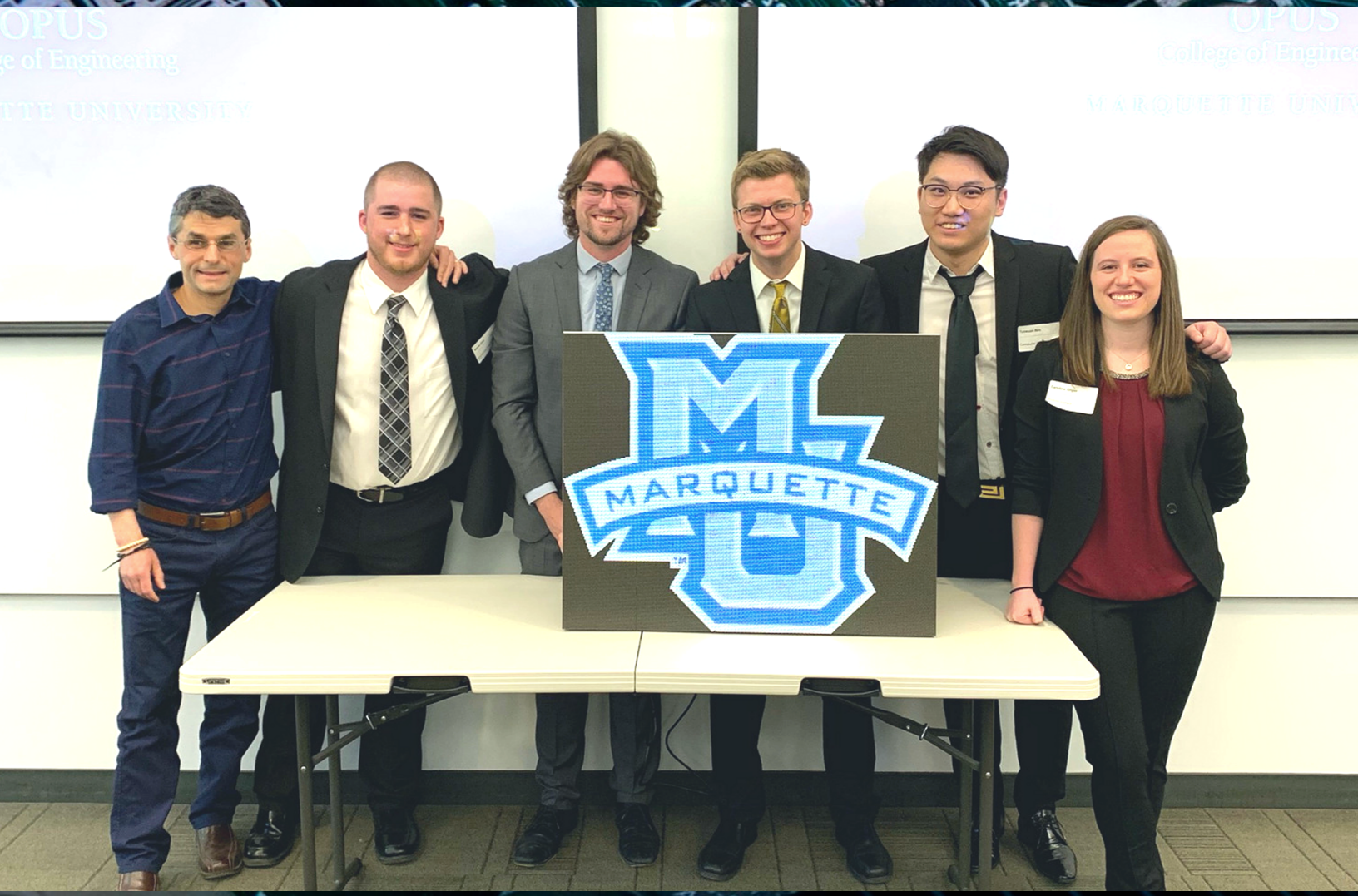
OPUS
College of Engineering
MARQUETTE UNIVERSITY

Department of

ELECTRICAL & COMPUTER

Engineering



SENIOR DESIGN PROJECTS

Picture Source: Medium.com

FOREWORD

from the Department Chair

On behalf of the Department of Electrical and Computer Engineering in the Opus College of Engineering, I would like to showcase our students' capstone senior-design course sequence for the academic year of 2018-19. These senior design projects are incredibly important because, in my opinion, both education and research can benefit greatly from close partnerships with industry - and vice versa.

