Senior Design Projects, Fall 2018

Development of an Actuator Base for the *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.

The current specifications for the actuator platform are few, but include

Mechanical

- Create a low-profile, portable, moving platform, perhaps similar to a Stewart platform
- Maximum levels of acceleration and movement are yet to be determined
- The entire platform must be portable, perhaps breaking into sections to fit through a standard 30” wide door
- The platform must be as low as possible for stability
- Kinematic design of the platform (linear vs. rotary actuators) must accommodate maximum workspace for motion
- Platform must have a top enclosure and safety rails/ guarding steps for protecting human interaction
- Must accommodate either VR goggles or monitors

Electrical

- Selection of motors, controllers, sensors, displays, power distribution and computer components
- Basic connection schematics and interfaces
- Electrical wiring design and layout

Computer

- Definition of computer controls and interfaces for the VR experience
- Programming software to control the experience (ROS?)

This will be a two-semester project. The first semester will develop a complete set of specifications (including a detailed budget) for the platform and build a small-scale, joystick-actuated working model to illustrate the computer control of the platform. The second semester will refine the design details if necessary, then build and test the platform.

Serapid - Efficiency of Rigid Chain Technology

SERAPID has been working with linear transfer equipment since 40 years. Advanced lift systems and linear actuators are defined by Serapid and designs with our rigid chain technology allows us to transfer loads from few kilograms to several tons.

The technology is based on the principle of a “rigid chain” that operates by deploying its links into an expanding bar under forward thrust. Each link has an extension, the so-called “shoulder”, which is form-fitting and force-locking with the shoulders of its neighboring links. Inside the drive housing, links are aligned exactly one after another by driving them through a guiding channel between two steel plates. The interlocking of the links makes the chain rigid and prevents bending.

Even though the technology has been proven through many successful projects, the fundamental efficiency of the rigid chain has yet to be demonstrated. To this end, the following multi-semester senior design project is proposed:

1. Project overview
   - Learning about Serapid products and applications (industry and theater activity)
   - Learning of boundary conditions and constraints impacting product efficiency.
   - Product that will be use for the project: LinkLift 30 and Chainlift 40
2. Technical study
   - Detailed functional analysis and modeling
   - Definition of the efficiency calculation on the product defined
   - Implementation of the calculations based on the model defined (ex: analytical or FEM)
   - Definition of the test protocols and equipment to validate the calculation (ex: current clamp on motor / torque wrench)
3. Technical validation
   - Implementation of the test with measurements record
   - Analysis and validation of the efficiencies with correlation of the experimental data
4. Additional features
   - Define the impact of the lubrication on the efficiency
   - Define the impact of the speed

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

Non-continuous Electrical Generation from Water Waves or Wind

There is a great need for low-cost, efficient sources of electrical power in remote or disaster areas. Over the last several semesters, SECS senior design groups have modeled and prototyped systems to capture the motion of water waves, convert that motion into electricity and store it. The challenges with all such systems are great, and most of them stem from low-power, low-speed sources of mechanical energy such as water waves or wind. Continuously generating electricity from a low-speed sources (water waves are typically 6-12 cycles/min) requires large increases in speed to efficiently spin generators (which typically run at 1000 rpm or more for efficient operation). This speed increase comes with a proportional decrease in torque, which in turn requires very large input torques, internal forces and massive components.

It has been suggested that instead of attempting to continuously produce electricity, it may be more advantageous to collect and store mechanical energy for a period of time, and generate electricity when enough mechanical energy has been accumulated to make that conversion efficient. For example, the motion of several water waves can be used to accelerate a flywheel. When that flywheel has accumulated a sufficient amount of kinetic energy, a relay is closed to an attached generator, which acts as a brake on the flywheel as it generates and stores electric power. Once the flywheel slows to the point where the generator is not efficiently producing power, the charging circuit is disconnected and the flywheel is again allowed to accumulate kinetic energy through the action of several waves.

This project will involve the modeling and prototyping of a non-continuous water-wave electric generating system. The mechanical portion of the prototype can be configured from bicycle components, all of the electrical components including sensors are readily available, and the control system is very straightforward.

During the summer 2018 semester this concept was explored with success. Further work on this concept will include more efficient flywheel energy storage, better ways of limiting the torque applied through the system, and better choices (or development) of appropriate low-speed generators.

Parking Lot Assistant App

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

The goal of this project is to improve student’s parking experience via graphic user interface (GUI) which provides real-time data from parking lots equipped with an array of sensors. After consulting the app, drivers will be able to determine which parking areas are already full, which are currently empty, and which have high amounts of traffic.

A small-scale proof-of-concept model will be constructed to demonstrate the feasibility of the hardware solution and the corresponding predictive algorithm. Beyond simply determining the best technical solution, an attempt to factor in the real-world elements such as cost and reliability of the finished product will be made in this project.

Radar technology will be used to detect vacant parking lots in this project, and a weather-resistant, durable housing will need to be designed for the radar. The two primary constraints of this project are 1) the radar must be energy efficient and 2) the radar must be able to track multiple spots correctly simultaneously.

Pinch Ring CVT Design Optimization

(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 - Latcha)

The PRCVT is a new proportional 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.

A traction surface encounters a compressive stress between contact surfaces ranging from zero to 250,000 psi, the maximum contact stress for steel surfaces. Lubricants must be chosen and tested to assure 250,000 mile life at an operating temperature of 250F without component wear, and further chosen for highest feasible traction (friction) coefficient. Surface texture may be a parameter entering the traction fluid study. Candidate lubricants may include greases.

A FEA model will be assembled and applied to right-size components for allowable stresses and to confirm deflections. A FEA study is needed to minimize weight, starting with material and condition, and allowable stress selections, and determination of a minimum shaft diameters, and proceeding to minimize component weights by re-optimizing shapes to develop equal stress levels under maximum load conditions for numerous designs while varying shaft-disk cone angle and Ring Arc between contact points as shown on figure 29 of the CVT Design12 presentation.

See attached presentation for additional details. I will have a working physical model in class tomorrow.

Confidentiality and non-compete documents may be required before work begins on this project (has not been decided by the project sponsors at this time)

Challenge - Autonomous Steel-Column Climbing Robots

As an example of the utility of robots for inspection in dangerous places, small autonomous robots will be developed that will start on the floor of the SDL at a starting line, make their way to the large steel column in the center of the south wall, climb the column, ring a bell at the top, climb down the column and return to the starting line.

Safety and speed are the main challenges of this task. Wireless video cameras should be incorporated into the device, if it can be done without sacrificing either safety or speed. The device must be able to complete the entire task without human interaction. No device will be allowed on the steel column without first demonstrating its safe operation to the instructors. Each group will be reimbursed for costs, the budget for the project will be determined through the project proposals.

At the end of the semester, all of the groups developing these robots will compete against each other. Scoring will consist of the time required to complete the task, divided by the cost of the device.