## EUE Proposal

### Project ID#

2020-09

### Project Title

Integration of an Experiential Learning Paradigm into Mechatronics, Robotics, and Control Engineering Curricula in the School of Engineering

| Project Director | ID Number | Telephone | Email |
|---|---|---|---|
| Dr. Nima Lotfi | 800618945 | 6186505189 | nlotfiy@siue.edu |

| Department | Campus Box | School College |
|---|---|---|
| Mechanical Engineering | 1805 | Engineering |

### Course or Program

ECE381, ECE365, ME356, ME356L, ME450, ME454/MRE454/ECE467, MRE358, and MRE320

| Project Co-Director | ID | Department | Email |
|---|---|---|---|
| Timothy York | 800026113 | Electrical and Computer Engineering | tyork@siue.edu |
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| Student Impact: | >400 |
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| Priority Rating (If Submitting Multiple Proposals): | |
|---|---|

### Project Budget

| Salary | Wages | Travel | Equip. | Comm | CServ | Auto | Tele | Awards | Total |
|---|---|---|---|---|---|---|---|---|---|
| | 3200 | | | 11300 | | | | | 14500 |

### Cost-Sharing

| Salary | Wages | Travel | Equip. | Comm | CServ | Auto | Tele | Awards | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

### Prior EUE Support

| Project Director | Project Number | Award Amount | Project Dates |
|---|---|---|---|
| Dr. Nima Lotfi | 18_05 | 4189 | Spring 2018 |

**Integration of an Experiential Learning Paradigm into Mechatronics, Robotics, and Control Engineering Curricula in the School of Engineering**

Engineers have played a major role in shaping the world since the industrial revolution and especially, in the past few decades, the field of engineering has experienced a tremendous and dynamic growth, mainly due to the advances in integrated circuits and electronics, embedded systems and computers, networks, and intelligent systems. In its commitment to shape a changing world, the School of Engineering at SIUE has undertaken numerous initiatives to be able to provide the best cutting-edge learning experience for the students to prepare them for this fast-paced job market. One such effort is the establishment of a new Mechatronics and Robotics Engineering degree program which has seen a remarkable growth in student enrollments since its commencement in Fall 2016. Prospective graduates of the School of Engineering, especially the MRE degree program, require an interdisciplinary knowledge of mechanical, electrical, computer, software, and systems engineering to be able to design smart and autonomous systems and processes to improve human life and welfare. The current curricula in the SoE departments, however, do not encompass sufficient experiential learning opportunities to expose students to the multidisciplinary nature of systems, especially in the field of Mechatronics, Robotics, and Controls. In this project, we propose to build a number of experimental laboratory platforms which can be used in Mechanical, Electrical, Mechatronics and Robotics Engineering and Computer Science departments. These platforms which include: a robotic arm, a hardware-in-the-loop electric vehicle emulator, pressure/fluid level process control experiment, and temperature regulation process control experiment would provide a comprehensive learning experience for the students and familiarize them with various important and integrated disciplines, present in real-world systems. Upon the completion of the development of these platforms, projected to be towards the end of summer, they can readily be used in various courses, including ECE381, ECE365, ME356, ME356L, ME450, ME454/MRE454/ECE467, MRE358, and MRE320, across the School of Engineering. Extrapolating from the enrollment numbers in these courses in the past two semesters, the introduction of these experimental platforms would improve the learning experience of more than 400 students.

## 1. Introduction

The concept of Mechatronics was originally developed to refer to mechanical systems which were integrated with some electric and electronic circuitry. Although this term was first coined in 1970s, systems satisfying this definition such as elevators, automobiles, and electric typewriters existed even earlier in 1900s. In the past few decades, the definition of a mechatronic system has evolved considerably to encompass smart and autonomous systems which involve a synergistic integration of fine mechanical engineering with electronics, intelligent computer control, and wireless communication protocols. This evolution has been accelerating continuously, mainly due to advancements in integrated circuits and electronics, embedded systems and computers, networks, and intelligent control systems.

In order to be relevant and competitive in today's market, industries, especially the ones in the field of technology, need an engineering workforce proficient in various disciplines involved in a real-world system. The future generation of engineers should possess an interdisciplinary knowledge of mechanical, electrical, computer, software, and systems engineering. They should be able to lead design teams, make informed judgments on various aspects of the design, understand the tradeoffs, and balance the choices in a multidisciplinary project.

