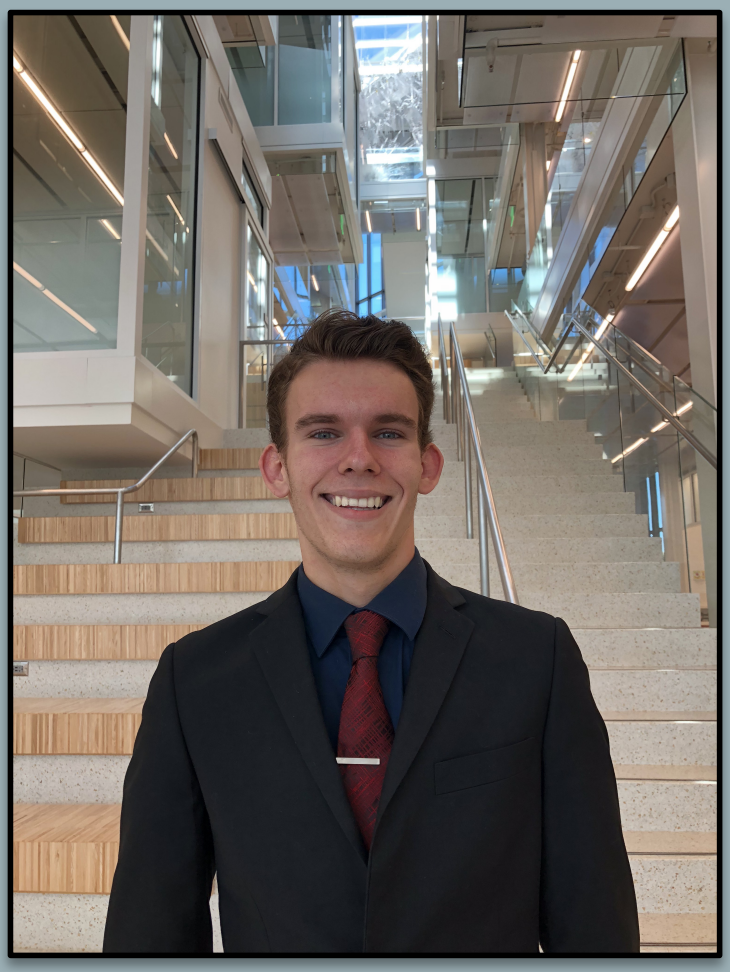

Anthony Tugman
Engineering Portfolio
atugman@iu.edu

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Introduction

My name is Anthony Tugman and I am an Intelligent Systems Engineering Student at Indiana University Bloomington. With a concentration in Cyber Physical Systems, my interests revolve around prototyping, hardware design, sensor integration, wearable devices, and The Internet of Things. This portfolio serves to supplement my resume, and provide greater insight into the projects I have worked on.

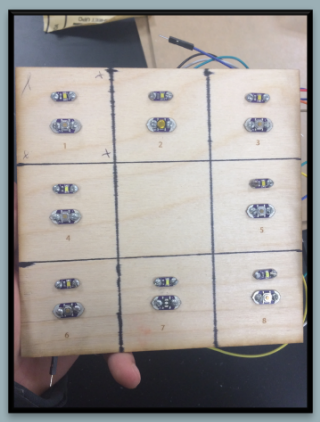
About Me

As cliché as it sounds, I have been obsessed with designing, building, and learning how things work since I was a kid. Whether it was retrofitting an electric scooter with a gas engine, creating a solar powered tricycle from scratch, or simply tearing apart an old VCR, my curiosity could not be stopped. After taking my first programming class in high school, I was hooked. I wanted the best of both worlds, designing physical objects intertwined with powerful technology; practically the definition of Cyber Physical Systems. Using Cyber Physical Systems I realize the endless applications that can be developed to advance health, efficiency, and safety in all aspects of society. Ultimately I hope to make a career as an Engineer on the leading edge of these technologies.