As you glance through the projects in the following pages and read through the testimonials by students, you will see evidence of technical depth and breadth in both our electrical engineering and computer engineering programs. Additionally, you will find examples of practical knowledge. This is incredible. The subject matter of the projects also shows our students' commitment to positively impacting industry and society at-large.

Finally, I would like to thank our faculty for their hard work planning, designing and implementing a world-class senior-design course. I am also grateful to our students for their creative work. This work aims to advance engineering and serve the broader community.

Sincerely,

Majeed Hayat

Dr. Majeed Hayat
Professor and Department Chair,
Electrical and Computer Engineering

A B O U T

The Senior Design Projects

All senior year electrical and computer engineering students are required to complete this two-semester multidisciplinary course. The course requires students to work on a design project in a team of three to five students. While working on the design project, the students learn and practice current project management methodologies, including written reports, oral presentations and the development of a working prototype.

Several of these projects are sponsored by our industry partners, giving students an opportunity to peek into the real world, and gain experience and insights into various practices and technologies employed by industry.

As a special note, we'd like to thank Dr. Chandana Tamma, who has skillfully and excellently coordinated the Department of Electrical and Computer Engineering senior design projects.

LIST OF SPONSORS

2018-19

Dr. Cris Ababei

Dr. Henry Medeiros

Ms. Teri Sippel Schmidt

Milwaukee Tool

Rockwell Automation

WE Energies

PROJECTS

2018-19

Optimization of MHT Algorithm

Project Team:
Isaac Bremseth
Mitchell Shreiner
Adam Shakal
Nathan Simon

Faculty Advisor:
Dr. Henry Medeiros,
Marquette University

Though the field of computer vision is growing, with new breakthroughs every day, object tracking is a largely unsolved problem. One solution which sticks out is the implementation of multiple hypothesis tracking. Multiple hypothesis tracking is designed to follow multiple objects through a field of view over a specific period of time.

The purpose of this project is to start with an open-source implementation of the multiple hypothesis tracking algorithm and create a modified, usable implementation which could be run in our faculty adviser s lab. His lab conducts sponsored research in the field of multiple object tracking.

The biggest risk going into the project was not knowing whether the provided open source implementation could actually be transformed into the desired end product.

Our first step was to make the open-source implementation functional. This process took nearly all of the first semester, as a result of several issues with retrieving source code documentation. However, the running implementation served as our prototype. During the second semester, we evaluated our prototype against the needs of our adviser's lab, then determined what changes needed to be made. We also discerned whether or not it would be possible to implement these changes. In order to verify the validity and effectiveness of the project, we ran data-sets designed for testing applications of multiple object tracking.

PROJECTS

2018-19

Electric Utility Augmented Reality Investigation

Project Team:
Cameron Baltrusch
Jenelle Lee
Gabriel Thalji
Alex Vonderhaar
Andrew Koetting

Sponsor:
Dave Nestler, WE Energies

Faculty Advisor:
Dr. Chandana Tamma,
Marquette University

Conducting work orders and inspections on electric utility substations is time intensive and expensive. In fact, utility companies often spend hundreds of thousands of dollars and exorbitant amounts of time each year just to meet federal requirements. The goal of this project is to investigate the advantages of augmented reality in electric utility workers, in hopes of improving the electric utility inspection process. We analyzed different avenues of implementing augmented reality, and finally settled on nursing homes and assisted living environments. We then conducted an entire study of the process, discussing the final design, and its implications.

The final design focused on the inspection process that an electric utility worker might have to go through. As substations contain hundreds of components which can be inspected, we chose to focus on three specific areas: battery bank, transformers, and circuit breakers. In addition to inspecting the equipment, we implemented a safety design feature which allows the utility worker to see the infrared signature of an image in front of him, and display this image, so that the user could see it throughout the inspection.