Increasing enrollment in the newly-developed Mechatronics and Robotics Engineering degree program (Fall 2016: 18 students - Spring 2019: 64) is a clear indication of the desire among future engineers to equip themselves with the skills required to be successful in this growing job market. Our job as a teacher/scholar in a predominantly undergraduate institution is to ensure that the students possess a solid understanding of the fundamentals of engineering while being familiar with the cutting-edge technologies in the field to be able to solve the problems of tomorrow. Hands-on (experiential) learning is an essential component of such an educational system as it would enable students to see a physical manifestation of their work and learn valuable lessons from mistakes they make and problems they encounter that they don't necessarily get from theoretical textbook exercises. This is especially important in courses related to control systems which are the cornerstone of any mechatronic system. Control systems have played a fundamental role in industrial automation, transportation, energy industry and other emerging areas such as robotics, manufacturing, IoT applications, and cyber-physical systems. The majority of the control-related courses include a heavy theoretical focus which could be overwhelming, especially for undergraduate students. In the past decades, numerous efforts have been made towards developing software and hardware packages in the field of controls. However, these efforts lack unity and furthermore, the required resources to achieve the implementations of such platforms are not readily available to every educational institution. We aim to solve this issue by developing and utilizing sets of low-cost and open-design laboratory platforms which can be used in multiple courses across multiple departments to provide a hands-on and engaging experience for the students.

## 2. Current Situation

The core courses related to Mechatronics, Robotics, and Controls in the School of engineering of SIUE include ME356 and ME356L - Dynamic System Modeling, MRE358 - Introduction to Mechatronics, MRE320 - Sensors and Actuators, ME450 - Automatic Control, ME454/MRE454/ECE467 - Robotics, Dynamics and Controls, ECE282 - Digital Systems Design, ECE351 - Signals and Systems, ECE365 - Control Systems, ECE341 - Electromechanical Energy Conversion, and ECE381 - Microcontrollers.

Among these courses, ME356L, MRE358, ECE282, ECE341, and ECE381 are officially accompanied by a laboratory section. In these labs, the students get exposed to individual components of mechatronic systems such as sensors, actuator, and the controllers and their performance. However, none of these courses involve an integrated real-world system in which the students can learn about the interconnection of the various components and control of the overall system.

Robotics - Dynamics and Control is the only permanent robotics-related course in the School of Engineering, which is cross-listed among ME, MRE, and ECE departments. It is elective for ME and ECE students and is only mandatory for the MRE students. This course officially does not have a laboratory component; however, to provide some hands-on experience for the students, two large and bulky robot arms, which date back to 1980s, are currently used as class projects. The students teach the robot to follow a certain path and then automate its motion. Two robots are certainly not sufficient considering the growing enrollment in this course (Fall 2016: 21, Fall 2017: 32, and Fall 2018: 38). Furthermore, as these robots are old, obsolete, and commercial, the students miss the opportunity to get exposed to most recent robotic technologies, the integration of their individual components, and their control.

Despite the essential role of controls in any mechatronics and robotic system, none of the control-related courses in the School of Engineering involve a hands-on experiment on the design and development of real-time control algorithms. Considering the heavy theoretical and mathematical focus in control courses, incorporating an experimental laboratory platform can significantly help the students learn the material. Finally, the modeling and control design for thermo-fluid systems is absent in the courses currently offered in the School of Engineering. Developing control methodologies for temperature, fluid level and pressure regulation is an essential part of many mechatronics applications, especially those encountered in industrial settings.

## 3. Proposed Project

We propose the design and construction of the following open hardware specification platforms which could be used as laboratory exercises in most of the aforementioned courses related to Mechatronics, Robotics, and Controls: a two degree of freedom robotic arm, a hardware-in-the-loop electric vehicle emulator, a pressure/fluid level process control experiment, and a temperature regulation process control experiment. All platforms will have their inputs and outputs connected to standardized and universal 40-pin (2x20) headers so that they can be interfaced with various controller boards, depending on the course level (for example, PSoC5 microcontroller in ECE381, Arduino in MRE358, ME356, and MRE356L, and National Instruments controllers in MRE358, ME454/MRE454/ECE467, ME450, and ECE365). The open-specification, controller-agnostic, and simple nature of these hardware platforms would make them comprehensive solutions for teaching fundamental concepts currently missing or scattered in School of Engineering curricula and can potentially reshape higher education in these fields.

