The University Senate of Michigan Technological University
Proposal 35-22
(Voting Units: Academic)

Establishment of a New Graduate Certificate in Industrial Robotics

Submitted by Department of Applied Computing

1. Proposal Date:
January 17, 2022

2. Proposing Contacts and Department
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3. Sponsor Department Approval
Approved by the department and college.

4. General Description and Characteristics of the Program

4.1 General Description of Certificate
The Department of Applied Computing in the College of Computing and the Department of Manufacturing and Mechanical Engineering Technology in the College of Engineering join efforts to introduce three graduate, stackable certificates leading to a Master of Science in Mechatronics. These certificates are: “Industrial Robotics,” “Automation and Controls in Mechatronics Systems,” and “Fluid Power in Mechatronics Systems.” All three certificates include the core courses for MS in Mechatronics. The “Industrial Robotics” certificate consists of EET5144 Real-Time Robotics Systems, EET5147 Industrial Robotic Vision Systems, and one of the cybersecurity courses. Both robotics courses come with FANUC industrial certification. Upon successful completion of the courses, eligible students receive “Material HandlingPro” and “iRVision-2D” FANUC industrial certificates.

4.2 Catalog Description
The Certificate “Industrial Robotics” is designed to develop skills and competencies in operating, programming, and troubleshooting FANUC industrial robots and configuring and setting up

robotic vision systems commonly used to enhance industrial processes. The curriculum contains a significant laboratory component operating industrial-scale FANUC robots and learning industry standards of Roboguide simulation software. The certificate teaches skills related to the network security and cybersecurity of industrial control systems.

5. Rationale for Certificate

Many existing jobs will be automated in the next ten years, and robotics will be a major driver for global job creation over the next five years. These trends are made clear in a study conducted by the market research firm Metra Martech, "Positive Impact of Industrial Robots on Employment." Many repetitive, low-skilled jobs are already being supplanted by technology. However, a number of studies have found that in the aggregate, the robotics industry is creating more jobs than the number of jobs lost to robots. With the rapid growth of robotics and automation, especially during the last few years, its current positive impact and future projections for the impact on the United States economy are very promising. Such rapid growth of robotic automation in all sectors of industry will require an enormous number of technically sound specialists with the skills in industrial robotics and automation to maintain and monitor existing robots, enhance the development of future technologies, and educate users on implementation and applications. It is critical, therefore, that educational institutions adequately respond to this high demand for robotics specialists by developing and offering appropriate courses geared towards professional certification in robotics and automation. The EET program in the department of Applied Computing in the College of Computing at Michigan Tech is a Certified Training and Education Site for FANUC Robotics Material Handling and iR-Vision 2D, directed by FANUC certified instructor Dr. Sergeyev. Since 2013, Michigan Tech has been FANUC Authorized Certified Training Facility. Under this agreement, Michigan Tech is a regional training center specializing in industrial robotics and automation, eligible to train and certify students from Michigan Tech and other institutions, industry representatives, and displaced workers. Michigan Tech is one of only three existing FANUC Authorized Satellite Training Programs in the United States and the only one in the state of Michigan.

Cybersecurity plays a critical role in industrial setting. Students will acquire knowledge of network security and cybersecurity of industrial control systems.

The proposed "Industrial Robotics" Graduate certificate will attract students from various departments at Michigan Tech and will make them more marketable in a very demanding job markets.

6. Related Programs

There are a variety of certification programs in robotics at undergraduate and graduate levels. Most of the certificates focus on autonomous robotics, forward and inverse kinematics, path planning, and optimization algorithms. Below are the most closely related certification programs at undergraduate and graduate levels. The proposed Michigan Tech certificate "Industrial Robotics" stands out by its specific focus on FANUC Industrial Robots that pertain to 80% of the United States market and two industrial certificates that accompany the program.

1. SINCLAIR COLLEGE https://www.sinclair.edu/program/params/programCode/IRT-S-CRT/
   Sinclair College offers one-year, 31 credit hour, technical certificate "Industrial Robot Technician IRT.S.CRT". The Industrial Robot Technician certificate provides the knowledge and skills required to meet the needs for technicians in industries that either

provide Robots systems for sale or use robots in their production facilities.

2. Lamar University, https://www.lamar.edu/engineering/industrial/undergraduate-program/certificate-in-automation-and-robotics.html
   The College of Engineering in Lamar University offers a certificate in Automation and Robotics. The certificate has two core courses Automated System Engineering, Fundamentals of Instrumentation and Control and two electives.
3. Conestoga College, https://www.manyagroup.com/universities/ontario-college-graduate-certificate-in-robotics-and-industrial-automation-co-op-eng-0938/
   Ontario College offers Graduate Certificate in Robotics and Industrial Automation The program offers key practical courses similar to those found in our highly successful Robotics and Automation Technology program.
4. University of South Florida, https://www.usf.edu/engineering/graduate/graduate-certificates.aspx
   The University of South Florida offers a graduate certificate in Robotics that includes many technical aspects, such as mechatronics, kinematics, controls, programming, algorithm development, and more. This certificate in Robotics prepares students for work in robotics and exposes them to several facets of the field. The program allows for a focus on the hardware and modeling or the algorithms, all of which are the integral components of robotics.
5. University of Michigan-Dearborn, https://umdearborn.edu/cecs/graduate-programs/certificates/industrial-mechatronics
   The University of Michigan-Dearborn offers a graduate" Industrial Mechatronics" certificate. The program provides fundamental principles of mechatronics with emphasis on the application of these principles in emerging and classical areas of manufacturing and automotive technology. It covers such topics as mechatronics, robotics, advanced controls, and automotive powertrains.

