Winter 2017 Projects

Development of a water-saving agricultural irrigation system

The availability of freshwater in many regions of the world has become very scarce. Many individuals and organizations have taken active steps to minimize water consumption. Current techniques of agricultural irrigation consume a tremendous amount of water. Many methods of agriculture have not been improved to account for the preservation of freshwater. To conserve more water, better methods need to be developed.

The purpose of this project is to challenge and reshape the traditional methods of agriculture by developing a flexible and autonomous water delivery system for crops. The intended device is to help develop a method of sustainable farming that not only simplifies the process, but also provides an environmentally friendly approach to conserve water. The device will allow the farmer the ability to irrigate crops automatically, select from the different watering options provided and independently select optimal watering times and durations. Numerous sensors will be implemented throughout the land in which the application will determine when it is acceptable to water based on the weather conditions, soil conditions, etc. Through implementation of this system, the farmer will be able to irrigate the crops for long periods of time with little to no monitoring. The system will take care of the entire irrigation process while taking an active step in preserving both energy and water.

Project suggested by students Marc Nahed, Martin Tarr and Chris Petros.

Development of a Self-Contained Smart Farm

Plants require an environment with a specific set of conditions to grow and prosper. These conditions include an adequate light source, routinely supplied water and nutrients, stable Ph level, and limited ranges of humidity and temperature. The goal of this project is to create an energy-efficient, compact, reusable, recyclable, automated system that can supply all the conditions necessary to grow a healthy plant from germination to maturity. The system will ideally be constructed of readily available components to have the most widespread application.

This project consists of the following tasks:

1. Choice of specific plant, preferably a fast-growing food plant to demonstrate the applicability of the system within the semester time frame
2. Choice of appropriate sensors (pH, moisture, light, etc.) to measure the conditions within the system and interface with a microcontroller
3. Development of a water supply, runoff and recycle system
4. Development of a ventilation system (sensors, fans, placement for optimal air flow)
5. Development of a temperature regulation system (sensors and heaters)
6. Development of a lighting system (appropriate light sources, selected for color, brightness and power requirements)
7. Choice of an appropriate microcontroller to automate the whole system
8. Development of an appropriate, non-porous enclosure that is large enough to hold the smart farm system, small enough to be transported

Project suggested by student Noah Fleck

Continued development of a water-wave electric generator system – Phase II

In the Fall 2016 semester, two teams of students developed a motor-driven test bed for the Oscillo Drive from Wave Water Works. The O-Drive is novel mechanical transmission invented for capturing the oscillating mechanical energy from water waves and transforming it into a uni-directional rotation suitable to drive an electric generator. The test bed uses an electric motor and mechanical linkage to produce an oscillatory input to the O-Drive, and the output generates electricity by spinning an automotive alternator.

This Winter 2017 project consists of the following scope of work:

1. Refine the test bed built in the Fall 2016 semester, if necessary, and perform a series of tests to demonstrate its utility, robustness and efficiency
2. Develop and construct a float system that will efficiently capture the oscillating mechanical energy from water waves in a suitable form to use as an input to the O-Drive
3. Explore and propose other applications and or markets for the O-Drive transmission
4. Explore and propose improvements to the O-Drive system

Phase III of this project will take place in the Summer 2017 semester, and will consist of installing the float-equipped test bed on a lake in Oakland county to measure and assess its practical potential as an alternative energy sources.

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

Serapid Harmonic Damper

Serapid's core technology is the Rigid Chain, the chain that can push. It consists of interlocking links that behave like a chain yet lock like a rigid bar, providing a safe, reliable and compact telescopic actuation mechanism that also works in harsh environments. The Rigid Chain drive system has matured over the 40+ years it has been manufactured. Due to proprietary designs of the sprocket and chain path profile it is efficient, smooth, and quiet. As markets for the technology have grown, there is an increasing demand for higher speed. With higher speed comes increased noise and vibration. To allow higher speeds, Serapid would like to develop a harmonic damper for its LinkLift product.