Alarm Mat

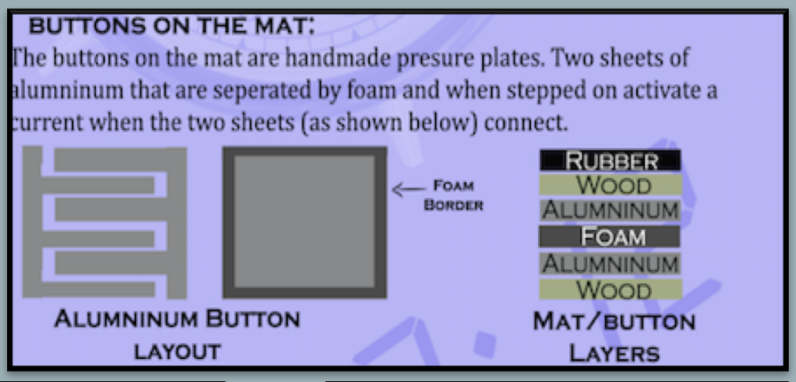
August 2016 - December 2016
Project Manager

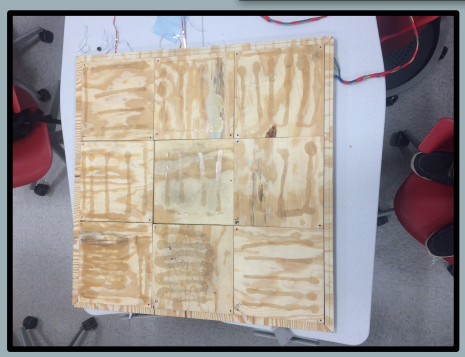
For *ENGR-E 101: Innovation and Design,* I lead a team of three undergraduate students tasked with creating a device to "improve peoples' lives using technology". It was decided that we would create an Alarm Mat, a device that incorporated mental and physical activity with an alarm clock to make the user get out of bed to stop the alarm rather than just hitting snooze and missing their meeting. Over the course of approximately 10 weeks, we went from prototype to a fully functional device that we presented at the Indiana University Fall 2016 research symposium.



The prototyping phase was used for proof of concept. Together we created a system where, when the alarm goes off, the user would have to stand on a Dance Dance Revolution style platform, and then step on the tile number corresponding to the number of beeps the alarm made. When beta testing our prototype, I realized there was a flaw. The "beep pattern" was the same each time and with extended use could become muscle memory. This would not effectively wake the user up. The beeps were made random for the final design.

Along with leading the team and keeping us on schedule, I was tasked with constructing the final device. I ran into the problem of needing a way to sense that the user was standing on the proper button without using expensive pressure sensors. An explanation of my resolution is shown to the right.

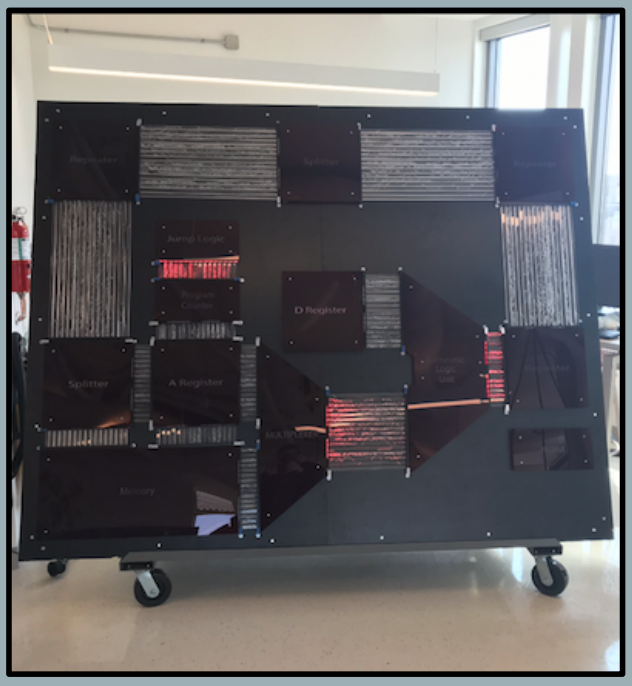




After countless hours of trial and error, and beta testing with users of different body types, I determined how to get the buttons to be the right sensitivity (shown above left). The clock enclosure (above right) was 3D printed and stores our Arduino microcontroller as well as the real time clock chip. At the research symposium many users said they could see themselves using the device.

