



OPUS
College of Engineering
MARQUETTE UNIVERSITY

Department of

ELECTRICAL &

COMPUTER

Engineering



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UNIVERSITY

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**SENIOR DESIGN
PROJECTS**

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 share with you some of the success stories of our students by showcasing our capstone senior-design course sequence for the academic year of 2017-18. Let me begin by saying that I strongly believe that both education and research can benefit greatly from close partnerships with industry, and vice versa. The senior-design projects that our students carry out each year are a perfect example of this.

As you glance through the projects in the next pages and read through the testimonials by students and their industry and university sponsors, you will see the evidence of the technical depth and breadth of our electrical-engineering and computer-engineering programs in practical knowledge. The choice of the projects also shows how our students believe in positively impacting the industry and society.

I would like to thank my faculty for their transformative work in planning, designing and implementing a world-class senior-design course sequence. I am also grateful to our students for their creative work, which aims to serve the 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. This requires students to work on a design project for the two semesters in a multidisciplinary team of three to five students. While working on the design project, the students learn and practice current project management methodologies, which involve written reports, oral presentations and the development of a working prototype.

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

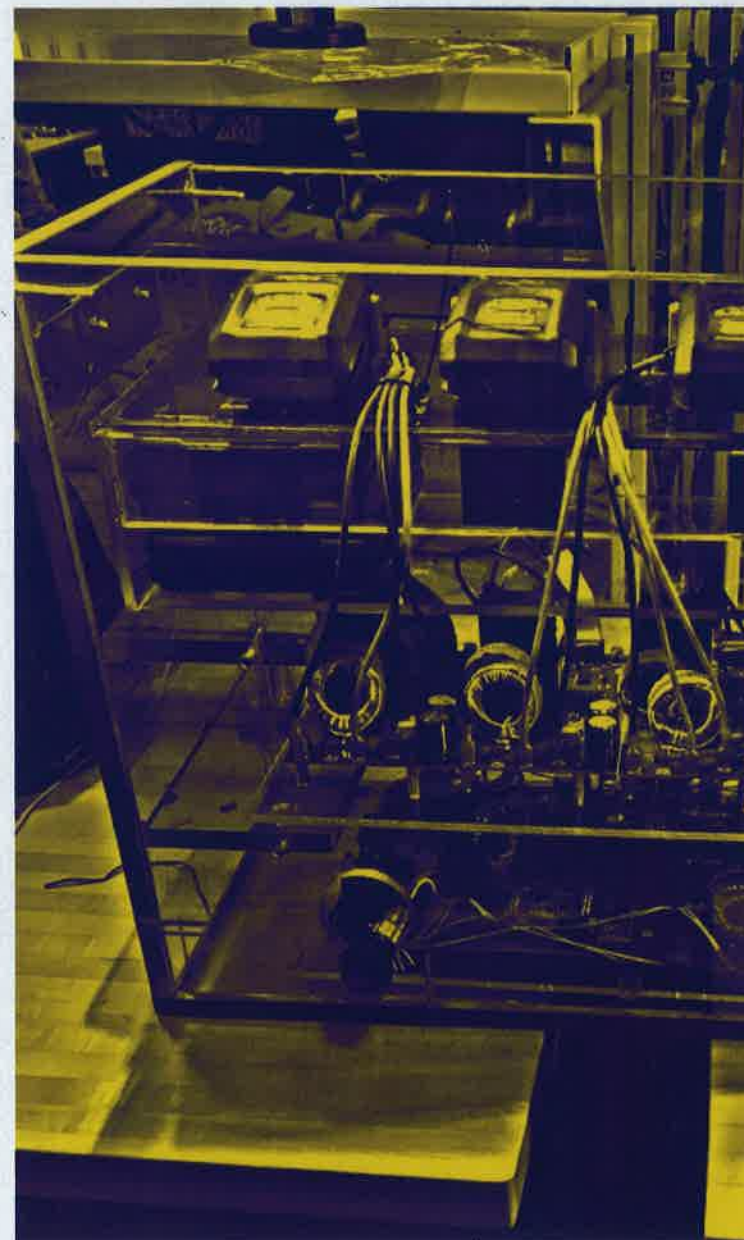


INDUSTRY

SPONSORS

2017-18

Kohler Company
Direct Supply
GasDay Lab
Briggs and Stratton
Ifakara Health Institute
UBICOMP Lab
Dr. Cris Ababei
Michael Bachmann



PROJECTS

2017-18

Internet of Things – Connected Clinical Devices

Project Team:

Zhou Shen
Franco Reda
Ryan Clulo
Samuel Norris

Sponsor:

Kent Newbury, Direct Supply

Faculty Advisor:

Dr. Richard Povinelli, Marquette University



The design team explored the application of internet of things (IoT) networking and machine learning within the home health care space. Direct Supply sponsored the project in an effort to gain a better understanding of how recent advances in the computer science field can make healthcare more personal, timely, and cost effective.