**The simple two-degree-of-freedom robot arm** will consist of a pair of motors, mechanical links for connecting the motors, quadrature encoders to measure rotational displacements, and an I2C accelerometer/position sensor for velocity and position feedback. The stage will mainly be used in ME454/MRE454/ECE470 to teach robot kinematics, dynamics, and controls. It will also be used in in ECE381 to replace the labs that currently introduce I2C and stepper motors.

**The hardware-in-the-loop electric vehicle emulator** will consist of a motor/generator set in which one motor is controlled in speed mode and the other motor (generator) is controlled in torque mode. The motor would act as the traction source of an electric vehicle while the generator will be controlled to emulate the loads acting on the vehicle. Quadrature encoders and hall-effect sensors will be used for velocity and torque feedback, respectively. Finally, motor drivers will be used to achieve the aforementioned control objectives. This platform is ideal for implementation in ME356, ME356L, ME450, MRE358, MRE320, ECE381 and ECE365 to teach the fundamentals of PWM control of DC motors, data acquisition, modeling, and control.

**The pressure/fluid level process control experiment** will comprise of a liquid tank with inlets and outlets equipped with electronically-controlled valves. Pressure transducers and mass flow rate and liquid level sensors will be used as the feedback mechanism to regulate the liquid-level and/or pressure inside the tank. This platform is ideal for implementation in ME356, ME356L, ME450, MRE358, MRE320, ECE381 and ECE365 to teach the fundamentals of data acquisition, modeling, and control.

**The temperature regulation process control experiment** will consist of a computer-controlled heating element and a fan, a metallic bar, spatially-distributed thermocouples, and conditioning circuitry for reading temperature measurements. Spatial temperature profile across the metallic bar will be regulated by closing the feedback loop with the thermocouples and using the heater and the fan as the actuators and/or disturbance sources. This platform is ideal for implementation in ME356, ME356L, ME450, MRE358, MRE320, ECE381 and ECE365 to teach the fundamentals of data acquisition, modeling, and control.

For MRE students, having these sets of simple platforms allows for continuity in their education. The same platform upon which they will learn lower-level interfacing and programing in ECE381 will be the same platform they will use to learn higher-level modeling and control concepts in MRE358 and ME450. For ECE students, having mechatronic-centric platforms allows them the opportunity to learn mechanical engineering concepts that are otherwise not present in their curriculum, while still being exposed to the core microcontroller concepts currently taught in ECE381.

We will supervise two student workers in the procurement and assembly of the four sets of the platforms (10 each), which we anticipate to take approximately 8 weeks over the summer. Upon completion, these platforms will be used in various courses, including ECE381 (65 students), ECE365 (44 students), ME356 (95 students), ME356L (106 students), ME450 (47 students), ME454/MRE454/ECE467 (38 students), MRE358 (15 students), and MRE320 (12 students), across the School of Engineering. Extrapolating from the enrollment numbers in these courses in the past two semesters (provided inside the parentheses), the introduction of these experimental platforms would improve the learning experience of more than 400 students. These experiments can also be used in the upcoming years and can potentially be incorporated to a wider range of courses in the School of Engineering.

## 4. Evaluation and Dissemination

The hardware designs, including all the schematics, a complete bill-of-materials, and step-by-step assembly instructions will be disseminated publicly on all course websites. These designs, as well as the accompanying labs will be disseminated on our website, and contributed to the Mechatronics Education community webpage. The design and development process, integration of the experiments to the current curricula, the implementation results, and students evaluations of teaching will also be disseminated as conference and journal publications in American Society for Engineering Education (ASEE). Finally, we are planning on critically conducting surveys among the students and faculty who will utilize these platforms. These surveys along with the students' evaluations of teaching will help us study the impacts of these platforms and identify ways to improve their effectiveness.