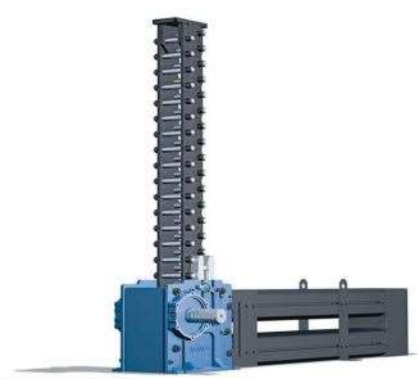


Figure 1 LinkLift

The Harmonic Damper, Rotational Mass Damper, or Harmonic Balancer, dampens torsional vibrations in a rotary shaft. The LinkLift has a relatively low excitation frequency (~ 2 to 6 Hz). Below 3 Hz, noise and vibration are negligible. If the damper has a natural frequency at the excitation frequency, it will dampen the induced vibration. Ideally the rotational mass is free to rotate at very low friction. Restoring and/or damping forces are often supplied by spring, fluid, or elastomer. With purely spring force, it is more critical that the natural frequency of the balance can be tuned to the operating frequency of the LinkLift.

At the completion of the project, the students should have designed and tested a proof of concept harmonic damper. Testing to include cycling a LinkLift at multiple speeds. Compare noise of the sprocket/tooth interface and vertical vibration amplitude of the chain column.

Serapid will provide:

- A LinkLift with motor and guide for the chain.
- An unwired control panel with power disconnect and VFD for motor speed and direction control
- Limit switches to limit chain stroke (VFD input).
- Accelerometer

OU students will:

- Mechanical Design
    - Design harmonic damper
    - Verify the design parameters with calculations or simulation
    - Manufacture prototype harmonic damper for LinkLift
    - Test damper on Serapid provided LinkLift 80
        - Baseline test w/o damper 50 and 150mm/s
        - Test damper at 50, 150, 300, and possibly 450mm/s.
    - Determine effectiveness of damper
    - Determine cost of damper as a production product
    - Work with Electrical Engineering team to define test and operational requirements for test fixture.
- Electrical Design
    - Design harmonic damper test fixture
    - Wire, program and debug test fixture
    - Setup data collection for vibration and noise
        - Vibration frequency and amplitude (fft)
        - Noise frequency and amplitude (fft, db)
    - Develop effectiveness measurement for noise and vibration (e.g. Vibration/Speed relative to baseline)
    - Work with Mechanical Engineering team to develop operational test fixture.
    - Work with Mechanical Engineering team to establish baseline data.

Because of the specific nature of this project, only students that have already completed ME 421 or ECE 431 are eligible to work on this project. Non-disclosure and non-compete agreements are required before students can commence work on this project.

Development and demonstration of a hybrid 3-wheeled scooter – Phase I

Berylline is a small company in the OU-INC business incubator, developing a 3-wheeled hybrid scooter to be used as secondary, short-range transportation. The Berylline hybrid system features a boost electric motor to improve both starting and hill-climbing performance while enhancing fuel economy.

This Winter 2017 project consists of the following scope of work:

1. Berylline will supply Ice Bear 150cc 3-wheeled scooter
2. Design/construct fixture for Formula SAE dynamometer
3. Dynamometer test 1:
   a. Vehicle/driver weight
   b. Acceleration: 0-30MPH
   c. Acceleration: 20-40MPH
   d. Fuel Economy: Decide a specific driving loop, measure fuel consumption
4. Install Fuel Injection System
5. Dynamometer test 2:
   a. Vehicle/driver weight
   b. Acceleration: 0-30MPH
   c. Acceleration: 20-40MPH
   d. Fuel Economy: Decide a specific driving loop, measure fuel consumption
6. Selecting electric motors compatible with existing motor controller
7. Packaging and hardware design
8. System software design

Phase II of this project will take place in the Summer 2017 semester, and will consist of further refinement and installation of the hybrid system followed by a third dynamometer test.