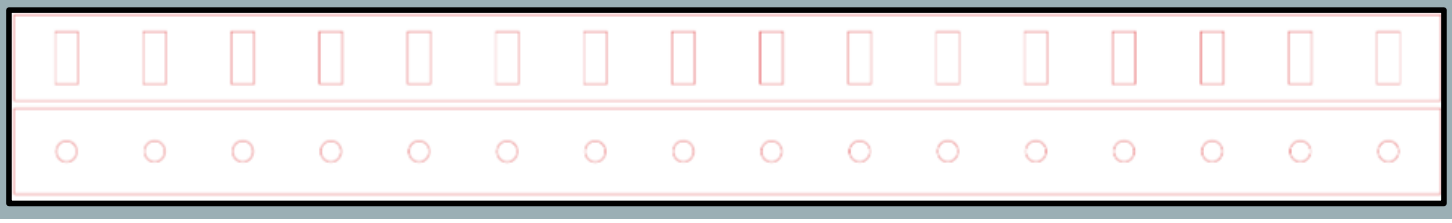
IU Light

January 2017 - May 2017



For *ENGR-E 110: Computer Architectures,* our class was tasked with creating a larger than life demonstration of a CPU. While each group had specific tasks including sourcing materials, logic design, and programming, my group was responsible for finding a way for the elements of the CPU to communicate in a visually appealing way.

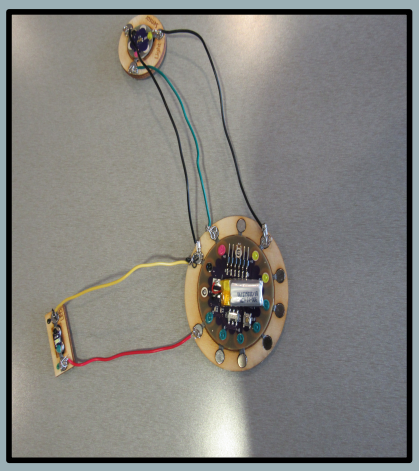
During the prototyping phase we determined that using LED strips with light sensors would be the best way for the elements to communicate with each other while being visually appealing to the viewer. We also determined that acrylic would be the best medium to transfer the light through. I was responsible for making a variety of test cuts on the acrylic, using a laser cutter, to check if length, thickness, and angled cuts would make a difference in the reliability of the light sensor reading and the amount of light bleed. Also, working with another group member, I helped to design the housing for the LED strips and light sensors. The laser cutter design file is shown below. In this housing the acrylic bar is "sandwiched" on each side by the top element. The light sensors are placed into the bottom element.



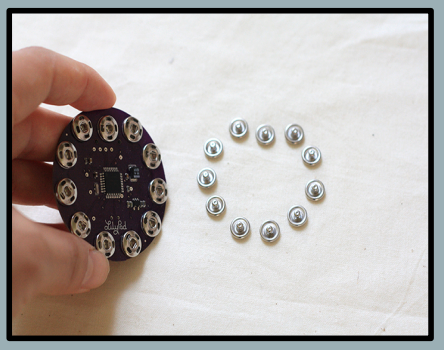
Improving Maker Technology for Older Adults

August 2017 - December 2017
Undergraduate Researcher

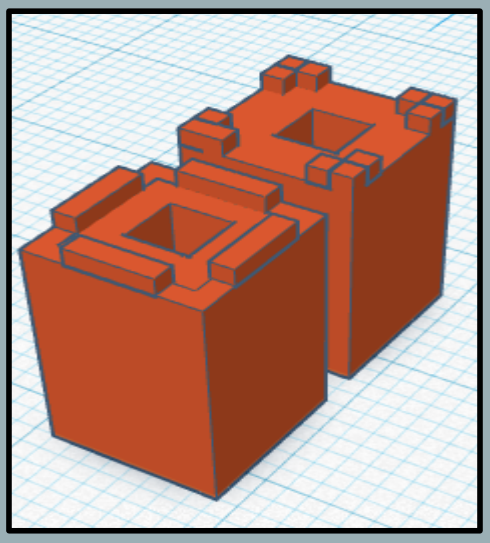
Desiring to do research outside of my coursework, I joined a team of National Science Foundation sponsored Indiana University Pro Health researchers. These researchers were developing a "toolkit" for elderly adults to use to learn simple circuits and adapt devices they created into their crafting projects. At my time of joining, the toolkit had been developed and user tested however, there were some design flaws. My goal was to resolve these flaws over the course of the semester.