The final design met all customer needs and target specifications: weight, amount of time required to learn the technology, set-up time, streamlined inspection process and mobility. This design is just the beginning of augmented reality in electric utilities, a feature which opens the door for safer, more effective services for the public.

PROJECTS

2018-19

Hybridized Soil-Moisture/Weather API Informed Intelligent Irrigation System

Project Team:
Max Marischen
Tharun Parackal
Michael Fiorini
Nicholas Mussoline

Faculty Advisor:
Dr. Chandana Tamma,
Marquette University

In modern landscaping environments, landscapers must implement irrigation controllers in several different situations. These can range from single zone control systems to many zone control systems. The systems could require different kinds of hosing depending on which area needs watering. With all these factors at play, landscapers would benefit from a modular, easy to set-up system which meets the needs of plant-life on the property.

We endeavored to meet this need by designing an intelligent embedded irrigation system. First for our design, we prioritized ease-of-use. This meant creating an easy setup process via a smartphone app. The system does not start unless someone has used the application, as we've set up a microcontroller to receive configuration before it launches into its routines. The system also contains modular zoning, which means that though several areas and soil types exist within a property, only one irrigation controller is required to monitor and manipulate them. Our product dispenses water at a required rate through solenoid valves while keeping power consumption low for the client. Further, the controller uses weather API data and soil moisture readings to inform its watering decisions throughout the day.

To test this product, we looked closely at the software routines and made sure there were no bugs in the control flow. This code was reviewed by team members, then underwent unit tests to confirm functionality. Other tests included fluid flow testing, power consumption testing, soil moisture testing and other small tests.

Our goal is to improve the lives of landscapers and their clients, ensure our product functions at the industry standard and ultimately, is easy-to-use.

PROJECTS

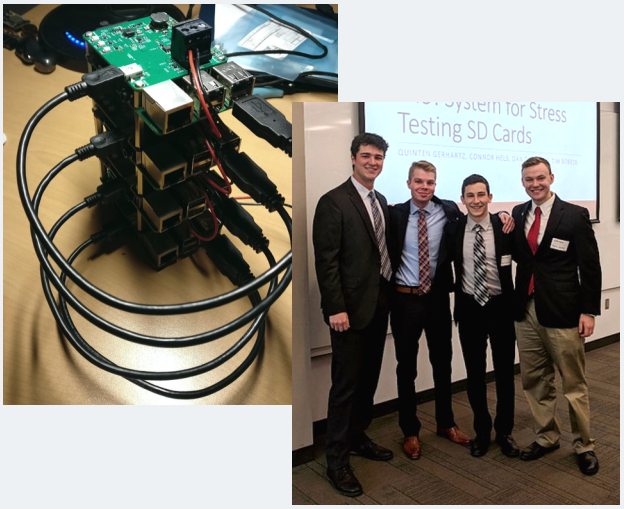
2018-19

SD Card Stress Testing Fixture

Project Team:
Quinten Gerhartz
Connor Hels
Timothy Bobeck
Daniel Zurawski

Sponsor:
Marco Naeve, Rockwell Automation

Faculty Advisor:
Dr. Richard Povinelli,
Marquette University



Rockwell Automation sells several individual SD cards. Moreover, these SD cards are sold as an official accessory to Programmable Logic Controllers (PLCs), Human Machine Interfaces (HMIs), and several other Rockwell Automation products. To ensure quality, Rockwell Automation tests these SD cards rigorously. However, the actual hardware platform used to test the SD cards is old and unreliable.

To specify the problems with the platform: it is prone to crashes, difficult to configure, and does not accomplish the testing at an optimal rate. In order to solve the hardware stability issues, we developed a new hardware attached on top ("HAT") . The HAT technology works alongside a Raspberry Pi, taking the place of outdated logicboards. Our goal is to create more reliable and streamlined technology than the current system.

To our delight, the new system performed much more effectively than the current one does. For example, there were no hardware failures while reading and writing to the SD cards. Additionally, the startup and test routine times were drastically reduced as a result of the more streamlined software and updated hardware. Finally, extracting data from the SQL database and inserting it into Microsoft Excel is much easier. We think this is a viable solution for Rockwell Automation, for it provides them with reliable and fast SD card verification.