The result of the project is an embedded smart hub that networks small medical sensors via bluetooth, capable of collecting and displaying the results. In addition, the system applies machine learning to the collected data to provide instantaneous analysis and flagging of abnormalities for further investigation by a medical professional. In addition, the system applies machine learning to the collected data to

provide instantaneous analysis and flagging of abnormalities for further investigation by a medical professional. The team was able to make suggestions to Direct Supply about using the Android platform along with the Android family hardware to design the embedded system and supply working code developed in partnership with Onkol.

Future design teams in this field will have a strong foundation environment to move forward with obvious avenues for necessary education. They were also able to provide the results of study on blood oxygen variability and the usefulness of this metric in determining health factors through the embedded machine-learning capability of the device.

PROJECTS

2017-18

Elder Care Robot: Helper and Companion

Project Team:

Glenn Brown
Zachary Burk
Catherine Martin
Michael Panetta
Alaa Shanaa

Sponsor and Faculty Advisor:

Dr. Sheikh Iqbal Ahamed, UBICOMP Lab, Marquette University



The project addresses the struggles in assisted living centers in the constant monitoring, care and entertainment required by senior residents. The sponsor provided the team with a Bioloid Premium Robot at the beginning of the project. The project was intended to research into the possibility of robotic assistance in elderly communities, and explore the possibility of a robot being able to entertain and improve the day to day life of the residence, as well as ease the stresses of staff and nurses.

The team investigated the current nursing home and assisted living environments (problems, room sizes, flooring, customer needs, etc.), as well as the abilities and limitations of the robot.

The robot's abilities were also investigated, such as the available sensors, motors, and compatible software. The team was able to assess the robot's success when trying to meet the desired specifications. Overall, the robot was successful across all testing; however, there were opportunities for improvement.

There were specifications that had to be eliminated or adjusted due to time restrictions in research and implementation. Different robot hardware could improve performance in the future, such as higher quality motors or different robot designs.

PROJECTS

2017-18

Monitoring the Health of Natural-Gas Demand Forecaster

Project Team:

Jim Reilly
James Drenovsky
Jashive Quintas
Justin Furst

Sponsor:

GasDay Lab

Faculty Advisor:

Dr. George Corliss, GasDay Lab,
Marquette University



To prevent use of the spot market or over-purchase of energy, local distribution companies (LDCs) have been incorporating mathematical modeling techniques to generate forecasts of their customer's energy demand. Marquette University's GasDay research lab generates natural gas demand forecasts over an eight-day period for their client. This ensures the clients have ample time to prepare enough energy for the day of use.

GasDay has developed a web application that they hope to deploy to new and existing customers in the near future. A major factor postponing deployment of the web application is that no tool currently exists to monitor the status of an LDC's web instance in real time.

The GasDay lab wanted to have a Health monitor tool that can identify errors in the web application as soon as they occur. This would make the GasDay lab aware of potential model errors in real-time, giving them the ability to have a more proactive customer support model.

The Health Monitor would run periodically throughout the day, giving the lab relevant status updates early and often. The option for a manual run of the Health Monitor is available as well, giving the lab a constant ability to see the most recent status of their models. The observed success of initial deployment and subsequent monitoring allows the LDCs to operate reliably. It reduces the chances of financial penalties resulting from the storage of excess gas or premiums from the need to purchase reserves, translating savings to both industrial and residential customers.

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PROJECTS

2017-18

Room Sensor Network

Project Team:

Adam Kobiela
Brian Stumph
Kevin Banky
Kevyn Schwab
Sunny Patel
Vincent Zornow

Sponsor:

Eric Plate and Jonathan Bradley,
Kohler Company

Faculty Advisor:

Dr. Thomas Schwarz and Dr. Chandana
Tamma, Marquette University



Homeowners often face an issue of not being able to know what is occurring in their household while they are away. These issues may include whether the faucet was left running, a fire is detected, or an appliance being left on. The outcome for this project is to provide the user with the ability to know when a fire is detected, an appliance is left on, or a faucet is left running remotely from an android application.