## 5. Budget and Budget Justification

Table below summarizes the projected costs for individual platforms along with the student worker salary.

| No. | Name | Unit Price | QTY | Total Price |
|---|---|---|---|---|
| 1 | Robotic Arm | $300 | 10 | $3,000.00 |
| 2 | Hardware-in-the-loop Electric Vehicle Emulator | $200 | 10 | $2,000.00 |
| 3 | Pressure/Fluid Level Process Control Experiment | $280 | 10 | $2,800.00 |
| 4 | Temperature Regulation Process Control Experiment | $250 | 10 | $2,500.00 |
| 5 | DC Power Supply | $100 | 10 | $1,000.00 |
| 6 | Student Worker | $1600 | 2 | $3,200.00 |
| Total | | | $14,500.00 | |

All projects will require a high-quality DC, high-current power supply for powering the motors/actuators. These power supplies will be approximately $100 each. The robotic arm will require approximately $100 for mechanical parts (rods, brackets, hinges, etc.), $100 for motors, and $100 for electronics (motor drivers, encoders, connectors, PCB fabrication of driver board/shield). The hardware-in-the-loop electric vehicle emulator will require approximately $50 for a driving motor and $50 for a DC motor in a generator configuration, $50 for electronics (including PCB fab., current sensors, position sensors, buffers, and connectors), and $50 for mechanics (shaft couplings, brackets). The pressure/fluid level process control experiment will require approximately $40 for the tank, $100 for controllable valves, $100 for electronics (sensors, PCB fab., motors, heating coils, valve drivers, etc.), and $40 for the mechanics. Finally, the temperature regulation process control experiment will require $50 for mechanics (mounting, thermal bar), $175 for electronics (thermocouples, signal conditioning for thermocouples, heating element, power controller), and $25 for a fan. The platforms will be assembled over summer by two student workers working 20 hours a week for 8 weeks (20 hrs/wk, 8 wks, $10/hour) for a cost of $3200.

**BIOGRAPHICAL SKETCH—DR. NIMA LOTFI**

Mechanical Engineering Department
Southern Illinois University Edwardsville
Phone: (618) 650-5189
Email: nlotfiy@siue.edu

## A. Professional Preparation:

| | | | |
|---|---|---|---|
| Sahand University of Technology, Tabriz, Iran | Electrical Engineering | B.S. | 2006 |
| Sharif University of Technology, Tehran, Iran | Electrical Engineering | M.S. | 2010 |
| Missouri S&T, Rolla, MO, USA | Mechanical Engineering | Ph.D. | 2016 |

## B. Appointments:

8/2016-present: Assistant Professor, Southern Illinois University Edwardsville, Edwardsville, IL
5/2010-6/2016: Research Assistant, Missouri S&T, Rolla, MO

## C. Research Interests:

Ground and Aerial Robotics, Mechatronics and Robotics Education, Electrified and Autonomous Transportation, Alternative Energy Systems, Real-world Application of Control and Estimation Theory

## D. Awards and Honors:

- 2019 – Outstanding researcher in the School of Engineering at SIUE
- 2019 – Outstanding teacher in the Mechanical Engineering Department at SIUE

## E. Teaching:

- MRE 358 - Introduction to Mechatronics
- ME 454/MRE 454/ECE 467 - Robotics-Dynamics and Control
- ME 356 - Dynamical Systems Modeling
- ME 450 - Automatic Control
- CS 490/ME 492/MRE 492 - Autonomous Ground Vehicles
- ME 354 - Numerical Simulation
- ME 492/ECE 492 - Integrated Mechatronic Systems using Raspberry Pi

## F. Publications (most closely related to the proposed project):

1. **N. Lotfi**, “A Multidisciplinary Course and the Corresponding Laboratory Platform Development for Teaching the Fundamentals of Advanced Autonomous Vehicles,” *ASEE Annual Conference and Exposition*, June 15 – 19, 2019, Tampa, FL, USA.

