Senior Design Projects – Fall 2019

OU Immersive VR Experience

A group of faculty and students from across campus (Art/Art History, SECS, others), supported by industry partners Rave Computers, MackeVision, Nabtesco Motion Control, Autoliv and Roush Entertainment have committed to design and build a two-seat mechanical motion-controlled platform that will interface with visual triggers supplied by an interactive movie, creating a VR immersive experience. This platform is to be a portable, flexible test bed for a VR experience that will be a proof of concept for the Dodge Museum when it opens at the OU campus in the next few years.

During the Fall 2018 and Winter 2019 semesters, teams of ECE and ME seniors designed the actuator base using input from Nabtesco and Roush engineers. As a proof of concept, they produced two small-scale models and implemented rudimentary control system based on the Robotic Operation System (ROS).

Construction of an Actuator Base for the OU Immersive VR Experience
In the Fall 2019 semester, teams of ME and ECE students, consulting with industry partners, will thoroughly review the present design, make changes where necessary, and construct and test the resulting system.

Mesh Electronics: A Neural Electrode with Chronic Implant Applications

Mesh electronics is a novel electrode architecture that was pioneered by Charles M. Lieber et. al to advance the state of neural prosthetics for recording and stimulating the action potentials in neurons. The design and MEMS fabrication steps have been published by the Lieber group, and their results from in vivo mice experiments have validated their hypothesis. This is groundbreaking research as recording multiple individual neurons over long periods of time will help humankind's understanding of neurodegenerative diseases, mental illnesses, and stimulating these neurons could lead to cures for paralysis and much more.

Following this work, the proposed senior design project is to fabricate said mesh at Lurie Nanofabrication Facility in Ann Arbor, MI. The success criteria would include a (1) fully conductive circuit with appropriate impedances for reading 100mV spikes, a processing system capable of (2) detecting and (3) sending these artificial spikes, and (4) connecting the electrode to the system using flexible flat cables (FFC) and carbon nanotube conductive ink. The next step thereafter would be to record real neuron action potential spikes ex vivo using mice retinas provided by Dr. Zhang in the Eye Research Institute at Oakland University.

Special Resources
The fabrication of materials and training will be provided by and done at LNF. The quality inspection can be performed using microscopes in Dr. Qu's laboratory. The software (Cadence) used to develop the fabrication process will be provided by Dr. Qu.

Design Challenges
Learning how to do MEMS fabrication at LNF. LNF does not support two photolithographic processes laid forth by the Lieber group, and they will have to be substituted. The computational architecture will need to be determined and developed.

Deliverables

1. Completion of MEMS design and fabrication steps
2. Completed training at LNF
3. Electrical testing results of fabrication
4. I/O interfacing with PCB

Auto-Injector (OU School of Nursing)

In the Summer 2019 semester, a team of ME students, working under the direction of faculty from the OU School of Nursing, developed a prototype of an auto-injector - a device that would allow nurses to prepare a syringe full of medication, load this medication, and administer it in a manner similar to an Epi-pen. Currently, there is no such device on the market that allows for loading on demand. All auto-injectors come with a predetermined medication and dose. The ability to use auto-injector delivery would be a desirable delivery method in environments like ER and psychiatric settings, where nurses and staff may need to give medications to combative patients, and the risk for needle stick injury is high.

The goal of the project is to develop a device that would handle an intramuscular injection, have a high level of sharp stability, can accommodate a large gauge needle and the ability to hold both 1ml and 3ml syringes such as those commonly in use at hospitals. The ability to use as many existing supplies as possible is desirable. Additionally, transparency in the body of the device would be highly desirable as all medications must be labeled in the hospital. The major aim of this device would be to essentially provide the ability to take a syringe of medication and deliver it through an auto-injector as needed, allowing a nurse to draw up the exact dose needed for the patient and administer it safely. Major considerations include infection control, cost and safety.

The prototype produced in the Summer 2019 semester hit most, but not all, of these goals. The project in the Fall 2019 semester will take the work started in the Summer and improve the safety, reliability and costs of this novel medication delivery system.

