Senior Design Projects, Winter 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 and Nabtesco Motion Control, has 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 219 semester, a large team of ECE and ME seniors designed the actuator base using input from Nabtesco engineers. As a proof of concept, they also produced a small-scale model and implemented rudimentary control system based on the Robotic Operation System (ROS)

Construction of an Actuator Base for the OU Immersive VR Experience

There will be an engineering senior design group that will thoroughly review the design from last semester, attempt to identify motors and/or power sources that will allow the system to run on conventional 110 V power without significant loss of performance, and to construct/test the resulting system.

Initial Programming of an Actuator Base for the OU Immersive VR Experience

In parallel, a computer science group (with an ECE student or two) under the direction of Dr. Patel from CSE that will take the small-scale system developed last semester and incorporate the necessary software to take visual clues from a video (to be determined) and, using open-source ROS, appropriately move the small-scale system to sync with the video.

Reversing Audio Compression from Amplifiers

(This is an Honors College project, and we need 2-3 ECE students and perhaps 1 ME student to complete the design team)

This project explores compression in audio and electrical signals. Compression occurs when different elements of a signal are pushed toward a common level or strength, but compression is undesirable in extremes.

The aim is to create solutions to expand a compressed signal (that is, reverse the compression) and evaluate the advantages and disadvantages of each solution. Other

topics that may help accomplish this objective include the conversion of electrical energy into heat energy, re-amping, and modular versus integrated design.

This project will provide new knowledge on the behavior of compressed, expanded, and attenuated signals as well as how to manipulate those signals. In addition, the usefulness of the other related areas (re-amping, etc.) will be evaluated for possible use for signal compression/expansion. The result of these evaluations will be several circuits/systems that combat compression and other audio problems that may occur in settings such as a concert or studio recording.

Serapid Efficiency Study

This is a continuing project to develop a tool for determining efficiency of Serapid Rigid Chain products. In the past, hardware and mathematical models have been developed to analyze the efficiency of a LinkLift 80 system. The results are that the chain system is more efficient than had been previously estimated. Efficiency is highly dependent on the internal friction of the system. Serapid would like to continue the development of this tool.

- Optimize the mechanical design to minimize friction caused by guiding the load
- Evaluate several lubricants to determine effects on efficiency relative to an unlubricated condition, and to each other.
- Develop stand-alone software to:
    - Define test profile
    - Command test operations
    - Collect data, analyze, and return results.
- Design and build electrical control system modifications to receive commands from the test software.
- Create user documentation so that the system can be operated by others.

This test system is specific to the LinkLift system made available to the OU senior project teams. Final system should be adaptable to other configurations of the system so that its use can continue at Serapid.

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

Wave Water Works – Electrical Energy from Water Waves

A local company, Wave Water Works, has been working with SECS Senior Design students for several semesters to develop a viable system to generate electrical energy from water waves. The basis of the system is the Oscillo Drive, a patented mechanical transmission that takes an oscillatory rotary input and speeds it up while converting it to a uni-directional rotary output.

Based on the work that has been done, the purpose of this semester's project is to design, construct and test a complete small-scale electrical generation system consisting of

- A water float to capture and convert the motion of the water to a rotational motion and transfer it through
- a 3:1 Oscillo drive and flywheel, which in turn will drive
- a small (100 W) generator or universal motor, which will generate enough electricity to trickle charge a 12 V deep-cycle battery.

Each of these steps has been thoroughly explored in past semesters; it is now vital that these components undergo final assessment and be assembled and tested so the system can be prepared for production.

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

Pinch Ring CVT Modeling and Lubrication

(This is a fairly extensive, all ME project, and would be appropriate for at least one group of students, perhaps more depending on level of interest)

The PRCVT is a new proportional continuously variable transmission. Motion is transferred from an input conical disk to an offset output conical disk by an encircling Nesting Ring Assembly, which pinches the input and output conical disks at separate disk radii. The shift ratio is increased by moving the self-adjusting ring and its 4 fixed traction contact points in the direction opposite to the offset from input to output shaft centerlines. The contact points move outward on input disk as they move inward on the output disk, increasing the shift ratio.

