ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

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Partnering with Industry to Improve First Year Outcomes

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The TI University Program is committed to engineering student success and supporting institutions of higher learning that will train the next generation of makers and creators.

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Focus on improving TI support at United States engineering schools and assisting faculty with preparing students to enter industry with effective knowledge in Design, System, Power, and Connectivity.

Work in Progress (WIP):
Adapting the TI-RSLK Robot to Teach Basic Embedded System and Programming Concepts

Introduction

The University of Central Florida (UCF) has the nation's largest on-campus undergraduate enrollment that includes nearly 11,000 engineering students (1,200+ who are freshmen). For nearly 20 years, UCF's College of Engineering and Computer Science (CECS) required freshmen engineering students to take *'Introduction to the Engineering Profession'* (EGS 1006C) in the fall. The one (1) credit hour course includes a weekly 50-minute seminar lecture and a weekly 80-minute lab that is taught by a Teaching Assistant (TA) who is also responsible for grading student work. The EGS 1006C seminar *lecture* curriculum has always focused on introducing students to various engineering disciplines to help them either change or verify their intended discipline major. Several years ago, part of our *lab* curriculum shifted from a mechanical-focused team project (designing and building a self-propelled 'rover') to a robotics-focused project to support the college's expanded programming course requirements. The *lab* curriculum now covers Excel spreadsheet skills (using an online teaching tool that proved successful during the fall 2020 remote learning semester) and introduces/enhances programming concepts and an understanding of embedded system applications (using the project-based Texas Instruments - Robotics Systems Learning Kit (TI-RSLK)[1]. The TI-RSLK is a lower-cost robotics kit, which includes a pre-established classroom curriculum, that teaches how electronic system designs work, with a special focus on embedded systems. This WIP paper discusses how the TI-RSLK is being adapted for freshmen engineering students who come from diverse demographics and possess robotics skills that span across a very broad spectrum.

Motivation/Background

Robotics is an interdisciplinary field that develops not only scientific, but also creative thought processes. According to the book, *Robotics in STEM Education: Redesigning the Learning Experience*, robotics learning promotes "cognitive, conceptual, language, and social (collaboration) skills"[2]. As such, the TI-RSLK is being used as a team-based project, with the teams being formed to intentionally include students of varied programming experiences. Having over 80% of our engineering college's incoming freshmen declare mechanical, aerospace, electrical, computer or industrial engineering as their intended major, it seemed logical to provide these students with a hands-on, project-based learning assignment that emphasizes how embedded computer systems control the physical operations in most machines/devices that are used today. Students in the remaining engineering majors, although not 'required' to take a programming course, are strongly encouraged to include a programming course relevant to their major and as such, they should benefit from the knowledge and concepts gained from working with the TI-RSLK robot as well. Even though the TI-RSLK curriculum was not used during the fall 2020 semester lab (due to COVID-19 remote learning), student survey data (collected in spring 2021) from the 2020 entering freshmen engineering class indicated the following:

- **7%** responded being “comfortable with programming and proficient in at least one language”.
- **37%** of students responded being “fairly comfortable with programming, but not enough to be considered proficient in any language”.
- **39%** of students indicated that they “never previously programmed anything”.
- **12%** of students replied that they “never previously programmed anything and are NOT comfortable with the subject matter”.
- **5%** of students stated that they “have no desire to learn any programming language”.

Since over half of the incoming students (56%) have either never previously programmed or are not comfortable with the subject, it was decided that the TI-RSLK curriculum should be adapted to meet the diverse range of robotics and programming skill sets held by our first-year students.

Project Materials and Methods

Previously for the lab, students were required to purchase a personal robotics kit that cost upwards of $150. Today, students do not purchase robotics kits since the TI-RSLK robots were donated to the college and this situation inherently increases access and parity for all. This initial batch of robotic kits is being recycled each summer by student lab techs so they can be reused by students during the fall. It is anticipated that the robots can be reused for at least three fall semesters. When needed, new kits will be paid for through an internal Tech Fee Grant and this effort not only continues reducing expenses for our students, but it also supports our university’s long-term Sustainability Initiative goals. The TI-RSLK Basic Kit robot (***Figure 1*** *– Courtesy of Texas Instruments*) includes: the SimpleLink™ MSP432P401R MCU LaunchPad™ development kit; a motor drive and power distribution board; robot chassis, motors, and line IR sensors; plus 50+ other mechanical and electronic components.