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

Rotary Valve Cylinder Head – Phase I

A local inventor holds the patent on a valve system for internal combustion engines that has the potential to greatly enhance the performance of an engine while drastically reducing the parts count, improving reliability and decreasing noise and vibration. He would like us to apply this concept to ta specific engine, and provide independent testing of the system and suggestions for improvement.

This Winter 2017 project consists of the following scope of work:

1. The sponsor will supply 2 new 13 HP Honda/clone Predator engines with electric start, one to be used for base line testing and the other to be used as modified rotary valve cylinder head engine
2. Map base engines valve timing events, intake and exhaust lift, duration, lobe separation angle, centerlines, relative to crankshaft angle. Sponsor has developed a fixture to assist with this mapping
3. Remove cylinder head from second engine and flow test both intake and exhaust ports at various valve positions (we will be using the Formula SAE flow bench)
4. Design rotary valve port runner shapes (elliptical, rectangular, round, etc.) to closely match poppet valve flow at various positions up to the maximum lift recorded from base engine. This will require extensive CAD and 3D printing skills
5. Spec ceramic material and mating surface material, finish, and/or surface coating that performs best without lubrication. (i.e. Saint Gobain Hexaloy)
6. Design and fabricate mock-up rotary valve and housing to spin test assembly and validate ceramic rotor shell to housing wear

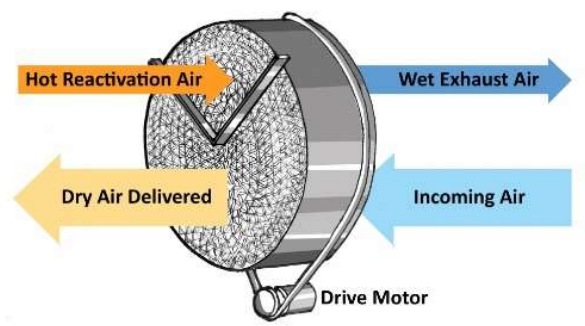
Phase II (Summer 2017) of this project will consist of

- Design and machine complete rotary valve cylinder head and assemble onto second test engine with appropriate timing belt/chain drive
- Dyno test base (stock) engine and record results, measure and record torque, HP, BSFC, BMEP, ignition timing, emission output
- Dyno test rotary valve engine, measure and record torque, HP, BSFC, BMEP, ignition timing requirements (may have to machine offset keyways and/or an adjustable timing bracket to allow for more timing advance), emission output

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

Desiccant bead regeneration system

As Earth's climate continues to change, the global need for air conditioning will increase. Conventional methods of air conditioning rely heavily on refrigerants to dehumidify and cool. This project is to explore methods of dehumidifying air with solid desiccants. Existing systems typically use a rotating desiccant impregnated wheels or other fixed bed systems. This project will attempt to move the desiccants by slowly passing desiccant bead material through a structure exposing them to air (to absorb moisture). This HVAC air drying system will be supplied to the student team.



The student team challenge is then to have the saturated desiccant beads removed from the bottom exit of this air dryer, then transported to a higher elevation (perhaps 24-36 inches) and passed through a heated regenerator unit to dry them. The beads are then fed back in a controlled fashion to the top of the air dryer where they descend to the bottom under gravity to then be removed again for repeated, continuous regeneration. This will be a very slow, continuous process controlled by sensors indicating the saturation level of the desiccant.

The proposed desiccant media is either 6-8mm silica gel beads, or 1/4 - 3/8 inch alumina beads. The scope of the project is to design and construct a conveying method to receive desiccant beads from the provided HVAC air dryer to the regenerator section. The beads must be elevated from bottom to top, dried, and deposited into a hopper which feeds the HVAC air dryer. We will use a simple electric heater for regeneration, but ultimately, a hot water heating coil will be used so that solar hot water, a condensing hot water heater, or waste heat from an engine may be used for low cost dehumidification. This dehumidified air will then be fed to an indirect evaporative cooler, for very low electricity cooling using no HFC refrigerants, providing a cooling option for any climate in the world. This entire system will be further described to the team(s). However, this project involves only the desiccant bead regeneration system.