2. M. Zhang, Z. Zhang, **N. Lotfi**, and S.K. Esche, “Development of automatic reconfigurable robotic arms using vision-based control,” *ASEE Annual Conference and Exposition*, June 25 – 28, 2017, Columbus, OH, USA.
3. **N. Lotfi** and M. Namvar, “Global adaptive estimation of joint velocities in robotic manipulators,” *IET Control Theory & Applications*, vol. 4, pp. 2672 – 2681, 2010.
4. **N. Lotfi**, P. Fajri, S. Novosad, J. Savage, R.G. Landers, and M. Ferdowsi, “Development of an experimental testbed for research in lithium-ion battery management systems,” *Energies*, vol. 6, pp. 5231 – 5258, 2013.
5. P. Fajri, **N. Lotfi**, M. Ferdowsi, and R.G. Landers, “Development of an educational small-scale hybrid electric vehicle (HEV) setup,” *IEEE Intelligent Transportation Systems Magazine*, vol. 8, pp. 8 – 21, 2016.
6. **N. Lotfi**, R.G. Landers, J. Li, and J. Park, “Reduced-order electrochemical model-based SOC observer with output model uncertainty estimation,” *IEEE Transactions on Control Systems Technology*, vol. 25, pp. 1217 – 1230, 2017.
7. **N. Lotfi**, H. Zomorodi, and R.G. Landers, “Active disturbance rejection control for voltage stabilization in open-cathode fuel cells through temperature regulation,” *Control Engineering Practice*, vol. 56, pp. 92 – 100, 2016.
8. J. Li, K. Adewuyi, **N. Lotfi**, R.G. Landers, and J. Park, “A single particle model with chemical/mechanical degradation physics for lithium ion battery State of Health (SOH) estimation,” *Applied Energy*, vol. 212, pp. 1178 – 1190, 2018.
9. H. Ferdowsi and **N. Lotfi**, “A PDE-based approach for fault detection in Li-ion batteries,” *ASME Dynamic Systems and Control Conference* (*DSCC*), October 11 – 13, 2017, Tysons, VA, USA.
10. L. Tang, **N. Lotfi**, J. Ishaku, and R.G. Landers, Dynamic modeling and control of PEM fuel cell systems, In *Hydrogen Energy and Vehicle Systems*, pp. 79 – 122, Boca Raton, FL: CRC Press, 2012.

## G. SYNERGISTIC ACTIVITIES:

- PI AND TEAM LEAD FOR “WORKSHOPS FOR THE FUTURE OF MECHATRONIC AND ROBOTIC EDUCATION”, NATIONAL SCIENCE FOUNDATION (NSF), AUGUST 2018, $49,957, CO-IS: MICHAEL GENNERT, VIKRAM KAPILA, JAMES MYNDERSE
- LEADERSHIP IN DEVELOPING AN ONLINE COMMUNITY OF MECHATRONICS AND ROBOTICS ENGINEERING EDUCATION PROFESSIONALS
- FOUNDER OF MECHATRONICS EDUCATION INNOVATION WEBINAR SERIES
- FACULTY ADVISOR FOR THE DRONE CLUB AND AUTONOMOUS ROBOTICS CLUB AT SIUE
- DEVELOPMENT OF NEW MULTIDISCIPLINARY COURSES AND THE CORRESPONDING LABORATORY PLATFORMS ON THE FUNDAMENTALS OF ADVANCED AUTONOMOUS VEHICLES AND INTEGRATED MECHATRONICS USING RASPBERRY PI
- REVIEWER FOR MORE THAN 10 PRESTIGIOUS JOURNALS AND CONFERENCES
- INVITED SESSION CHAIR, ORGANIZER, AND CO-ORGANIZER IN DSCC2015, ACC2017, ACC2018
- PROFESSIONAL SOCIETY MEMBERSHIPS: ASEE, IEEE (CONTROL SYSTEMS SOCIETY, INTELLIGENT TRANSPORTATION SYSTEMS SOCIETY, ROBOTICS AND AUTOMATION SOCIETY), ASME (DYNAMIC SYSTEMS AND CONTROL DIVISION)

**Timothy York** (618) 650-2615, tyork@siue.edu
Assistant Professor http://www.siue.edu/~tyork
Dept. of Electrical & Computer Engineering Campus Box 1801
Southern Illinois University Edwardsville Edwardsville, IL 62026


**Education:**

| | | |
|---|---|---|
| May 2015 | Ph.D. Computer Engineering | Washington University in St. Louis |
| August 2007 | M.S. Electrical Engineering | Southern Illinois University Edwardsville |
| December 2002 | B.S. Electrical Engineering | Southern Illinois University Edwardsville |