The original toolkit, shown at left, used magnets to form circuit connections. During user studies, the magnets proved to be simple to use, intuitive, and provide a secure connection. However, many of the users were inadvertently creating short circuits, since they were learning the concepts for the first time. This caused the magnets to lose their strength after being connected incorrectly for even just a few seconds. Also, this connection method required excellent coordination, something which many of the elderly users did not possess. After familiarizing myself with the toolkit, I set off to design a solution.



After first considering using jewelry snaps, shown at right, I decided that they were far too small and would not provide an enjoyable experience for the elderly adults. Using 3D printed connecters seemed like a much more viable option. Using CAD software I went through multiple iterations of the connector before I arrived at my final design, shown below.



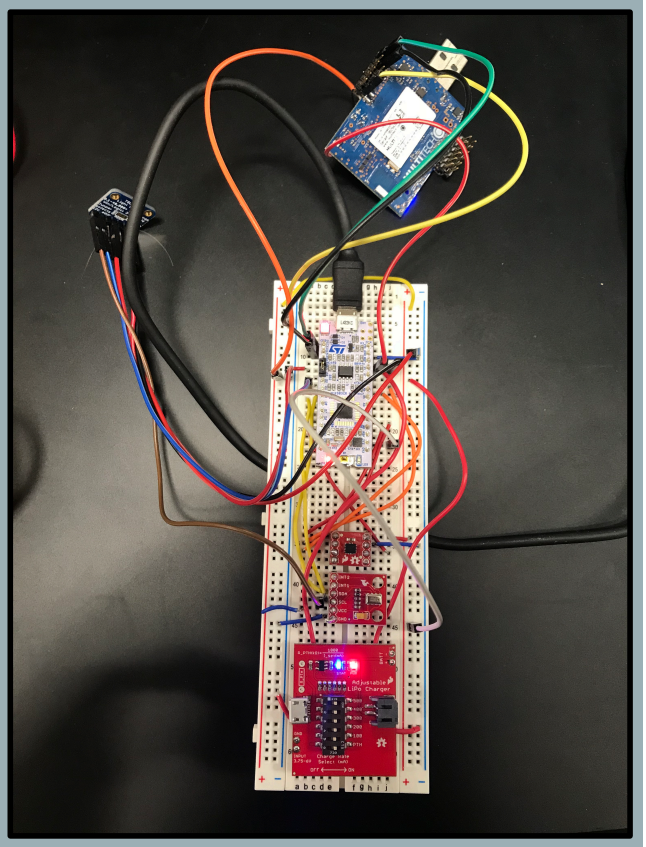
My design solved both flaws of the previous toolkit. It was large enough to grasp easily, allowing those with poor coordination to use the connectors with ease. Also, because of the notches on the top of each connecter, they can only fit together one way, preventing short circuits. My research mentor was impressed with the design and it was incorporated into the next user study. When I ran into my research mentor in Summer 2018, he said they were still moving forward with the design.

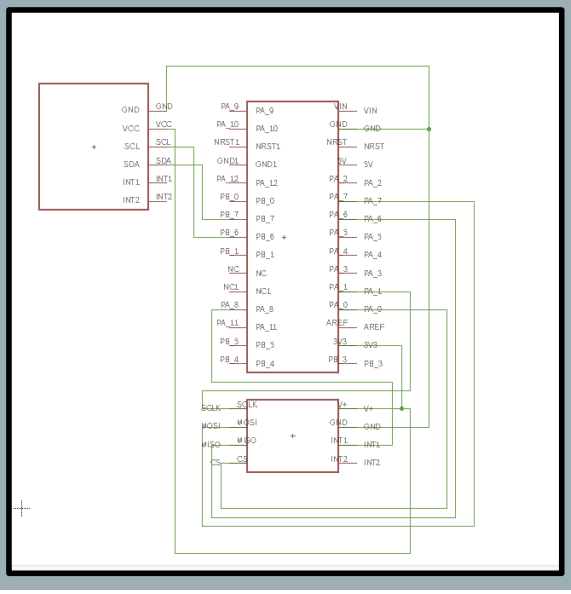
Light Monitoring System for Indiana DNR

January 2018 – May 2018
Embedded Systems Developer

For *ENGR-E 210: Engineering Cyber Physical Systems,* the semester project was to create an embedded system that the Indiana Department of Natural Resources could use to measure trail activity and light pollution within the state forests. This system needed to be low power, have wireless communication, and require minimal maintenance once deployed. With the help of my partner we were able to prototype such a system.