Automotive Data Logger

Project Team:
Eric Ciliske
Chelsea Conard
Madison Hertel
Jake Rozewicz
Scott Stewart

Sponsor:
Milwaukee Tool

Faculty Advisor:
Dr. Susan Schneider,
Marquette University

Vehicles have many different electrical and computer systems which monitor vehicle operation and transmit on-board diagnostic ("OBD") data. Currently, many diagnostic tools which log vehicle data exist on the market. However, several of them do not store data long-term, and some overwrite previous diagnostic information. These solutions do not help customers who want access to previously logged information.

The purpose of this project is to provide an automotive data logger which logs vehicle energy demands (i.e. voltage, engine temperature, engine speed (RPM), vehicle current draw, and vehicle speed). The automotive data logger utilizes a microcontroller, an SD card, a control area network ("CAN"), voltage regulators, and an enclosure. The microcontroller analyzed data from the vehicle CAN bus, such as engine temperature, engine speed, and vehicle speed. Further, analog-to-digital converters, located on the microcontroller, logged battery voltage. The voltage regulators provided regulated 5 Volts and 3.3 Volts to the circuitry. The voltage was necessary for logging and reading data. Finally, an enclosure housed the internal circuitry of the device. With these components, data from a car can be communicated through the vehicle's CAN bus and recorded during startup, while it is idle and when the vehicle is off.

Our automotive data logger was verified by simulations and in-vehicle testing. It is capable of logging data by the millisecond during ignition, by the second while idling, and once every minute when the vehicle is turned off. Overall, it was a successful implementation.

PROJECTS

2018-19

Synoptic Radiology Reporting

Project Team:
Jared Funk
Blake Miller
Natalie Olson

Faculty Advisor:
Ms. Teri Sippel Schmidt,
Marquette University

After performing a procedure, a radiologist often finds significant information that must be stored and used later on. In order to simplify the process of retrieving information, it is important that any findings from a procedure or other service are organized and detailed. Currently, radiologists record findings using a speech-to-text program which transcribes dictations directly into a document. While this method is incredibly quick, it is not organized.

The purpose of this project is to create organized, consistent reports for medical centers, effectively filling the market gap. Our product connects to a medical data server using the FHIR, ("Fast Healthcare Interoperability Resource") standard. It also connects to the Electronic Medical Record system at any given healthcare center using SMART, an an open source healthcare technology platform which keeps records secure. To begin use, the radiologist selects a patient and a reporting template, then creates a report. The patient's information is pulled directly from the records into the report. Afterwards, the radiologist is prompted to fill out a template containing relevant information. Once the report is filled out and completed, it is converted into a PDF and stored in the server as a diagnostic report. For reference, a diagnostic report is a resource created for FHIR servers which displays the results of a medical procedure or study.

After analyzing the product, we concluded that the completed PDF report was significantly more organized than the paragraphs produced by a speech-to-text system. It took around the same time to complete as current competitors on the market. However, the process is more efficient because it automatically provides patient information and uploads completed reports to the server. We recognize that additional professional trials are required before full commercial adaptation is considered.

PROJECTS

2018-19

Software Application for the American College of Radiology

Project Team:
Kyle Chang
Alex Dums
Peter Moras

Sponsor:
Ms. Teri Sippel Schmidt

Faculty Advisor:
Ms. Teri Sippel Schmidt, Marquette University

The objective of this project is to develop a software application for the American College of Radiology which makes medical imaging data-sets easily and globally accessible to artificial intelligence (AI) researchers. For this project, two main use cases were considered which highlight the first two functions of the computer programming storage system: (“Create” and “Read”). The project was implemented using an ASP.NET MVC web application linked to a MongoDB database in order to manage the cases. It includes the following primary components in fulfillment of those use cases.

Regarding user registration, three levels of authorization have been utilized: guest, signed-in user and administrator. This allows one to track data-set provenance easily and enables users to view their data simply.

The search page enables users to perform queries based on search parameters. We derived these parameters from the data-set summaries provided in the abstract. Query results are returned to the web browser and provide the individual with summaries of matching data-sets and a URL link by which to access them. The "abstract form" page provides a plethora of fields for the user to fill in information about their data-set. Once submitted, the abstract is stored in the database and is queued for administrator review.