The team was able to detect fire in the bathroom or kitchen with the use of the particulate and Temp/Humidity sensor remotely from android app; however, they were not able to detect whether an appliance or the faucet was left running before the timeline. This was largely due to not being able to get useable data from the microphone and processing the audio received.

PROJECTS

2017-18

System for Water-Usage Data Synthesis

Project Team:

Thomas Hicks
James Markvart
Alex Dawson
Matthew Mogenson
Rene Mercado

Sponsor:

Eric Plate and Jonathan Bradley,
Kohler Company

Faculty Advisor:

Dr. Debbie Perouli and Dr. Thomas
Schwarz, Marquette University



The team designed a system for synthesizing water usage data as determined by the output of an ultrasonic flow meter. Through accessing the webpage, a user can view their personal water usage data up to the minute. With a moderate upgrade to the flow meter used, the team believes that their product can grow to be very successful in the future.

The average consumer generally has very little insight into the finer details of their monthly water bill. Short of installing an in-line flow meter and checking every so often to view the total volume consumed up to that date, the customer cannot easily view their overall water use habits. The purpose of this project was to explore new technologies for sensing water flow, and to create a proof-of-concept system to collect water usage data in a home over time, and display that information to the customer via some website or application.

PROJECTS

2017-18

Fighting Malaria One Smelly Sock at a Time

Project Team:

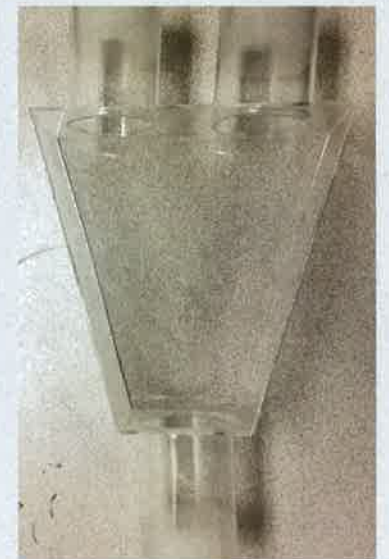
Brett Van Rossum
Cole Blazer
Colin Quinn
Damen McKay
Douglas Whitney
Jake Miller

Sponsor:

Ifakara Health Institute

Faculty Advisor:

Dr. George Corliss, Marquette University



The goal was to design a semi-autonomous olfactometer to be used in IHI's Smelly Sock Project. The goal of designing a new olfactometer system is to make it easier to conduct IHI's daily malaria research, increase the public engagement of the institute through the Smelly Sock Website, as well as to ultimately combat the spread of Malaria in Tanzania. In 2016, 91 countries throughout the world reported cases of malaria transmission. In these countries, an estimated 216 million cases of malaria were found, resulting in the death of 445,000 human beings. This number is an increase of about 5 million cases over 2015. The team was trying to help reduce this problem not by vaccine or cure, but by creating an effective measurement-sensor system in an

olfactometer so we can track and count mosquitos as they are attracted to different stimulants. The system used at IHI uses an olfactometer that manually counts mosquitos. The olfactometer developed by the team has sensors that automatically count and record the mosquitos. This will improve reliability and accuracy of results. The olfactometer system meets all product specifications and performance requirements except for one: The testing of live mosquitos within the system. Due to the lack of mosquitos, there has been no testing of mosquito response rates to different olfactory stimuli and tracking their position throughout the machine. However, with that being stated, the team has made promising progress by mimicking mosquitos passing though the olfactometer system.

PROJECTS

2017-18

Device to Supply Household Power from a Battery

Project Team:

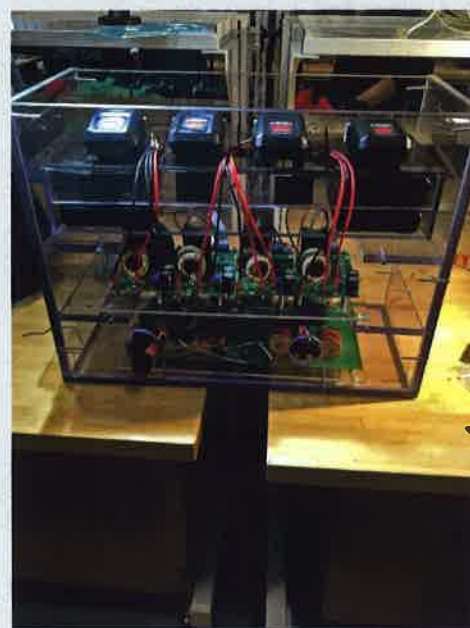
Dingwei Wang
Jeff Josse
Justin Lizalek
Kyle Haberkorn
Luke Haberkorn
Matthew Deroeck

Sponsor:

Briggs and Stratton

Faculty Advisor:

Dr. Nathan Weise and Dr. Chandana
Tamma, Marquette University



It can boost the DC battery voltage up to 200V, and then produce standard AC output that can be used by most household appliances. In addition, our device will charge the batteries when the grid power is available. This feature is utilized by a manual switch which will consume grid power in order to charge up to four batteries. The final product can still be improved on the future. The team designed a prototype for the enclosure. The team also provided recommendations for further research on material-type selection and cost reduction.