For this project, I was personally responsible for wiring all sensor elements, analyzing the sensor communication protocols using an oscilloscope to debug the code, and checking that sensors were in range for power consumption per their data sheets. A major constraint for this device was the size of the LiPo battery. The device is meant to be deployed into the forest for months at a time, without needing the battery changed. Our design caused the device to wake up once per hour to take a light measurement recording and then sent the data to the base station once per day. For trail counting, the device is in a low power sleep until it recognizes vibrations similar to a human walking, only then does it go to full power to record the passing traffic.



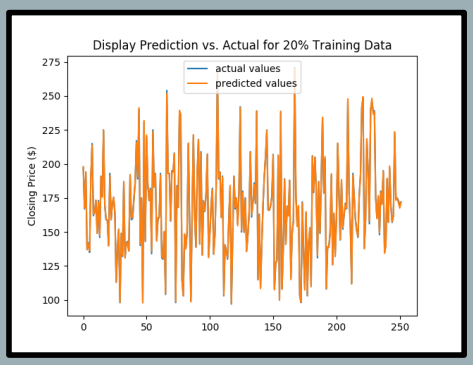


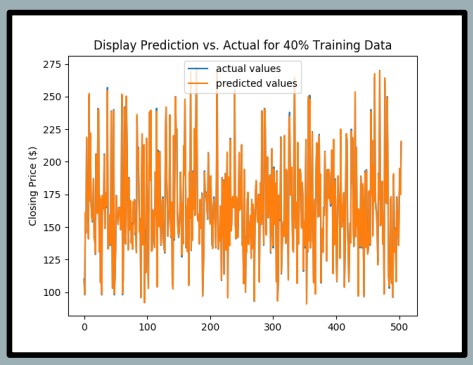
This device consists of Nucleo microcontroller, a pressure sensor, a light sensor, a LiPo battery charger, and a LoRa radio module. A partial Eagle schematic I created is shown at right. Learning Eagle was valuable to me, as I am interested in hardware design and plan to use these skills in the future. I also learned much more on the complexity of PCBs and now realize that there are many more things going on in the inner layers than you can see from the surface.

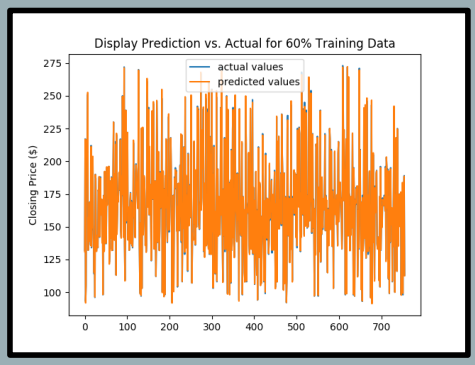
Predicting Stock Prices With Machine Learning

March 2018 – May 2018

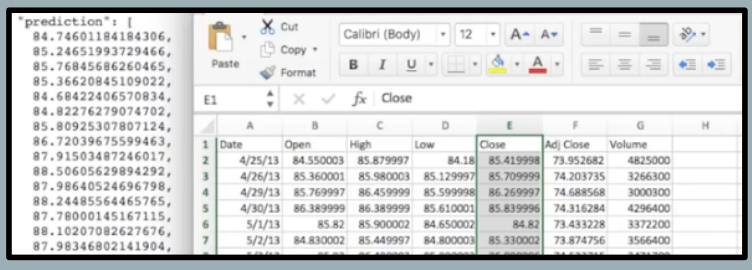
For *ENGR-E 222: Intelligent Systems 2,* I was tasked with creating a python program that used aspects of machine learning, creating a Flask API to display the results of the data analysis, and launching this API using Docker. I decided to create a program that would attempt to predict the closing prices of stocks for freight companies such as FEDEX, UPS, YELLOW, and J.B. HUNT. I made this decision based on the fact that 5 years worth of data was readily available for these companies, which would make a good training set, and because freight companies typically have steady, linear trends. Using *scikit-learn* and *pandas* the data is imported and separated into different ratios of testing and training data. Each time a new data set is uploaded, the model becomes more accurate. The program checks each ratio, and chooses the one that is most accurate. Example output is below.