**Appointments:**

| | |
|---|---|
| 08/14 – Present | Assistant Professor, Dept. of Electrical & Computer Engineering, SIUE |
| 08/09 – 08/14 | Graduate Research Assistant, Washington University |
| 09/07 – 08/09 | Part-Time Instructor, Dept. of Electrical & Computer Engineering, SIUE |
| 09/06 – 05/09 | Computer Engineer, United States Air Force |
| 01/03 – 05/05 | Teaching Assistant, Dept. of Electrical & Computer Engineering, SIUE |

**Research Interests:**

Polarization sensitive image sensors, imaging systems, mixed-signal VLSI, biomedical imaging, remote sensing, computer networking and security

**Awards:**

2016 – IEEE Donald G. Fink Award
2016 – Annette and Henry Baich Research Award

**Teaching:**

ECE 326 – Electronic Circuits I
ECE 381 – Microcontrollers
ECE 477 – Network Engineering
ECE 483 – Advanced Digital System Design
ECE 484 – VLSI/CAD Design
ECE 492 – Embedded Systems Security (w/ Dr. Thoshita Gamage)
ECE 577 – Advanced Network Engineering

**Publications:**

*Journal Articles*


1. M.Garcia, C. Edmiston, T. York, R. Marinov, S. Mondal, N. Zhu, G. Sudlow, W. Akers, J. Margenthaler, S. Achilefu, R. Liang, M. Zayed, M. Pepino, and V. Gruev, "Bio-inspired imager improves sensitivity in near-infrared fluorescence image-guided surgery," Optica **5**, 413-422 (2018)
2. T. York, R. Marinov, V. Gruev, "260 frames-per-second 648x488 resolution division-of-focal-plane polarimeter with structural dynamics and tracking applications," *Optics Express,* vol. 24, pp. 8243-8258, 2016
3. N. Skelley, R. Castile, T. York, V. Gruev, S. Lake, R. Brophy, "Differences in the Microstructural Properties of the Anteromedial and Posterolateral Bundles of the Anterior Cruciate Ligament," *American Journal of Sports Medicine*, vol. 43, no. 4, pp. 928-936, 2015

4. T. Charanya, T. York, S. Bloch, G. Sudlow, K. Liang, W. Akers, D. Rubin, V. Gruev, and S. Achilefu, “Trimodal color-fluorescence-polariztion endsocopy aided by a tumor selective molecular probe accurately detects flat lesions in colitis-associated cancer,” *Journal of Biomedical Optics*, vol. 19, no. 12, pp. 126002-1:126002-14, 2014
5. T. York, et. al. “Bioinspired Polarization Image Sensors: From Circuits and Optics to Signal Processing Algorithms and Biomedical Applications,” *Proceedings of IEEE*, vol. 102, no. 10, pp. 1450-1469. 2014
6. T. York, L. Kahan, S. Lake, V. Gruev, “Real-time high-resolution measurement of collagen alignment in dynamically loaded soft tissue,” *Journal of Biomedical Optics*, vol. 19, no. 6, pp. 066011-1:066011-6, 2014
7. T. York and V. Gruev, “Characterization of a Visible Spectrum Division-of-Focal-Plane Polarimeter,” *Applied Optics*, vol. 51, pp. 5392-5400, 2012
8. T. York*, Y. Liu*, W. Akers, G. Sudlow, V. Gruev, and S. Achilefu, “Complementary fluorescence-polarization microscopy using division-of-focal-plane polarization imaging sensor,” *Journal of Biomedical Optics*, vol. 17, no. 11, pp. 116001, 2012 (* denotes equal contribution)
9. V. Gruev, R. Perkins, and T. York, “CCD polarization imaging sensor with aluminum nanowire optical filters,” *Optics Express*, vol. 18, pp. 19292-19303, 2010

*Conference Papers*

1. N. Cui*, T. York*, R. Marinov, S. Mondal, J. Margenthaler, S. Achilefu, V. Gruev. "A 110 × 64 150 mW 28 frames/s integrated visible/near-infrared CMOS image sensor with dual exposure times for image guided surgery," *Circuits and Systems (ISCAS), 2016 IEEE International Symposium on*, Montreal, QC, 2016, pp. 101-104. (* denotes equal contribution)

2. M. Garcia, S. Gao, C. Edmiston, T. York, and V. Gruev, “A 1300 x 800, 700 mW, 30 fps Spectral Polarization Imager” *Circuits and Systems (ISCAS), 2015 IEEE International Symposium on*, pp. 1106-1109, Lisbon, Portugal, 24-27 May 2015.

