UNIVERSITY OF LOUISIANA AT LAFAYETTE

STEP Committee

Technology Fee Application

Robotics System Learning Enhancement for Undergraduate Instrumentation and Measurements Lab

Title

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Name of Submitter
(Faculty or Staff Only)

Department of Mechanical Engineering

Organization

Title: Robotics System Learning Enhancement for Undergraduate Instrumentation & Measurements Lab Date: 07/14/2021

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Department/College/Org: Department of Mechanical Engineering (MCHE)

ABSTRACT (250 words or less):

In problem based learning (PBL), students are given a systems-level problem and challenged with finding solutions by applying course concepts and taking an approach that is similar to that of post-graduate work, where there is commonly more than one solution to a problem. The addition of robotics system learning kits in the Instrumentation and Measurements Lab in the Department of Mechanical Engineering will enable the addition of PBL in the current undergraduate curriculum. The kits will enable experiments featuring systems-level problems where students will explore the design and application of embedded systems. This provides valuable experience to students who typically acquire hands-on experience in instrumentation and measurements concepts singularly rather than in a system. Furthermore, the kits provide a variety of challenges where students complete tasks in an interactive setting. The challenges, which will be implemented as an end-of-the-semester final project, have the potential to be showcased at recruitment events for both incoming freshman and industry professionals. With a low investment of approximately $5000, an enhanced learning experience will be provided to undergraduate students by technological modernization of instruction to include PBL through the use of robotics system learning kits.

1 Purpose of Grant

Traditionally, experiments in lab-based classes, like the Instrumentation and Measurements course (MCHE 357) in the Department of Mechanical Engineering, focus on a single concept and are performed immediately after instruction on the topic. While this method of instruction has its benefits, one major drawback is that it does not provide students with the experience of finding solutions to problems in a system, such as those that engineers are usually tasked with. Supplementing a course curriculum with instructional exercises provided to students in a systems-level approach can motivate students and encourage them to cooperate with one another to make judgments and reach solutions that are based on multiple principles. The difficulty of this instructional method is the requirement of flexible systems that remain technologically relevant.

The Robotics System Learning Kit, developed by Texas Instruments[1], was designed to be integrated into university courses to add embedded systems to curriculums. The modular kit, shown in Figure 1, features a development board mounted on a mobile platform that can be controlled to operate autonomously (without user intervention). The kits provide the students with a wide variety of sensors and devices that can be integrated into the system simultaneously and control its operation based on their results. This allows the students to observe and compare the effectiveness of multiple solutions to a single problem. Additionally, the kit is capable of wireless communication where data can be collected and analyzed.

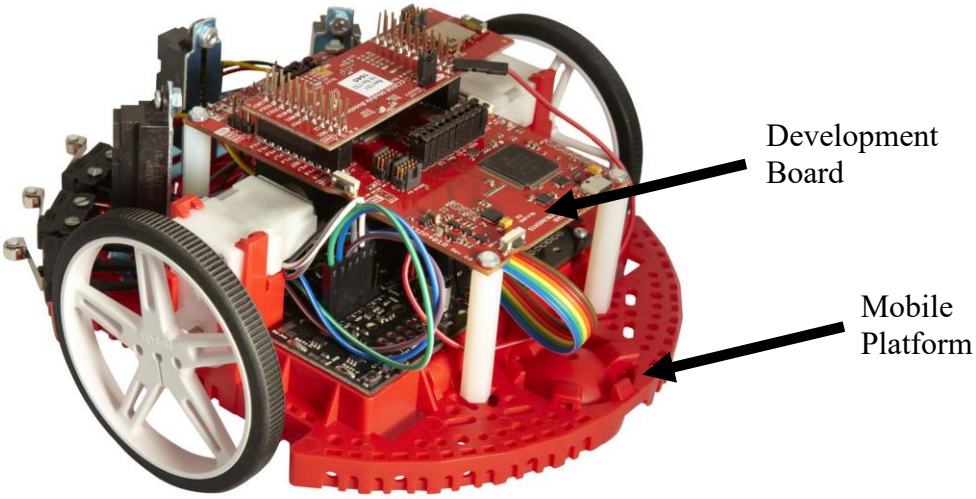

Figure 1: Texas Instruments' Advanced Robotics Learning Kit[2]

The addition of embedded systems in the MCHE 357 course will be seamless as it will supplement the instruction of already covered topics, providing a curriculum enhancement. In the course, which all Department of Mechanical Engineering students are required to complete, students gain knowledge and skills in developing electrical systems for monitoring, operation, and experimentation. Practical experience is gained through laboratory experiments where students design measurement systems, calibrate sensors, acquire measurements, and analyze data from data acquisition systems, all of which can be performed individually and simultaneously on the Robotics System Learning Kits.