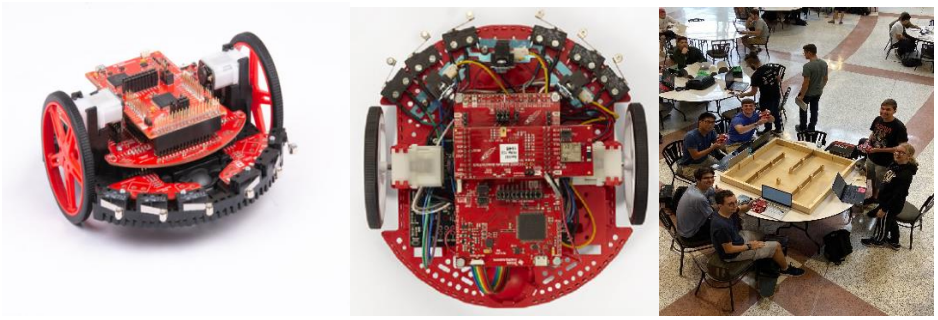

Figure 1: Side/top views of TI-RSLK Basic Kit robot (*Courtesy of TI*); Freshmen with robot and practice maze (*Courtesy UCF CECS)*

Admittedly, the inaugural year using any new product or technology can be challenging and our first year the with the TI-RSLK was no exception to this rule of thumb. The first semester that freshmen-level students used these kits, some student teams experienced difficulties assembling, soldering and programming their robot. The originally developed TI-RSLK curriculum, although it includes basic concepts, was primarily designed with advanced electronics topics in mind and students who had little or no experience in these areas struggled with their assignments. Additionally, TI’s Code Composer Studio™ (CCS) was originally used as the integrated development environment (IDE); however, difficulties occurred when UCF’s IT Department attempted to install this professional-grade software wide-scale in a networked environment. Similar problems occurred when students tried installing the CCS on their personal laptops. It was decided that a simpler IDE needed to be used - one that provided an easier interface yet

retained the core features of the CCS software. Since the COVID-19 pandemic closed our campus to students during the '20/'21 academic school year, we are only now developing a curriculum that will be more responsive to students from varying educational backgrounds and skill levels. We are also working to incorporate Arduino open-source software (along with TI's Energia IDE updates) which will hopefully be more familiar to incoming students and easier for them to install on their personal devices, which should also result in less burden on our college's IT Department. An example of revised lab curriculum being designed is presented below (***Figure 2***). This robot testing system was created by UCF's TI Innovation Lab, directed by co-author Don Harper, to help students recognize robot assembly errors and assess the robot's basic functionalities (e.g. testing the wheel encoders, bump switch sensors, etc.).

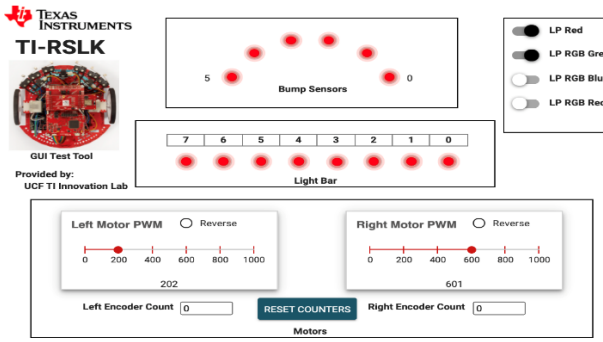

Figure 2: Graphical user interface of robot testing system - created by UCF's TI Innovation Lab
(Courtesy of UCF CECS)

The overall TI-RSLK curriculum for this fall 2021 semester will include: 1) *Understanding embedded systems*, 2) *Introducing robotics and coding* (lessons on soldering, testing, syntax, coding, motors, navigation, sensors), and 3) *Final semester robot navigation and 'field game' project*. Another goal is to incorporate the Excel skills, that the students are simultaneously learning this fall semester, into one or two of the robotics lessons as well.

Goals/Anticipated Outcomes

The goals of this effort are to create a unique, broad-based first-year engineering curriculum using robotics lessons that: teaches embedded systems; improves overall student 'understanding and comfort level' with programming and robotics; encourages creative thought; and promotes teamwork and shared learning experiences through hands-on, project-based efforts. To evaluate effectiveness, students will be surveyed at the beginning and end of the semester. It is hoped the survey will show this project-based experience enhanced student's enthusiasm for engineering.

Acknowledgments

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References

[1] www.ti.com/rslk
[2] Book Review: Robotics in STEM Education: Redesigning the Learning Experience; Taylor, Ragina Y. Journal of STEM Education: Innovations and Research; Auburn Vol. 19, Issue 5, (Jan-Mar 2019): 65-66.