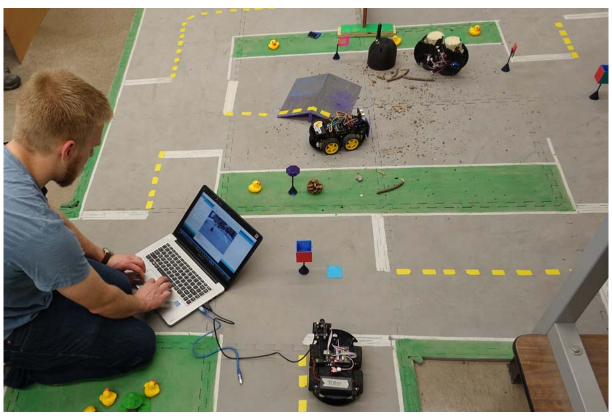

Fig. 3: The off-road obstacle consists of a gravel track and small ramp. The gravel track requires students to be able to operate with feedback from the global environment, the ramp forces students to modify their cars slightly to be able to achieve enough ground clearance to not get stuck.

shows the off-road obstacle. Students can go through this obstacle in either direction. The main idea behind the off-road segment is that students will only be able to successfully navigate the obstacle if they use external feedback such as the camera effectively and any odometery based approaches will have poor performance.

3) The *dead end* is located on a road spur. If students decide to complete the dead end obstacle, their cars must recognize that the road ends, perform a u-turn, and re-establish road following going back towards the rest of Duckietown. This challenge tests students open loop controller performance and line re-acquisition after losing the line.

4) The *stop sign* obstacle is an optional replacement for one of the stop lights. To navigate the stop sign, students must recognize that it is a stop sign and not a stop light, assess the traffic situation, and maneuver appropriately. At the stop light a car is placed in each of the directions that the student does not want to travel. These must be recognized in order to determine turning direction. This challenge tests object recognition and logic as the vehicles will need to recognize the difference between a stop sign and a stop light even though both are the same shade of red.

5) The *gate* obstacle consists of two doors located on a one way segment of road. One of the gates is locked at random and marked. The cars must recognize which gate is locked and proceed to the unlocked gate. This challenge forces cars to recognize the difference between two objects that are similar with only a small color difference to mark the locked vs unlocked gate.

6) The *garage* obstacle is located at the end of the course. It is a garage door that each of the cars can park in. In order to make it into the garage, the vehicle must be aligned with the garage and sized to fit inside. The size constraint is intentionally small to mimic parking in any residential garage. This naturally excludes designs that are too tall such as mounting the vision system on a pole, even though such designs may be helpful for the other obstacles.

A video of students attempt to navigate the car through town is available online[1]. Sample codes of the final project are available in the course repository[2].

IV. Survey Result

Surveys were conducted at the beginning and the end of the course to gauge student experience and learning. Questions included 7-point Likert scale, free response, and multiple choice. Pre-course survey (N=36) questions focused on coursework and personal experiences before the course, interest and confidence in robotics related activities, and course expectations. The post-survey (N=36) focused on hands-on experiences in class, interest and confidence in robotics related activities mainly programming and troubleshooting, and the course's impact on students' career choices. Questions asked in the both surveys are listed in Tables II and III.

Pre-survey Questions
Why did you sign up for this course?
What robotics experience do you have before this course?
What programming experience do you have before this course?
What courses have you taken related to robotics, controls, and mechatronics?
Did you attend any robotics camps prior to college?
Rate your interest in robotics on a scale of 1 (low) to 7 (high).
Rate your interest in computer programming on a scale of 1 (low) to 7 (high).
What do you want to do after graduation?
Do you have any family members who have pursued STEM?
What are your hobbies?

TABLE II: Pre-survey questions focused on students background in robotics and programming, N=36.

A. Pre-Survey

Students were asked if they had prior experience with robotic activities such as robotic competition, course/research, or personal projects. Eight students mentioned previous participation in robotic competitions such as FIRST, VEX, and

[1] https://youtu.be/G8SsZQY6Zuc

[2] https://gitlab.com/naslab/Autonomous-Systems

Post-survey Questions
What was your favorite part of the course?
What course content did you enjoy the most?
Are there any specific challenges in the final project? Do you think you have the tools necessary to complete the task?
Do you have any personal projects related to course content?
Rate your confidence in programming on a scale of 1 (low) to 7 (high).
Rate your interest in robotics on a scale of 1 (low) to 7 (high).
Rate your interest in computer programming on a scale of 1 (low) to 7 (high).
What type of job opportunities are you pursuing?
Has this course helped you receive any offers of employment?
What course content did you enjoy the most?
Would you say that you learned more or less in this course compared to lecture-based courses? (1 is a lot less learned, 7 is a lot more learned)
This course was more interesting compared to lecture-based courses. (1 strongly disagree, 7 strongly agree)
This course was more challenging compared to lecture-based courses. (1 strongly disagree, 7 strongly agree)
This course was more time consuming compared to lecture-based courses. (1 strongly disagree, 7 strongly agree)
What percentage of your learning was completed in lecture, with provided resources, with direct TA/instructor interaction, and independently?
Did the rotating TA schedule help your learning?
Would you be interested in an advanced level Autonomous Systems course?
Would you recommend this course to other students?
Any other comments?

