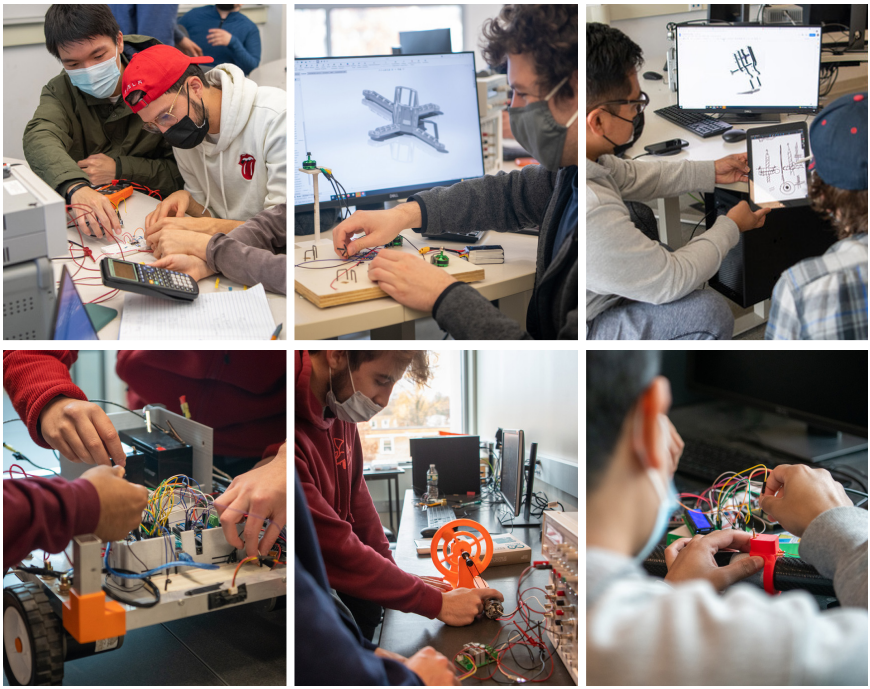
DIVISION OF ENGINEERING PROGRAMS

Virtual Engineering Project Review

Friday, December 10, 2021



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WALDEN ENVIRONMENTAL ENGINEERING

Table of Contents

SENIOR DESIGN I

Team 1

Educational Duffing Oscillator for Displaying Chaotic Motion

Amira Shagan (EE), Bryce Manz (EE), Yan Lok Ko (EE), Steven Quar Zakirov (EE)

Advisor: Dr. Mohammad Zunoubi (EE)

Co-Advisor: Dr. Richard Halpern (Physics)

Abstract

The objective of this project is to build an inverted pendulum to show chaotic motion. This inverted pendulum will be used in the Physics Department as an educational tool in their Nonlinear Dynamics course. The oscillation of an inverted pendulum can be modeled by the Duffing Equation, given in Equation (1) below. This project focuses on the bi-stable case, in which α is negative and β is positive.

$$x + \gamma x + \alpha x + \beta x^3 = A\, cos(\omega t) \quad (1)$$

The type of oscillation produced by the inverted pendulum is dependent on the following values from Equation (1): α, β, γ, and ω. The amplitude of the current, A, is directly proportional to the amplitude of the driving force provided by the Helmholtz coils. α is the spring constant of the material used for the pendulum. β is the nonlinear restoring force caused by the stationary magnets positioned on the apparatus. γ is the damping force on the pendulum. Finally, ω is the frequency of the current provided to the Helmholtz coils.

During the first semester, possible designs for the power supply of the Duffing Oscillator were investigated and the apparatus itself was constructed. An embedded system using a time-of-flight (ToF) sensor and Raspberry Pi board was designed to measure the displacement of the pendulum, so that it can be plotted and displayed on a monitor.

For the second semester, the power system will be finalized and improvements, such as a plot of the velocity of the pendulum, will be added to the embedded system.