Following administrator approval of the abstract, the data is processed by the application. Data from the DICOM headers are then parsed and used to generate a new collection in the database, which specifies the user as its “owner.”

PROJECTS

2018-19

Vibrating Alert Bracelet

Project Team:
Alex Foyer
Tom Janik
Patrick Hara
Jason Reichard
Jon D'Souza
Kelsey Conley

Faculty Advisor:
Dr. Cris Ababei, Marquette University

Elderly residents in retirement homes and assisted-living facilities are at risk of missing fire evacuation notices or any other emergencies. This condition is exacerbated when resident have hearing impairments. The current market provides alert systems which help elderly residents in the case of an emergency. However, many of them rely on loud, repetitive auditory tones, meaning that a new alert paradigm is necessary for the hearing-impaired. The Vibrating Alert Bracelet ("VAB") was proposed as an alternative solution to conventional alarm systems.

The goal of the VAB is to create an Internet-of-Things (IoT) wearable bracelet which can be worn by residents of assisted living facilities. Its intended capability includes alerting users of emergencies via haptic forces and a bright LED visual signal, sent over WiFi connection. To alert a resident, a client must communicate with a Raspberry Pi back-end server. The Raspberry Pi functions as a middleman between the bracelet and Android app. The system handles the administration and deployment of the VABs, relaying emergency signals. Finally, the Android app creates a way for the administrator to interface with the server as they monitor users and send alerts.

Design verification tests prove that the VAB fulfills base design goals. These include: functioning as an IoT-enabled wearable device, sending tactile and visual alerts to the user of the VAB, and sending emergency signals via Android app and WiFi connection.

MU-MatriX: Electronic Display

Project Team:
Kevin Etta
Logan Wedel
Drew Maatman
Tuoxuan Ren
Caroline Gilger

Faculty Advisor:
Dr. Cris Ababei, Marquette University

Electronic displays are used in many applications, ranging from billboards to scoreboards in a sports arena. This project describes the creation of a 320 by 256 pixel LED display system. The system has a 9 bit color resolution, fully integrated logic and power, as well as an Android App user interface.

In order to create this, a custom logic PCB was developed, hosting a 32-bit, 252MHz microcontroller, 8 serial Flash memory chips, and a complex image caching system. In addition to the logic board, a power PCB was developed to safely power the LED panels. This power PCB has a quad-phase 1MHz buck converter, which can supply 5V at up to 45 Amps. The buck converter features many protection and ruggedization features to ensure the LED panels are protected against electrical faults. The project required extensive microcontroller firmware to be developed, so that the microcontroller could draw images on the LED panels, control the flow of image data, and interact with users.

The main user interface is an Android app which allows users to select up to eight images to display in a slide-show. The user can select the cycle time between images. The Android app also allows the user to dim the screen, and turn it on and off.

The final project yields a 320 x 256 pixel LED display, the two custom circuit boards, a consumer-off-the-shelf power supply, and a custom fabricated aluminum frame. It can display any set of eight images through the android app, and has a color density of 9 bits of color. The final product is about 2.5 feet by 2 feet in size. Both circuit boards and the COTS power supply are attached to the back of the 20 LED panels, so the project is self-contained. A user can connect to its built-in WiFi network via an Android phone.

TESTIMONIALS

from students

Frankly, I was skeptical of how this class would affect my engineering development. However, it proved to be one of the more meaningful classes I have taken in college. No other class teaches you about finances, patents, hardware/software design techniques, or even gantt charts. My group's project was sponsored by Rockwell Automation. For the project, we developed a faster, cheaper, smaller, more reliable, and more efficient way to evaluate SD cards. I am happy to say that this project was successful across the board. The true accomplishment, however, was the skills we learned about hardware/software design, as well as team management!"

Timothy Bobeck

Senior design was the perfect mix of a four-year engineering curriculum and key project management skills. The opportunity to witness the first-hand importance of proper documentation, of experimental verification and validation was incredible, and made it clear why we are taught the Engineering Design Process. The senior design process mimicked the standards expected in industry and helped prepare us for what we may see in our engineering careers. Ultimately, senior design encouraged us to accept challenges. It put our problem-solving abilities to the test."