TABLE III: Post-survey questions focused on effectiveness of hands-on teaching method in students' learning process and their level of interest in autonomous system course, N=36.

BEST. Also, 22% of students experienced robotics through personal projects while 10% percent previously enrolled in courses related to robotics. The survey indicates that half of the students did not have any prior experience with robotics.

Based on the pre-survey, students started the class with mixed programming experience levels. Fifty percent of students had previous experience with Arduino or C language. The other 50% of the students had at least minimal experience in MATLAB as it is the software taught in the fundamentals of engineering curriculum at Michigan Tech. To have a unified basic level of programming and an introduction to robotics, a series of basic programming tutorials was incorporated into the lab instructions at the beginning of the course.

To study students background, they were asked during the pre-survey if they have a family member who has pursued a STEM related profession. Twenty one students mentioned a family member or friend with STEM career. The remaining 48% of students selected STEM careers without a prior connection to the field.

Students were also asked about the motivation behind enrollment in the autonomous class. The majority of students mentioned learning the basics of autonomous systems as an emerging technology at present time and leading technology in the future. Other motivations included interest in robotics and programming.

B. Post-Survey

The post-survey contained two types of questions; follow-up on the questions asked during the pre-survey and questions to investigate the effect of the autonomous systems course on students knowledge, interest, confidence, and future career choice.

	Pre-survey	Post-survey
Interest in Robotics	5.98 ± 0.90	6.16 ± 0.99
Interest in Programming	4.90 ± 1.47	5.00 ± 1.62
Confidence in Programming		4.38 ± 1.26

TABLE IV: Comparing student *average* interest and confidence pre- and post- course. Student interest in both robotics and programming increased. N=36

Seventy five percent of students mentioned that their interest towards robotics increased or didn't change after this course. The response average was 6.1 in post-survey compare to that of 5.9 in pre-survey on a 7 point Likert scale. Fifty eight percent of students responded that their interest increased towards computer programming. Careful examination of each response reveals that interest in robotics had a close relationship with the level of interest in computer programming. Students were also asked to rate their level of confidence in computer programming. The median of the responses on a Likert scale of 0 to 7 was 4 for confidence in programming while the median of their interest in programming was 5. This shows that this group of students were interested in learning more about computer programming at college level, but recognized the current limitations to their knowledge (Table IV).

Students were asked about their experience with the teaching team and the impact on their learning. Ninety four percent of the students emphasized that dedicating multiple TAs and the bonus lab hour for a hands-on course helps the learning process especially in individual code debugging and system troubleshooting.

Regarding the future career choices, student interest in pursuing a career in automation related industries increased from 12 students to 18 students. Three students stated that they have received job offers as a direct result of the Autonomous Systems course in the post-survey.

When students were asked about their favorite part of the course; programming, debugging, and testing were among the favorites. In this course, the main objective was to familiarize students with implementation of software into hardware and learn how to troubleshoot and resolve issues. Post survey results show that students were engaged with the projects and they enjoyed solving problems and being challenged.

In the post-survey, students were asked if they had necessary tools and skills to complete the final project (the Duckietown). Students expressed unanimously that they learned the required skills throughout the course to solve the final project. Although many students stated that time management was the main challenge considering the amount of work needed for programming the car to navigate through town and avoid obstacles. They also mentioned having more time with the Pixy camera could help them to overcome the challenges of Duckietown more efficiently. One of the biggest challenges of the final project was the lighting of the environment. The Pixy camera is sensitive to changes in ambient light. The quality of data collected by the camera was disturbingly affected by shadows of moving objects, change of lighting in mornings compared to evenings, and even changing the arrangement of people in the room. In future attempts of this class, the test course will be set up on high ground with more fixed lighting to resolve this issue.

Question	Average
This course was more interesting than lecture-based course.	6.19
Would you say you learned more in this course compare to lecture-based?	5.07
This course was more challenging.	4.58
This course was more time consuming.	4.67
Did you learn more compared to a structured project based course?	4.58

TABLE V: Autonomous System course– unstructured project based– comparison with lecture-based courses taught at Michigan Tech, N=36, Likert scale 1-7.