Team 2

Mechanical Stress Monitor Used for Mechanics of Materials Combined Loading Lab

Nazim Wali (CE), Hugo Ramirez Grijalba (ME), Zachary Zeppieri (ME), Nicholas Deoki (CE), Justin Boswell (ME)

Advisor: Dr. Ping-Chuan Wang (ME)

Abstract

At SUNY New Paltz, mechanical engineering students are required to take a course called “Mechanics of Materials Lab.” One of the labs, referred to as the “Combined Loading Lab”, is a lab that analyzes the stresses and strains along a configuration of three perpendicular orientated carbon fiber pipes. Our project will seek to provide real-time stress and strain characterization at six locations along the pipe configuration. A coded program written contains an algorithm to determine stress and strain using changes in resistance from the strain gauges. The ADC onboard the microcontroller is used to determine the resistance of the strain gauge through a voltage divider. By completing this project, this device will be used to benefit the students and lab instructor by providing an interactive and fluid experience.

Team 3

Autonomous Delivery Robot

Alekse Forgione-Cardona (EE), David Wood (CE), Sanjai George (CE),
Ian Kirk (EE), Evan Drivas (ME), Taylor Gangel (ME)

Advisor: Dr. Mahdi Farahikia (ME)

Abstract

The purpose of this project is to build and improve upon an autonomous delivery robot constructed by a Senior Design Team in Spring 2020 for the SUNY New Paltz campus. As a team, we collectively want to see a fully functioning autonomous delivery robot. The robot came with limited mobility and navigation capabilities, a simple locking mechanism, and a tracking application, making it not truly autonomous. Improvements to frame durability, obstacle sensing, and drivetrain power delivery are needed to improve its maneuverability. Campus-wide access to the application will improve its accessibility, resulting in a secure, autonomous delivery robot which can navigate the SUNY New Paltz Campus.

Team 4

3D Printer for Hybrid Materials

Amanda Berryman (CE), Leo Santala (ME), Zachary Fanion (ME),
Samuel Palermo (ME), Jaime Prince (EE)

Advisor: Dr. Ping-Chuan Wang (ME)

Abstract

This project is aimed to design a 3D printer that is capable of printing two materials, in slurry form, with adjustable proportionality as specified. The main design elements of the project consist of a mixing system, an extruding mechanism, Marlin firmware to interface with the control board and a custom G-Code as the control algorithm. As a work in progress, the team has designed a mixing system involving a custom mixing paddle for homogenizing the two materials before extrusion and has made progress in understanding the operation of the control board and code in order to ensure the material proportionality of the printed structure. To our knowledge, there are currently no printers on the market capable of adjusting the proportionality of two materials in slurry form. This type of technology would be beneficial to the community that is looking to manufacture parts with various material properties within one print.

Team 5

Design and Implementation of a Drone

Wolf Wolbeck (EE), Michael Wilson (ME), Robert Cervone-Richards (ME), Christopher Lepore (CE)

Advisor: Dr. Ghader Eftekhari (EE)

Abstract

The popularity and effectiveness of drones has been growing exponentially, creating a need for more affordable drones for both commercial and recreational purposes. The design team will collaborate to analyze and construct an operational quadcopter that will initially be capable of basic flight by the end of Senior Design I. Throughout Senior Design II, various innovations and modifications will be incorporated into the initial drone design, therefore improving it and allowing additional capabilities. One such improvement will be to the flight capabilities, which will be accomplished by using components such as a gyroscope, video capture system and improved RC telemetry. The drone will use four 3D printed propellers powered by four brushless 3-phase AC motors that are operated remotely using a controller and running on a 12V Li-Po battery and using a STM 32 F405 Matek microcontroller for operation. The purpose of this project is to improve on drone design, think of new drone technology and additions that have not been done before while keeping the drone cost effective, and serve as a learning tool by providing an opportunity to work on a project that encapsulates multiple fields of design and development. Drones serve many important purposes, including photography, surveillance, and research, making this project very versatile.