Jenelle Sanders

TESTIMONIALS

from students

Senior design was a fantastic opportunity to utilize the skills that you developed while at Marquette. The wide variety of projects afford you the chance to select a project that you will be passionate about, while getting a sample of the processes and technologies which are currently used in the various industries. It was a great experience and one that will help prepare you for your future career."

Alex Luczak

The senior design course was perhaps the most valuable experience in my entire college career. The two-semester project allowed for an in-depth assessment of customer needs and a more informed and pointed design structure than any other class project I worked on. This was by far the most applicable any coursework was to the demands and expectations of engineering work in industry, and along with my internship and co-op experiences, this project gave me a great insight into the direction I wanted to take my engineering career post-graduation."

Jimmy Drenovsky

FACULTY

Hayat, Majeed, Ph.D.
Professor and Chair
Dynamical models for interdependent cyber-physical systems, signal and image processing, statistical communication theory, avalanche photodiodes

Ababei, Cris, Ph.D.
Assistant Professor
Network-on-chip based multicore processors and datacenters, embedded systems, FGPAs, distribution networks and smart buildings

Coutu, Jr., Ron, Ph.D.
V. Clayton Lafferty Endowed Chair and Professor
Microelectromechanical systems (MEMS), advanced microsystems, device fabrication , chemical sensors

Demerdash, Nabeel, Ph.D.
Professor
Electric machine and drives, computational electromagnetics, power electronics, power systems

EL-Refaie, Ayman, Ph.D.
Werner Endowed Chair and Professor
Electrical machine and drives, power electronics, power systems, renewable energy, aerospace applications, oil and gas applications

Josse, Fabien, Ph.D.
Professor and Director of Graduate Studies
Solid state and acoustic wave sensors,

Lee, Chung Hoon, Ph.D.
Associate Professor
Micro/nano scale device fabrication, ultrasonic/bio MEMs, microfluidics, thermal analysis of biochemical molecules, molecular electronics

Medeiros, Henry, Ph.D.
Assistant Professor
Computer vision, robotic vision, vision for embedded devices, multi-sensor/camera networks, object detection and recognition

FACULTY

Povinelli, Richard, J., Ph.D.
Associate Professor
Machine learning, signal processing, dynamical systems and chaos

Richie, James, Ph.D.
Associate Professor and Associate Department Chair
Electromagnetic scattering and inverse scattering, antennas and wave propagation

Schneider, Susan, Ph.D.
Associate Professor and Director of Undergraduate Studies
Non-linear systems, sensor systems, educational methods: novel pedagogy and assessment

Tamma, Chandana, Ph.D.
Adjunct Assistant Professor
Pervasive computing, embedded systems, impedance tomography

Weise, Nathan, Ph.D.
Assistant Professor
Power electronics, power and energy conversion, electric drives, vehicular power systems, high voltage direct current converters

Yaz, Edwin, Ph.D.
Professor
Stochastic, non-linear, and uncertain systems, signal processing, networked control systems, gender issues in STEM education

Ye, Dong Hye., Ph.D.
Assistant Professor
Machine learning, image processing, biomedical image analysis, computed topography, microscopic imaging, automatic target recognition

OPUS
COLLEGE OF ENGINEERING

Since 1908, the Marquette University Opus College of Engineering has been uniquely blending professional engineering preparation with a liberal arts education to provide the world with well balanced leaders in their profession.

OUR MISSION

The mission of the College is to excel in four critical areas:
- To prepare all students for successful careers based on a strong moral and ethical foundation
- To advance the state-of-the-art in engineering
- To serve our professional and technical communities
- To contribute to our global society

ACCREDITATION

All undergraduate programs offered by the Marquette University Opus College of Engineering are accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, 410-347-7700.

THE UNIVERSITY

Founded in 1881 in Milwaukee, Wisconsin, Marquette University has been educating people of faith to be leaders in their professional lives, their communities and in society.

Since the first graduating class of five men were awarded bachelor of arts degrees in the 1880s, Marquette has grown into a modern coed campus of more than 11,000 students who learn and grow through nationally admired undergraduate, graduate and professional programs.

MARQUETTE
UNIVERSITY

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