In the Fall 2018 semester this transmission was modeled in Catia and Solidworks and initial analyses were conducted to determine the internal forces and stresses. In addition, several lubricants were evaluated for their traction and heat transfer properties.

The tasks to be carried out this semester include

- Characterization and evaluation of traction fluids
    - Characterize and find ideal traction fluid
    - Conduct simple friction coefficient testing at various temperatures
    - Compare results between fresh and aged samples
- Study of traction forces and stresses
    - Resolve and understand forces on Ring Assembly
    - Demonstrate motion at contact patch
    - Investigate axial offsets and impact on performance

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

Drive Me Safe (DMS) Docking Station

A unique phone docking station that will have:

Electronical components:

- Visual display:
  - Red light indicator, with a LED message to the driver when phone is undocked
  - Green light indicator, with a LED message to the driver when phone is docked
- Audio cue:
  - Beep noise, similar to a seatbelt sound when the phone is detected when driver enters the vehicle.

Mechanical components:

- The mount base should open and close similar to a CD tray or the holding area would flip up and down accordingly

Software interface:

- Driver can only use the GPS while driving, all other apps automatically disabled
- Must have emergency override just in case - liability concerns

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

P_2 H_2 Performance

Athletes around the world do everything they can to improve in their individual ability. Through rigorous training, blood, sweat, and tears, they push themselves to the limit of human capabilities. Athletes are constantly looking for anything that can be done to improve training exercises and give athletes a better understanding of how they stack up to their opponents and colleagues.

There is one large area that is seemingly missing an obvious improvement. That being the area of timing. In order to know how fast they are swimming, running, or climbing, an athlete must either rely on inaccurate human operated stop watches, or expensive and complex equipment that takes several minutes to relay the data.

As an alternative to these methods we propose a, relatively inexpensive, devise that will instantly and accurately relay how long it has taken for an athlete to travel a given distance. An unencumbering tether will be attached to the athlete, which will activate a

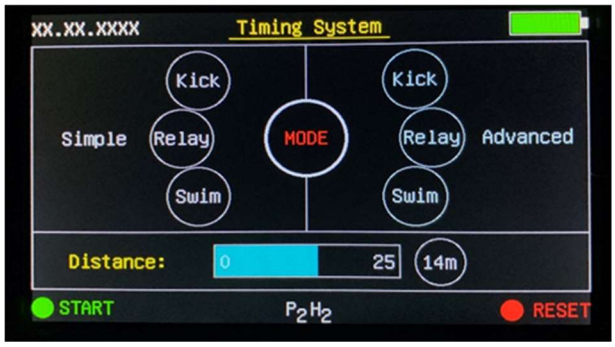
timer upon being pulled. The timer will stop after the athlete has reached a predetermined distance from the starting point. This will instantly and accurately tell the athlete how long it took them to travel that distance.

Whether it be a swimmer trying to improve their first fifteen meters off the block, a wide receiver running a forty-yard dash, or a rock climber racing to the top of a wall, this device will revolutionize how athletes train.

Electrical: Development of custom-made circuit boards, connecting electrical and mechanical components, circuit protection, calculations on how electrical resistance correlates to torque, new (better) ideas.

Computer: Datalogging, development of an app, creation of different user interfaces, “coding for various safety mechanisms”

Mechanical: Creation of a clutch mechanism, creation of a custom-made level-wind, creation of a custom-made spool, 3d-design and 3d-printing, fixing the “water problem”.