7. Projected Enrollments

Based on the popularity of the courses included in this certificate and the fact that they are part of the MS degree in Mechatronics, we have estimated the following enrollment:

Academic Year	Enrollment
2022-2023	5
2023-2024	10
2024-2025	15
2025-2026	15

8. Scheduling Plans

No change in the regular scheduling of the existing courses is anticipated. The Department of Applied Computing will deliver the courses in our regular scheduling plans. Initially, the courses will be delivered on-campus, with the goal of offering later in a blended format. The blended version will be comprised of the theoretical content being offered in the online format, followed by intense training in the laboratories.

9. Curriculum Design

Required Core Coursework: 8 credits

EET 5144 Real-Time Robotics Systems (4)

EET 5147 Industrial Robotic Vision System (4)

Select one of the following courses from the elective list below
EE 4723 Network Security (3)
EE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems (3)
MEEM 5315 Cyber Security of Auto Systems (3)
SAT 3812 Cybersecurity I (3)

Course Descriptions:

EET 5144 Real-Time Robotic Systems (4 credits): Covers the components of a robot system, safety, concepts of a work-cell system, geometry, path control, automation sensors, programming techniques, hardware, and software.

EET 5147 Industrial Robotic Vision System (4 credits): Procedures for setting up, teaching, testing, and modifying robot vision systems widely used in industrial automation. Introduces advanced Teach Pendant Programming to develop complex scenarios for integrating robots into industrial cells. The final project must demonstrate proficiency in setting up and programming an advanced robotic vision scenario.

EE 4723 Network Security (3 credits): Learn fundamental of cryptography and its application to network security. Understand network security threats, security services, and countermeasures. Acquire background knowledge on well-known network security protocols. Address open research issues in network security.

EE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems (3 credits): General introduction to cybersecurity of industrial control systems and critical infrastructures. Topics include NIST and DHS publications, threat analysis, vulnerability analysis, red teaming, intrusion detection systems, industrial networks, industrial malware, and selected case studies.

MEEM 5315 Cyber Security of Auto Systems (3 credits): Modern automotive control and communications systems from a cyber-security perspective. Topics include: V2X communications, vehicle attack surfaces and vulnerabilities, in-vehicle networks, threat analysis and vulnerabilities, security mechanisms and architectures, security requirements analysis, hardware security modules, and standards.

SAT3812 Cybersecurity I (3 credits) The evolution of information security into cybersecurity and its relationship to nations, organizations, society, and individuals. Exposure to multiple cybersecurity technologies, processes, and procedures; analyzing threats, vulnerabilities and risks present; and developing appropriate strategies to mitigate potential cybersecurity issues. Applied lab to develop cyber security offensive attributes and learn how to prevent and/or mitigate threats.

10. Model Schedule Demonstrating Completion Time

The certificate can be completed in two academic semesters, during summer Track A and Track B, or a combination of both.

Fall Semester or Summer Track A

EET5144 Real-Time Robotic Systems (4)
SAT3812 Cybersecurity I (3 credits)
EE 5455/MEEM 5300 Cybersecurity of Industrial Control Systems (3)

Spring Semester or Summer Track B
EET5147 Industrial Robotic Vision Systems (4)
EE4723 Network Security (3)
MEEM5315 Cyber Security of Auto Systems (3)

11. Library and other Learning Resources

No library or other learning resources are required at this time.

12. Faculty Resumes

The following faculty will be supporting the program.

Dr. Sergeyev, Professor, Department of Applied Computing, Graduate Program Director of Mechatronics, Director of FANUC Certified Training Center
https://www.mtu.edu/technology/about/faculty/sergeyev/index.html
Dr. Goldsmith, https://www.mtu.edu/mechanical/people/scholars-instructors/goldsmith/index.html
Dr. Cai, http://www.mtu.edu/technology/about/faculty/cai/

13. Equipment

No additional equipment will be required

14. Program Costs

Initially, there will be no additional costs for offering the certificate. However, as enrollment grows, additional instructional resources will be needed.

15. Space

There are no new space requirements.

16. Policies, Regulations, and Rules

Not Applicable

17. Accreditation Requirements

The proposed certificate will not seek additional accreditation.

18. Planned Implementation Date

Fall 2022

19. Assessment

Upon successful completion of this certificate, students will be able to do the following:

1. Apply safe techniques for operating industrial robots.
2. Manipulate and program industrial robots.
3. Configure robotic vision systems.