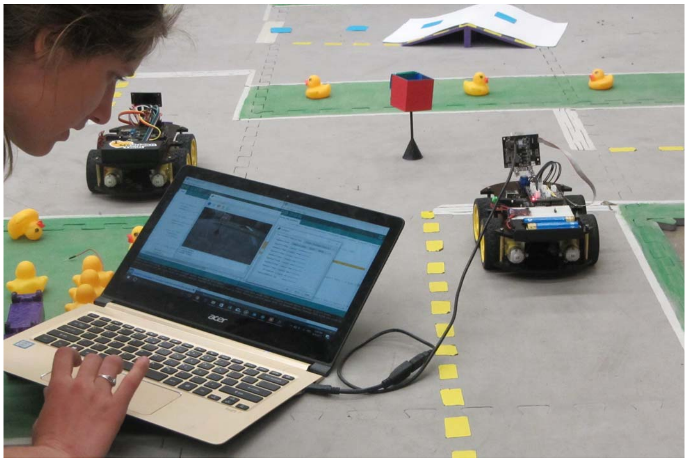

Fig. 4: MEEM4707 student–"This a good course to get an understanding of autonomous cars. The ability to implement our understanding on the robots helped me to further strengthen my concepts".

To compare the Autonomous System course with other lecture-based courses including lab hours, a series of question was asked in the post-survey. Table V depicts the questions and students average rating on a Likert-based scale. The result suggests that students did not find this course more time consuming or more challenging than lecture-based course. Students expressed this course was more interesting than lecture-based courses and that they learned more.

Due to the nature of this course, the learning process was not only based on the lecture but also depended on students' self-learning through various resources. In post-survey, 36% of students indicated independent learning with peers as most effective, followed by direct TA interaction 28%.

To evaluate students interest in autonomous systems topics at the end of this course, the post-survey asked students if they would enroll in an advanced level course. Over 86% of students mentioned they would definitely take an advanced course if the opportunity was offered to them. In addition, the class unanimously expressed they would recommend this course to other students especially if they want to experience "a real-life applicable course here at Tech".

C. Testimonials

Students showed high interest towards the Autonomous System course. As a hands-on project based course it challenged them with programming, debugging, and testing. Although the course structure has room for improvement, the testimonials are heartwarming and indicate the success of the course, teaching team and the students. Fig. 4 shows a student working on calibrating her car.

- "This course not only developed an interest for robotics in me but also have taught me the broad aspects and applications of autonomous systems in industries or even in day to day life. And since the course was very much practical and project-based, I learned a lot and that is why I would recommend this course to other students. And also, unlike other courses, TAs were quite helpful and friendly".
- "I liked the hands-on aspect of this class and I think most other students would too. Sometimes, it is hard to be interested in the material covered in a traditional course with lecture three days a week because you never get to apply what you are learning like we did in this class".
- "I really liked everything about the course. There was a lot of freedom to learn on your own while being given guidance by the TAs. This learning style allowed me to enjoy the material I was working on and made learning fun!".
- "The extra lab hours helped tremendously. It was nice that they did their best to fit that extra hour into the students schedule".
- "I enjoyed the extra lab time the most and got the most out of them because we already had most of the code done, and could work on debugging and increasing the performance of our code with the TAs".

Overall, the Autonomous Systems course was well-received. Survey results indicate that students appreciated the hands-on, unstructured nature of the course more than a traditional lecture-based course. Students rated the course at 6.2 on a seven point Likert scale for being more interesting compared to a lecture-based course.

V. Conclusions & Future Work

This paper has presented the idea behind MEEM 4707-Autonomous Systems, a senior level technical elective in the mechanical engineering department at Michigan Tech. In this course, students learn core concepts in autonomous systems and also gain significant hands-on experience by using a commercially available low-cost mobile robot and vision system to navigate through a model town.

This course was inspired from the Duckietown project of MIT. The course material, syllabus, and final project were tailored to better suit the knowledge base and interests of mechanical engineering students. An Arduino and compatible hardware components were used for lab development and the final project instead of the singleboard computers and ROS ecosystem employed in Duckietown. This decision helped the students to gain first-hand experience in a relatively short time. By the end of the course the students were encountering the limitations imposed by the Arduino ecosystem. We welcomed the exposure to these shortcomings as a natural part of robotics developments that required creativity and adaptation from the students to overcome.

The course was split between a traditional lecture component and a project-based lab. The lecture topics included programming basics, locomotion, mobile kinematics, perception, vision, planning, localization, and SLAM. These topics were presented as part of the 'see-think-act' cycle and related to material covered in the labs.

The labs were organized such that they increased in complexity and student freedom over the semester. As the rigid course structure was removed, students explored the possibilities with their own personal mobile robots and further developed their own understandings of autonomous control.

The final project took place over the final four weeks of the semester. Students had to develop the control algorithms to have their cars navigate through a small model town, Duckietown. Unique to our version of the project are the obstacles that must be navigated. Students accomplished this task and were able to get their vehicles to travel through the town with only occasional minor corrections.

Future iterations of this course will further develop the lab content based on feedback received from students. While the feedback overall was extremely positive some small aspects of the different projects can be improved. Additionally, the relationship between lab content and lecture content was assumed to be self-evident. However, based on survey results, the lecture content sometimes felt disconnected from the lab resulting in a degradation in student learning. This will be remedied for future iterations of the course. Based on the post-survey, students also desire a more advanced Autonomous Systems course that we may offer in the future.

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