This Winter 2017 project consists of the following scope of work:

1. Research desiccant types

2. Using provided beads, test for mechanical durability and friability (in a small rock tumbler)
3. Design and construct bead conveying mechanism with hot air dryer section
4. Control speed of conveying based on humidity (sensor location and method to be determined)

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

Design, construction and installation of a 2-axis solar PV tracking device

The OU Engineering Center building has a roof area intended for solar energy research and testing. In the Fall 2015 semester, several teams of students designed and installed several types of PV solar panels in this area for instructional and research purposes. One of the tasks that was left unfinished was the design, construction and installation of a 2 axis solar tracking mechanism to automatically position two crystalline Si PV solar panels towards the sun (for comparison of the fixed panels already installed).

This Winter 2017 project consists of the following scope of work: Design and construct a 2 axis solar tracker, as a follow up from the Fall 2015 effort. All parts from the Fall 2015 effort are available, including the sensors, actuators, PV panels assembled on a uni-strut frame, and an aluminum post (from scrapped OU campus light pole). Structural design, mounting, the base plate and assembly is needed.

This will involve an analysis of the wind loads on the system to design a stable base plate, verification and refinement of the mechanical system, and design and configuration of an appropriate power supply for the controllers and actuators. It is important that a functional unit be fully constructed and tested by semester end, and integrated into the data acquisition system currently in place.

Lastly, a Solar Edge DC to AC system is installed in lab EC370. This system will connect to the Solar Edge inverter, and all data can be displaced on a cloud based Solar Edge monitoring system. This system is not yet fully commissioned, and it the student team could assist with getting their tracker online and displayed on this web monitoring portal for future study and logging of operational data.

Skittle®-sorting challenge

Sorting small parts quickly and accurately is vital to the efficient manufacturing of most products. This recurring senior design project contains all the tasks involved with practical industrial sorting in a fun and competitive setting. The challenge is to sort, *without error*, an entire family-size bag of Original Skittles® candies by color into individual containers as fast as possible, at most within 5 minutes.

- There are approximately 1800 Skittles candies in a family-size bag. It may not be required to sort 1800 candies; sorting 6 candies per second is the minimum acceptable sorting rate.
- Each of the colors (purple, yellow, green, orange, and red) must be sorted into separate containers.

- The candies must be visible during at least 90% of sorting process.
- The candies may be poured by the user into the device at whatever rate the user chooses.
- Upon pouring the candies into the sorter, a visible digital timer will begin counting (to the tenth of a second) as the candies are sorted and deposited into the containers. Above each container, a separate counter will display the number of candies currently in that container. As the last piece is sorted and deposited, the timer will stop and display the elapsed time, and the container counters will display the number of candies in each container.
- The colors are to be sorted in the order they are found, that is, the first color goes into the first container, the second color into the second, etc. There will not be a designated container for red, another for yellow, etc.
- The candies must not be damaged or altered during sorting.
- If more than one design group selects this project, all of the Skittle®-sorting design groups will compete head-to-head to determine the best design, using a minimum of 200 candies per test.
    - The competition score will be the total time in seconds, plus 1 second for any improperly sorted candy, plus 1 second for incorrect color counts, multiplied by the total cost of the sorting device. For example, a single yellow piece in the mostly green container will result in a penalty of 3 seconds – one for the yellow candy in the green container, one each for the incorrect counts of yellow and green. The lowest score wins.
    - Each group will be allowed to take up to three attempts at sorting, the best score will be used to determine the competition standings.
    - Sorting runs that result in one or more containers that cannot be determined to be "mostly" one color, in the judgment of the instructors, will be disqualified.
    - Sorting runs that take more than 5 minutes will be stopped at 5 minutes and the score determined on the candies that have been sorted at that time.