Team 6

Portable Solar Powered Cooler

Marcos Lozano (ME), Sarina Hamling (ME), Jose Ruiz (ME), Umit Sedgi (ME), Ian Connolly (EE)

Advisor: Dr. Rachmadian Wulandana (ME)

Abstract

This design project is for a portable cooler that runs on solar power. The project plan is to have the cooler to operate on solar power using foldable solar panels which will be used to power a Peltier device. The fabrication of the inner chamber will have direct contact with the items it is transporting in which the next layer will consist of insulation in order to keep the cold temperatures in the cooler chamber. The outer layer will be the one to be exposed to the atmospheric temperature, along with the Peltier device. The Peltier device will have the job to cool the inner chamber that consist of fins, and fans that removes the heat created by one side of the Peltier, and draw in the low temperature created by the cold side of the Peltier. The cooling of the Peltier device has the intended use of transporting vaccines that requires a low temperature to remote areas that do not have easy access to electrical cooling resources. The cooler chamber may have the ability to keep food and drinks cold for an extended period in future works. During the development of this project it has been acknowledged that the Peltier tested are less efficient when running at the rated voltage. The Peltier will now be operated at about 50–60% to achieve maximum efficiency. Through further testing, the team had observed that a single fin/ fan/ Peltier system is not nearly enough to achieve the goal temperature of 0° Celsius for the inner chamber. More than one Peltier will be incorporated into the design.

Team 7

Programmable Charger for the Test and Development of New Batteries

Han Lin (EE), Alfredo Olmedo (EE), Vera Ruiz (EE), David Gonzalez (ME), Michelle Narvaez (EE)

Advisor: Dr. Julio Gonzalez (EE)

Abstract

This senior design project focuses on the steps and series of events to successfully design a programmable charger for the development and tests of new batteries. The goal is to utilize a closed-loop system that will regulate the desired current allowing the user to program different testing schedules. This will help maximize rechargeable batteries' efficiency and lifetime. Research included the heat sink to dissipate the heat because of the power absorbed by a transistor from a high current; the hall-effect sensor in avoidance of the current draw which exists if a regular ammeter is used; the Darlington transistor to deliver high output current to charge the battery. The importance of this project is its long-term effect to give developers a tool to optimize their batteries, benefiting consumers of electronics and energy storage of renewable resources.

Team 8

Temperature Sensitive Casement Window

Chandler Murphy (ME), Justin Mellion Solomon (ME), Paul Tola (EE),
James Maltes (ME), Matthew Araujo (EE)

Advisor: Dr. Julio Gonzalez (EE)

Abstract

Comfortable living conditions are one of the most common desires of any building occupant, be it in a home, business, or hospital. A cost-effective way to maintain a specific room temperature is through the natural ventilation of a window. However, under certain circumstances, windows can be difficult, and even dangerous to open, such as in the case of inaccessible and heavy windows. This project aims to create an electro-mechanical system to automate the process of opening casement windows to mitigate these factors. These windows require a crank to open manually and are one of the few most commonly implemented windows to a building. The system implements a temperature sensor to control the voltage output to a circuit, which can be combined with a 555 chip or a transistor as a switch (each with their own risks and benefits), in order to power a DC motor. This motor will provide the mechanical torque required to turn a gear-linkage system, in order to open and close a prototype model of a casement window. To this point in the project, we have had to take into account the tolerance for 3D printing parts, as what has been modeled in SolidWorks is not accurately reflected in the final print. Electrically, we have determined that an n-MOSFET transistor will be required for the switch, as well as a diode to protect the motor from overloading. The prototype design uses 3D printed gears and links, as well as a transistor switch due to simplicity and ease of access. Doing so will allow for frequent testing and experimentation of the system, in order to consider using metal parts and a printed circuit board for the final design.