3. T. York, V. Gruev, D. Saha, B. Raman, “A 220 × 128 120 mW 60 frames/s current mode polarization imager for in vivo optical neural recording” *Circuits and Systems (ISCAS), 2014 IEEE International Symposium on*, pp.1849,1852, Melbourne, Australia, 1-5 June 2014

4. T. York, R. Marinov, V. Gruev, “A 250-frames-per-second 640 by 480 pixels division of focal plane polarimeter for the visible spectrum”, *Proceedings of SPIE 9099, Polarization: Measurement, Analysis, and Remote Sensing XI*, 909915, Baltimore, Maryland, 2014

5. T. York, S. Powell, and V. Gruev, “A comparison of polarization image processing across different platforms,” *Proceedings of SPIE 8160, Polarization Science and Remote Sensing V*, San Diego, California, USA, pp. 816004, 2011

6. T. York and V. Gruev, “Optical characterization of a polarization imager,” *Circuits and Systems (ISCAS), 2011 IEEE International Symposium on*, Rio de Janiero, BRA, pp. 1576-1579, 2011 (**Winner Best Student Paper Award**)

SOUTHERN ILLINOIS UNIVERSITY
EDWARDSVILLE

March 27, 2019

Ref: Letter of support for Dr. Nima Lotfi and Dr. Timothy York

Dear Excellence in Undergraduate Education Program Committee,

I am writing to support the EUE proposal submitted by Dr. Nima Lotfi (PI) and Dr. Timothy York (Co-PI). Dr. Lotfi is an Assistant Professors of Mechanical Engineering who joined our department in 2016. Dr. York is an Assistant Professor of Electrical and Computer Engineering. While the new and rapidly-growing Mechatronics and Robotics Engineering (MRE) program is housed in the Department of Mechanical Engineering (ME), the MRE faculty come from several departments including ECE, IE, and ME. Therefore, the impact of this project is well beyond one department within the School of Engineering.

While the Mechanical Engineering program has three specific laboratories in the curriculum, the MRE program has limited resources and depends on expanding the applied components of the curriculum by designing hands-on experiments like those offered in this project. This project develops a number of low-cost laboratory platforms to cover a diverse set of experiments that may be used in more than one engineering discipline. These experiments are essential part of engineering training in this field.

I am especially excited about having Dr. Lotfi to direct this program because of his unique educational and research background in both Mechanical and Electrical Engineering disciplines. Dr. York has extensive experience and interest in microcontrollers and image processing. I am equally excited about the potential this proposal has to enhance the educational experience of our ME and MRE students, enabling them to excel in their career path through excellent technical and hands-on skills gained during their educational experience at SIUE.

Sincerely,

Majid Molki

Majid Molki
Distinguished Research Professor and Department Chair
Department of Mechanical and Industrial Engineering
mmolki@siue.edu; (618) 650-2372

SOUTHERN ILLINOIS UNIVERSITY
EDWARDSVILLE

TO: Excellence in Undergraduate Education – Review Committee

FROM: Andy Lozowski, Chair of Electrical and Computer Engineering

SUBJECT: EUE application from Dr. Nima Lotfi and Dr. Tim York

DATE: March 27, 2019

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Dr. Nima Lotfi and Dr. Tim York are coming forward with their proposal "Integration of an Experiential Learning Paradigm into Mechatronics, Robotics, and Control Engineering Curricula in the School of Engineering." Their intent is to create a set of laboratory stations that are equally suitable to electrical engineering students, mechanical engineering students, and software/firmware engineering students. Mechatronics happens to be right at the intersection of all of these disciplines. Being interdisciplinary is not the only aspect of the proposal. More importantly, having lab experiments and lab settings crafted for early exposure of students to specific applications will create learning environment much needed today. In fact, our department Advisory Board communicated to us that they wished for our undergraduate students to have more practical awareness of modern interdisciplinary technology. This proposal will serve exactly the need.

The essence of the proposed lab settings is to provide a self-explanatory challenge to the students. "Here is a robot arm. Make it pick up the fuzzball and deposit it over there." This is sufficient as a lab assignment, the rest is on the student to fill in and execute. One of ABET accreditation criteria calls for challenging the students to define engineering problems but also to solve them. Properly designed lab settings, as described in the proposal, will focus the students on such activities.