[1] https://university.ti.com/en/faculty/ti-robotics-system-learning-kit/ti-robotics-system-learning-kit
[2] https://www.newark.com/element14/robot-advanced-kit/advanced-robotic-kit-education/dp/43AC8494

2 Impact on Student Body

This initiative will impact students in the following:

1. Technology enhancement of undergraduate teaching lab to include robotics system learning
2. Potential for each student to use equipment to develop and conduct lab experiments using embedded systems following a problem based learning (PBL) approach
3. Ability to impact over 100 students per academic year, detailed in Table 1
4. Potential for use as recruitment tool for current MCHE 357 students to showcase skills on and off campus to industry personnel as well as potential College of Engineering students

Table 1: MCHE 357 Enrollment Per Academic Year

Semester	Number of Students
Fall 2020	48
Summer 2020	17
Spring 2020	45
Total	110

3 Projected Lifetime of Enhancement

The kits are expected to last at least 5 years without serious hardware failures or the need to upgrade.

4 Person(s) Responsible for Project

a. Implementation: Yasmeen Qudsi
b. Operation: MCHE 357 Students and MCHE Faculty
c. Installation & Maintenance: Yasmeen Qudsi, John Carroll, Dept. of Mechanical Engineering
d. Training: Yasmeen Qudsi, John Carroll, Dept. of Mechanical Engineering

5 Qualifications

Yasmeen Qudsi earned her M.S. degree in Mechanical Engineering at the University of Louisiana at Lafayette. She gained valuable experience in robotics and mechatronics performing research for her master's thesis of the design and control of quadruped robots with lower leg flexibility. Currently, she teaches the Instrumentation and Measurements course (MCHE 357) for the Department of Mechanical Engineering. Yasmeen will lead in the implementation, maintenance, and training of the equipment as it is integrated in the MCHE 357 course. She will implement the kits as part of a problem based learning (PBL) approach that she was trained in while attending the National Effective Teaching Institute conference on Inquiry Based Teaching (NETI-2A) in the summer of 2021.

John Carroll earned his B.S. degree in Mechanical Engineering at the University of Louisiana at Lafayette. His capstone project featured 3D printing embedded sensors in flexible robotic legs. He is currently pursuing a PhD in Systems Engineering with a concentration in Mechanical Engineering and is conducting research in material characterization of lightweight metal alloys for in-space manufacturing in the Cajun Integrated Computational Materials Engineering (C-ICME) Lab. John is familiar with data acquisition systems and has the skills necessary to assist in installation, training, and maintenance during the first one to two years.

6 Previously Funded STEP Grants

a. Yasmeen Qudsi co-authored "Advanced Materials Testing System for Undergraduate Students" submitted by Dr. Ahmed Khattab [Cycle FA18]

7 Budget Proposal & Timeline

The equipment will total $4999.60 and will include the fully functional kits, electrostatic discharge straps to protect the equipment from damage due to static electricity when in use, and storage bins to protect the equipment when not in use. A total of 24 kits will be purchased to account for groups of two students per kit. Groups of three students per kit will allow for continued use after enrollment increases. A cost breakdown is provided in Table 2 with a budget proposal attached at the end of this document.

Table 2: Cost Breakdown

Item	Cost Per Unit	Cost Per 24 Units
TI-RSLK Advanced Kit[3]	$ 199.99	$ 4799.76
Electrostatic Discharge (ESD) Strap[4]	$ 2.50	$ 59.88
Storage Bin[5]	$ 5.83	$ 139.96
	Total	$ 4999.60

The technology enhancement will be implemented the semester following purchase as all items are ready to use out of the box with pre-defined learning modules. The kits will be expanded with sensors and equipment already used in the laboratory after the conclusion of Year 2. A condensed timeline showing the expected progression is presented in Table 3.

Table 3: Timeline of Enhancement

	Year 1		Year 2	Year 3+
	Spring	Fall		
Grant Awarded/Purchasing	■			
Implement Kits with PBL Modules into Existing Curriculum		■		
Create Original PBL Modules			■	■
Expand Kits with Existing Sensors/Equipment in Lab				■
Maintain Equipment/Replace Damaged Items as Needed			■	■

[3] https://www.newark.com/element14/robot-advanced-kit/advanced-robotic-kit-education/dp/43AC8494
[4] https://www.amazon.com/dp/B08VDMGPSX/ref=cm_sw_em_r_mt_dp_KDZPXDN1K3WWV78AB191
[5] https://www.amazon.com/dp/B07PK1CTF6/ref=cm_sw_em_r_mt_dp_FTDTRDHZMV5CN452YXSW

Budget Proposal

1.	**Equipment**	**$ 4799.76**
2.	**Software**	**$ 0**
3.	**Supplies**	**$ 199.84**
4.	**Maintenance**	**$ 0**
5.	**Personnel**	**$ 0**
6.	**Other**	**$ 0**
TOTAL:		**$ 4999.60**