Non-disclosure and assignment agreements are required before students can commence work on this project.

Harvesting the Motion of Water Waves – Linear Wave Generator

Beginning in the Winter 2019 semester, we began to explore the idea of generating electricity using an array of small floats, each containing a linear generator capable of producing approximately 1-2 W. If an array of these units were connected, larger amounts of electricity could be generated and stored. One example would be enabling the electronic instrumentation on the Great Lakes buoys to obtain their own energy from the surrounding environment. These buoys collect real-time data for wind, waves, water temperature, etc. for both research and recreational information. In order to operate all the equipment on one buoy, about 50 W of power is required.

The goal of this project is to design, construct, test and demonstrate an effective yet inexpensive linear generator, tuned to efficiently generate power from an input motion of 10-12 cycles/min, and develop a system to connect several such generators in order to continuously charge a 12 V battery.

This project has been examined in previous semesters, with some success. More work remains, including:

- Brainstorming innovative ways to increase the amount of power generated (e.g. increasing the frequency of the magnet movement or perhaps utilizing both the rocking motion and up down motion of the waves concurrently)
- Optimizing the magnet size and air gap between the stator and the coils, reducing mechanical losses due to overall design configuration, and maximizing the efficiency of converting the energy from AC to DC
- Develop and demonstrate a strategy to manage the power developed from an array of small floats, with the purpose of generating at least 50 W of electrical power in order to charge a 12V battery
- Design and build a test fixture that simulates wave motion in order to validate the design of the wave power generator. Such a test fixture was started in the Summer 2019 semester, but the design needs modifications to make it more robust.
- Using common materials, build and demonstrate a prototype linear generator tuned to typical wave frequency that can be commercially produced.

Lightening Health LED therapeutic device

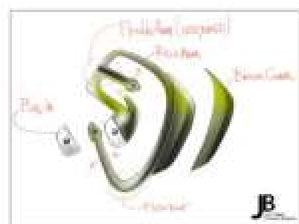
The Lightening Health LED therapeutic device is a novel “wearable” that integrates contact light therapy (via LED) to help treat both chronic and acute behavioral management concerns and other therapeutic applications.

This project is to design and build a low-fidelity prototype of the Lightening Health LED therapeutic device. This prototype will help validate the initial design with regard to its primary use case to deliver low-level, sustained LED light application to specific stimulation points in the ear, which will yield therapeutic benefits for desired treatment objectives (as designed, for appetite suppression, smoking cessation, anxiety management, et al.) The system design includes battery-powered, programmable multi-position LEDs with auditory feedback, with Bluetooth connectivity.

Concept Approach:
Wearable device that delivers specific, timed programmed intensity application of red LED to predetermined stimulus points on the outer and inner ear. Design will allow proper placement of LEDs (1-fixed on "bud", 2-on flexible arms) for a variety of ear shapes and sizes. Design may deliver auditory cues or feedback when operating in position and allow "pass-through" audio via Bluetooth.

Concept Target Features & Specifications (All features/specs to be confirmed by sponsor at project kickoff).

- Battery powered (rechargeable/USB)
- 1-fixed point LED on "bud" (position TBD)
- 2-flexible/semi-rigid LED arms
- Bluetooth connectivity (voice/audio)
- Power on/off button
- Volume +/- control
- PCB/microprocessor
- 3-LEDs (660nm)
- Variable duty cycle (TBD)
- Power output 4 Joule per LED
- Options: interchangeable "bud" w/alt. LED



Non-disclosure and assignment agreements are required before students can commence work on this project.

Leader Dogs for the Blind - Veterinary Surgical Tables

In the Winter 2015 semester, several senior design groups collaborated to produce two novel veterinary surgical tables for the Leader Dogs for the Blind. These tables were designed and produced in consultation with LDB veterinarians to meet their specific needs, most notably the ability to lift and tilt the dogs during surgical procedures. The project was a great success and the surgical tables have been in constant use since April 2015.