I am in support of the effort of Nima and Tim. I see a great benefit to our department, and to the entire School of Engineering, if they implement the proposed ideas.

With regards,

Andy Lozowski

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
BOX 1801

SOUTHERN ILLINOIS UNIVERSITY EDWARDSVILLE

March 27, 2019

Excellence in Undergraduate Education Program

Dear Review Panel Members,

This letter is to express my support for the EUE proposal titled "Integration of an Experiential Learning Paradigm into Mechatronics, Robotics, and Control Engineering Curricula in the School of Engineering" submitted by Dr. Nima Lotfi of Mechanical Engineering and Dr. Tim York of Electrical and Computer Engineering Departments. The new Mechatronics and Robotics Engineering (MRE) degree program is established in the school of engineering in fall of 2016 and quickly gained popularity among students. The MRE program provides an interdisciplinary education in the fields of mechanical, electrical and electronic, computers, and control systems in order to address the industry demands in this rapidly growing field. Students learn fundamental theory, modeling methods, hardware components, interfacing requirements, simulation and programming tools, and practical applications of mechatronics and robotics. Needless to say, the hands-on experience provided to the students is one of the most important aspects of the MRE program and also crucial for the overall educational outcomes. Therefore, the school of engineering strongly supports this proposal as it aims to build a number of experimental laboratory platforms which will include a robotic arm, a hardware-in-the-loop electric vehicle emulator, pressure/fluid level process control experiment, and a temperature regulation process control experiment. These devices that can also be used in our ME and CS labs can provide a comprehensive learning experience for the students and familiarize them with important integration elements present in real-world applications.

With their extensive backgrounds in the field of Mechatronics and Robotics, Drs. Lotfi and York are highly qualified to accomplish the objectives of this proposal effectively. I enthusiastically support their proposal.

Sincerely,

Cem Karacal, Ph.D.
Dean
School of Engineering
Southern Illinois University Edwardsville
Edwardsville, IL 62026
Phone: (618) 650-2435
Fax: (618) 650-3374

**Prior EUE Support:**

Fall 2017
Proposal Title: Development of Low-cost Educational Platforms to Improve Mechatronics Education and Promote it among the University Community and General Public
PI: Dr. Nima Lotfi
Co-PI: Dr. Mingshao Zhang
Amount Awarded: $4,189.00
Project summary:
Through this EUE grant, we identified, procured, and developed 21 sets of mechatronics kits. These kits comprised of some of the most commonly-encountered mechatronics parts including Raspberry Pi single-board computer and its auxiliary components, Arduino microcontroller and its auxiliary components, servo, stepper, and DC motors and their driver boards, various common sensors, and miscellaneous items such as batteries, wires, and breadboards. These kits were first used in ME492/ECE492 – Integrated Mechatronics using Raspberry Pi in Summer 2018 (total enrollment: 18). Due to the online nature of this class, the students don't have an opportunity to get hands-on experiences in the lab. However, thanks to this EUE grant, the students were able to take the aforementioned kits home over the summer. The availability of these kits enabled the introduction of important mechatronics topics which was not possible in the previous offerings of this course. The kits were returned at the end of the summer and are currently being used in MRE358 and MRE320. They will be used again this summer and in the upcoming years in ME492/ECE492 and other MRE courses. Furthermore, due to the availability of these kits, we did offer an educational outreach course on integrated mechatronics which was unfortunately cancelled due to low enrollment numbers. We will reshape and offer this course again in the near future.

Spring 2015
Proposal Title: An Interdisciplinary Hands-on Approach to Cybersecurity Education
PI: Dr. Thoshita Gamage
Co-PI: Dr. Timothy York
Amount Awarded: $11,836.00
Project summary:
This EUE Grant in Spring 2015 gave $11,836 to Dr. Gamage and Dr. York to develop a co-taught course on the topic of Embedded Systems Security. This course was developed around small, hands-on lab projects utilizing a BeagleBone embedded device, with a focus on securing or breaking the security of different embedded devices. The course was co-taught in the Spring of 2016 and was attended by 17 students. The course is planned to be offered again in the future, and is slated to become a core course in the proposed Cybersecurity Engineering degree offered through the School of Engineering.