When power outages occur, home generators are currently the most popular solution. However, generators consume a lot of gasoline. These generators are not only heavy to carry, but also waste a lot of resources during use. Another way to provide portable power to users are "power banks;" however, they have very limited capacity and can only generate DC output, which is not usable as household power supply. The purpose of this project is to make a portable device that can provide 120V standard AC power from 12V or 82V batteries when grid power is unavailable.

PROJECTS

2017-18

SolarDash: Android Dashboard for a Solar Car

Project Team:

Kathleen Baert
Alexander Luczak
Jeremy Cook

Sponsor and Faculty Advisor:

Dr. Cris Ababei, Marquette
University



The goal of this project was developing a scalable dashboard to wirelessly retrieve and send information about critical components of a solar car prototype. This dashboard will be displayed on a smartphone or tablet to show the user important data about the performance of the car. The ultimate goal of the larger project is to implement a fully-operational one-person solar car to participate in solar car races, such as the American Solar Car Challenge.

The general idea is that as long as the on-board car processors send information in a format the app is expecting, the app will get the data to the correct places to be meaningful for the user. The app is also extensively documented, so further years can understand how the logic of it works to further develop additional functionality as required.

PROJECTS

2017-18

Enhancing Parallel Processing Using GPU Clusters

Project Team:
Chandan Matta
Liam Jonas
Matt Kinzler
Timothy Buente

Sponsor:
Michael Bachmann

Faculty Advisor:
Dr. Satish Puri, Marquette University



Dynamic Field Theory (DFT) is an emerging simulation tool used to model behaviour that functions similar to the human brain. The systems employed emulate neural operations and groups of neurons which can do anything from input, processing, and output of data to be used. This makes DFT an important tool for the future of robotic operation. The problem at this point is that current processor power is not high enough to support the calculations required by multi-dimensional field differentials which all have distinct interactions on one another. Research, therefore, using DFT is quite stunted, and in an effort to alleviate this slow down our project has been to enable offloading of tasks to external hardware for faster execution. The project was successful in proving that GPU parallelization with this

technology is possible. However, they were able to prove that GPU parallelization with this technology is possible. The problem with parallelization however is it requires a large amount of resources, including manhours, experience, and hardware. The applications of this technology are endless when it comes to looking forward at the future. Right now, DFT is mostly used by researchers in the field of robotic control, but there have also been some successful experiments with modeling PTSD, and other serious mental conditions. Therefore this product will mostly be used as a research and as it is an open source tool licensed using the GNU Lesser General Public License which means that any software which includes this product or updated versions of this software must be made available for free.

TESTIMONIALS

2017-18

from Industry Partners



The Kohler Team had the opportunity to chat on a bi-weekly bases with the Marquette Teams. These conversations were collaborative and surprised the Kohler Team with the amount of learning the Marquette Teams were able to share above and beyond the scope of the project. Conversations around the process the teams were using to attack the project provided insight to our own processes."

Jonathan Bradley, Kohler Company



As an employer, working with students on their Senior Design project is a rewarding experience. The students develop a solution for a real-world business or engineering problem that you bring to them. They get useful project-based experience, and the employer gets to see development progress on something that is important to their business."

Kent Newbury, Direct Supply



TESTIMONIALS

2017-18

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 that 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 experience. 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



TESTIMONIALS

2017-18

from students



Our senior design was focused on utilizing a single apparatus to preform the function of a number of power converters, specifically DC-DC, DC-AC, AC-DC, and AC-AC converters. Through this project, we gained experience in power electronics, control systems, and PCB layout, design, and manufacture. Although this was a single project, we were fortunate enough to gain invaluable experience relating to design and build work that our team experiences on a daily basis in our post graduation careers."

Luke Haberkorn



Working on my senior design project was a great opportunity to collaborate with industry sponsors and learn about the many different aspects of product design. Through working with fellow engineering students, I gained a greater insight into the different disciplines and strengths that each individual can bring to a team. By the end of the project I felt much more confident in my engineering capabilities."

Brian Stumph