Creating the Flask API was an entirely new experience for me. After hours of trial and error, I was able to generate a basic webpage for the user to check the data outputs as well as the predictions. This ran through a container on Docker, so I also created the Docker file, requirements file, and the make file. By doing so, the user simply has to upload their training data into the proper folder and then type “make run”. All of the background work is done for them, and when their Docker container is ready, a link will be generated for them to view their results. I value this experience because I developed a basic understanding of deploying applications to the cloud as well as machine learning techniques using Python.



Example predictions compared to actual closing values.

InLocus REU

May 2018 – August 2018

Undergraduate Researcher

As a summer REU student I joined a group of university researchers working with autonomous drones to establish communication networks for firefighters fighting wildfires. As part of my research, I wrote Python scripts to explore using LoRa radio modules for data transfer.

On board sensors check for a variety of conditions that are important to those fighting the fire on the ground. Through my exploration of edge computing I came to the understanding that edge computing can reduce server load and power consumption, by only transmitting data when significant changes have been met that requires the data to be transmitted to the firefighters.

An example of this would be having one hundred temperature sensors in a warehouse that check temperature every five minutes. Rather than using valuable server capacity to send 100 identical data points, with edge computing we would find any outliers calculated at the microcontroller powering the sensor. These data values would be the only ones sent to the server. Essentially this increases efficiency by only using the server for necessary calculations. This is important when trying to operate a system such as InLocus where server capacity is at a premium.

Anthony Tugman

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EDUCATION

Indiana University, Bloomington, IN — May 2021
M.S in Intelligent Systems Engineering

Indiana University, Bloomington, IN — May 2020
B.S in Intelligent Systems Engineering *– Concentration in Cyber-Physical Systems*
Minors in Mathematics, Small Business Management – Cumulative GPA: 3.36/4.0

PROJECTS

InLocus REU, Bloomington, IN — May 2018-August 2018
Undergraduate Researcher

- Integrated LoRa communication using Python scripts to transfer data from autonomous drones.
- Explored edge computing techniques to reduce power consumption and server load.

Light Monitoring System for Indiana State Parks, Bloomington, IN — January 2018-May 2018
Embedded Systems Developer

- Prototyped an embedded system and checked performance using oscilloscopes and multimeters.
- Designed an efficient PCB layout integrating the system microcontroller and sensors using Autodesk EAGLE and adapted a weatherproof device enclosure to dimension using Fusion 360.

Improving Maker Technology For Older Adults, Bloomington, IN — August 2017-December 2017
Undergraduate Researcher

- Fabricated 3D printed circuit connectors allowing those with impaired coordination to use the device. Documented my design so that researchers may incorporate it in future research.

Alarm Mat, Bloomington, IN — August 2016-December 2016
Project Manager

- Lead a team of three undergrads to create the device using laser cutting, 3D printing, and Arduino.
- Used the design process to bring the device from an idea on paper to fully functional.

TECHNICAL SKILLS

- **Languages:** Python, Verilog, Arduino C, C, C++, Java
- **Platforms:** Linux, MacOS, Windows
- **Other:** 3D Printing, Laser Cutting, Git, Fusion 360, Autodesk EAGLE, Adobe Illustrator

EXPERIENCE

Teach IT Internship, Bloomington, IN — January 2018-May 2018
Student Intern

- Developed personalized tutorials for adults in the community to improve their technology skills.

LEADERSHIP

INgineering Club, Bloomington, IN — September 2017-May 2018
Outreach Director

- Executed methods for increasing club membership, successfully recruiting 20 members.

Banneker Community Outreach, Bloomington Indiana — September 2016-January 2017
Student Mentor

- Mentored underprivileged students, providing resources for them to meet academic goals.