The LDB is branching out to new applications involving trained dogs and they need two more surgical tables. There are several enhancements to the table design they would like, namely

- Rust proof metal, or durable rust-resistant paint. The powder coating on the original tables has areas of rusting with no obvious trauma such as scratches or dings
- No caulked seams, which has made cleaning much harder, primarily at edges of where plastic top meets the table structure.
- Could be 2 inches lower to start, movement height would still be good
- Non-rusting hardware, some of the nuts and some of the wheel hardware is rusting

This design group will review the work from Winter 2015, make changes and updates as necessary to accommodate the needs of the LDB veterinarians and construct, test and deliver two surgical tables.

Non-disclosure and assignment agreements are required before students can commence work on this project.

GKN - Open Differential Screening Tester V2.0

In 2017 a senior design group working with engineers from GKN designed and constructed a fixture to screen small differential gearboxes. The purpose of the screening was to identify vibration issues as the drive train was being assembled, helping to eliminate costly service and warranty issues. The mechanical portion was mostly completed but the motor drive and data acquisition aspects of the projects were not.

This project will continue the work from 2017:

- GKN to supply Motor Driver and Battery Pack
- GKN to loan data acquisition system to support project
- Mechanical
    - Design/build anti-rotation mechanism
    - Optimization of speed encoder transducer to reduce jitter
- Electrical / Controls
    - BDC Motor Driver Integration
    - BDC Motor Controls
- Computer
    - Data Acquisition
    - Signal Analysis

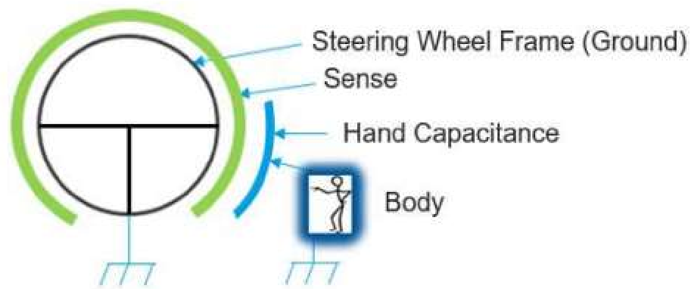
2019 Primary Deliverables: Initial results from test rig including hime histories (1000 Hz) of accelerometer and motor speed data for 4 provided DUTs.

Non-disclosure and assignment agreements are required before students can commence work on this project.

Autoliv – Steering Wheel Capacitive Sensor

Highly automated driving will become mainstream in the automotive industry. One of the big challenges is the control handover between vehicle and human. It is critical for the vehicle to know if the human is holding the steering wheel or not.

Many OEMs rely on a steering rack torque sensor to determine when the driver is holding the steering wheel. However, torque systems are capable to be "tricked" by hanging bottles of water on the steering wheel and thus do not provide enough statistical reliability. Therefore, Autoliv has integrated a capacitive hand sensing system into production steering wheels to compliment the vehicle torque sensing system to achieve the necessary reliability.



For this senior design project, Autoliv will provide current production steering wheels with a capacitive sensor mat installed as well as capacitive sensor mats by themselves for technical investigation. The objective would be for the students to create a proof-of-concept ECU (Electronic Control Unit, can be mocked up using bread boards and a software like Labview) design that can distinguish a human touch of two fingers or more, and take additional data to demonstrate the effect of one hand, two hands, etc.

The students would start by researching and determining findings on the basic capacitive principles of the system, design an ECU with an integrated detection method according to the principles, and take data to demonstrate the performance of their design.

Non-disclosure and assignment agreements are required before students can commence work on this project.

Mechanical Clock

Design, simulate and plan for the construction of a weight or spring driven, purely mechanical clock.

- The clock must run for a minimum of 26 hours between windings
- Clock must be conveniently adjustable to within 10 seconds per week
- Must be able to wind the clock without disturbing its function
- Must clearly display both hours and minutes
- Plan for construction using 3D printed parts and involute gear forms
- Added complication – incorporate a striking mechanism that will chime both hours and quarter hours.