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No-Bend Shoe for Persons with Disabilities

No Bend Shoes by Jay Shah (Leelayan, Inc., patent pending)

People with disabilities who cannot bend or feel their feet have difficulties inserting their foot in to a shoe. Others when wearing a loafer style shoes, must bend down to either use shoe horn or a finger to get it right. Some (often young boys) would try and wiggle their foot in. Over time, this breaks down the shoe backing around the ankle and

destroys the shoes. People wearing boots have often difficulties inserting their feet as well.

In the summer 2018 semester a team of students developed a prototype of this concept. Based on the success of that prototype model, Mr. Shah was able to interest several shoe manufacturers and distributors. The purpose of this project is to make the system more robust, miniaturize the mechanical components and electrical circuits, install it in an actual shoe and test for functionality.

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

Harvesting the Motion of Water Waves

In our work with Wave Water Works, one difficulty that we have constantly had to deal with is the fact that the low-power water waves are also low speed, typically 10-30 rpm. This makes it very difficult to generate electricity with conventional generators. Mechanically speeding up the motion is counterproductive and very expensive in terms of the available power in the waves.

This project can be taken in one of two directions:

- Design, construct, test and demonstrate a low speed (10-30 rpm) rotary electrical generator capable of generating 100 W to continuously charge a 12 V battery.

- Explore the idea of generating a total of 100W of electricity using an array of small floats, each containing a linear generator. Design, construct, test and demonstrate an effective yet inexpensive linear generator, tuned to efficiently generate power at 10-12 cycles/min, and develop a system to connect several floats in order to continuously charge a 12 V battery.

LED Linear work light for task applications

(Mr. Rob Pope is deeply invested in industrial lighting and has done a lot of background work on this project. He is highly motivated to making the project successful.)

Goal: To create a luminaire that produces 2000 (or better) LUX at 1-meter distance, lighting a 2-meter square area, using 6000 K CCT LED's that are 90 CRI and positioned in a linear array on a circuit board that will create the least amount of heat possible. The circuit shall be designed to be placed directly onto the aluminum extrusion (heat sink) and will be capped at both ends as well as lensed. The unit will be used in industrial applications where vibration, ingress, voltage spikes, and related are present. The unit will be built to UL specifications. Physical heat of unit shall not exceed 90 F or

less. Package size is critical. Looking for the smallest package size that will accommodate the heat.

- Linkable (daisy chain) circuit allows us to build the fixture in 300, 600,900,1200,1500mm lengths
- Circuit shall be Constant current design for even distribution of light and higher efficiency
- Circuit shall be powered by a standard external switch mode type 24VDC power source (provided by our customer) and should allow for variance of voltage from that power source of 10%. If customer wants to use AC power then either have the circuit designed to accept 100 to 277 VAC OR, provide power pack in the form of “wall wart”.
- Circuit board shall be physically no more than 15mm wide and if we need to double up the LED’s or stagger them to accommodate the output goal then width of board with be determined together.
- Circuit should not draw more than .5amps per 300mm increment.
- LED’s should have some type of protection circuit as we intend to warranty for 5 years
- Life of product should exceed 80,000 hours continuous
- Circuit will be dimmable by a turn pot with a push on push off feature (holding the point of where the customer has set the brightness)
- ON / Off switch, dimmer and electrical connector will be located at the end cap that will consist of a “daughter board”. ON the daughter board will have the electrical connector, and the rotary on/off dimmer switch. Here is an example for the switch and connector:
- Switch Bourns 3310H-003-104L, on/off and dimmer (if you use PWM dimming then switch will have to be re-visited) If you offer alternate to this switch it is ok because this one in expensive.
- Connector M12-A code male receptacle IEC 4 amp rated.

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

Sucrose Density Gradient Microfractionator (A. Goldberg, ERI)

A current focus of biomedical research is to understand how particular proteins contribute to cell structure. A major goal within the Goldberg lab is to determine how a particular protein, peripherin-2/rds (P/rds), contributes to rod and cone photoreceptor cell structure. P/rds self-assembles into variously-sized polymers, and we are investigating how genetic defects affect this property (and eventually cause retinal disease). The primary test we use for assessing P/rds self-assembly is “sucrose density gradient velocity sedimentation”, a general technique for separating and characterizing biological macromolecules (including proteins).

This assay uses centrifugation to apply centripetal force to the macromolecule of interest, which causes it to sediment in a water-based solvent, with a rate proportional to its mass, density, size, and shape. Fractionation by sedimentation is most effective in solutions of continuously increasing density, and sucrose density gradients are commonly used for this purpose. A challenge for the overall process occurs once centrifugation is complete, and the liquid gradient (ca. 2 mls) must be collected. The aim is collect sequential aliquots of liquid along the entire density gradient, without mixing of the tube's contents (typically 11-15 fractions).

Our current method for fractionating sucrose density gradients is entirely manual. It includes puncturing the bottom of a thin-wall polycarbonate tube with a 22 ga syringe needle, then directing drops falling from the centrifuge tube into a series of collection tubes. We attempt to maintain an even flow rate by applying finger pressure over the centrifuge tube top. Once the bulk of the liquid has exited the centrifuge tube, finger pressure is used to help expel and collect any remaining liquid.

A simple mechanical device is envisioned that would aid tube puncture and of flow rate regulation, to reduce variability encountered during manual collections and expand the range of personnel able to perform this operation. The device would consist of a close-fitting sheath and sealing cap that would enclose the centrifuge tube, allowing access to the tube bottom for puncture and to the tube top for regulated air entry and pressurized liquid expulsion.

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

Shelby Lions Football Club Press Box

The Shelby Lions are looking to build a press box out of shipping containers that would also add storage for our club's needs. This project will need to be approved by both the City of Shelby Township and by the Shelby Township Parks and Recreation department by submitting completed blueprints of the project. A power source large enough to fulfill the needs of the press box will also be necessary. A general image of what we have in mind has been included.

Nextfeed ® Electronic Dog Scoop Caddy

The Nextfeed customer is a dog lover who is concerned with their pet's health. They are also someone who often forgets or doesn't realize if their dog was fed or not. There are many causes for underfeeding or overfeeding including (1) busy schedule, (2) multiple household members or (3) forgetfulness. The Nextfeed customer understands the health implications of an overweight pet and is motivated to take action.

The mechanical version of the Scoop Caddy has been developed and is on the market. It stores the feeding scoop and automatically advances a display to show the day and time of the next feeding.

The electronic version of the Scoop Caddy is the focus of this project. Its features are to include

- Storing the scoop
- Display of the next feeding (1x or 2x daily)
- Link feedings to phone app
- Calculates amount of food
- Next veterinarian appointment reminder
- Heartworm reminder
- Flea treatment reminder

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

Lightsaber Combat Robot

(This is an Honors College project, and we need several ECE and ME students to complete the design team)

The aim of this project is to create a robotic system that can attack and defend against a human opponent with an LED-lit polycarbonate rod using techniques associated with sword fighting. The system will be able to use visual input from a camera in order to observe the opponent's movements and react accordingly. Additionally, a supporting system by which a user can directly control the robot via a head-mounted display will be used in order to teach the robot how to move in response to an opponent. A recurrent neural network known as an LSTM will be used to decide how to react to the opponent.

What must be done in the course of this class is to modify and train the LSTM network, build a system incorporating a head-mounted display in order to assume control of the robot's movement, devise a way for the various sensors to mount to the robot, and design and build a new gripper attachment that allows the robot to hold the weapon. So far, I have started and almost completed the program that will be able to observe a human opponent and send the angles of their joints for processing. This program will likely be used both in the training and operation of the neural network, as well as the teleoperation component of the support system.

This project will need assistance in all fields of engineering, focusing strongly on coding with some mechanical and a few electrical elements. I anticipate this will be an intense and difficult task, but the result should be something fun and exciting. I welcome anyone who is prepared to work through the challenges of this project.