Team 9

Stirling Engine Using Concentrated Solar Power

Jenna Corti (ME), Zachary Hartrum (EE), Shane Callahan (ME),
Ryan Schenkel (ME), Kaitlyn Kreider (ME), Zachary Baker (ME)

Advisor: Dr. Kevin Shanley (ME)

Abstract

The focus of this project is the design and analysis of a solar-powered Stirling engine (heat engine). This engine consists of a single cylinder containing a power piston and a displacer piston. The heat source is solar radiation. Through convection, the cylinder is heated. The temperature differential, as well as the change of pressure and suction generated in the cylinder, creates a closed-loop cycle of the working-fluid. Through thermodynamic analysis on the working fluid, compression ratio outputs are analyzed to achieve high efficiency. Through kinematic and kinetic design and analysis of the piston-rod linkages, generated torque and angular velocity are analyzed to achieve desired power outputs. Applications include electric power generation with the addition of an electric generator assembly.

MATLAB has been used to calculate vectorized values for the dimensions of the cylinder, swept volume of the pistons and compression ratio of the working fluid using general volume and displacement calculations. The position, velocity and acceleration analysis of two four-bar slider-crank mechanisms has been performed using matrix multiplication, on MATLAB, to solve unknown values of torque and forces on the linkages. Calculations have been performed to relate the RPM of the flywheel to the voltage output in an electric generator. Thermodynamic calculations relating to the volume of the working fluid, compression ratio and power output of the system have been performed using EES. The first 3-dimensional iteration of the system has been made to provide a tangible prototype. The MATLAB calculations pertaining to the Finite Element Analysis of the heat sink, cooling fins and structure have been started. The second iteration of system dimensions, kinematic analysis, kinetic analysis and thermodynamic analysis has to be achieved. The first SolidWorks 3D design also has to be completed. This will then leave the project ready for the second iteration in which we will compare analytical results to experimental results. After these conclusions have been made, the project will be continuously improved to increase efficiency and decrease experimental error.

Team 10

Thermal Expansion Generator

Ethan Eisloeffel (ME), Nicholas Scarano (ME), Timothy Stanich (EE),
Frank Seelmann (CE), Dylan Piccorelli (EE)

Advisor: Professor Michael Otis (CE)

Abstract

The thermal expansion generator serves as an alternative product for electrical generation via solar power. Our design utilizes the principle of volumetric thermal expansion, where a fluid will expand as a result of a temperature increase. The source of the heat comes from an evacuated solar heat tube with a copper tip that warms up rapidly in sunlight. The evacuated tube collects heat through the aluminum-nitrite material, which is then transferred by an aluminum fin to the copper heat pipe. The evacuated heat pipe is filled with an alcohol solution which vaporizes with increased temperature, the alcohol vapor then rises to the bulb, where it transfers its heat from vaporization, then condenses and moves back downward through the evacuated heat pipe. Using conductive and convective heat transfer methods, the heat energy is transferred from the copper tip to an aluminum block, which the fluid then extracts energy from as the piping passes over the block's surface. Temperature distribution at the system's heating source was modeled using ANSYS, a commercially available finite element analysis software. The purpose of this project is to use a renewable source of solar energy to generate electricity in an efficient manner with zero waste. As a result of the thermal expansion, the fluid is displaced vertically and then overflows its original container into a bell siphon, which is then directed back downward over impeller blades, causing rotational motion and electrical generation. The fluid is then cooled using a radiator, to which the cycle is repeated using microcontrollers, servo motors and electrically operated valves. While temperature distribution and fluid flow can be simulated, determination of a specific fluid with its own unique properties is required in order to provide proof-of-concept. Access to directly testable and measurable values, such as power generated, temperature, volume, and time, are important in order to compare the cost effectiveness and efficiency of the design to existing technology. Understanding the aspects of the proto-type, will allow for optimization of the project during the refinement process, leading to an improved efficiency. This ambitious tabletop design could serve as the framework for a large-scale renewable energy solution.

Team 11

Dynamic Balancer for Lab Demonstration

David Myszelow (EE), Maximus Meighan (ME), Marcus Romero-North (ME), Mario Cora (ME)

Advisor: Professor Ken Bird (ME)

Co-Advisor: Mr. Graham Werner (ME)

Abstract

Dynamic balancers are rotating systems in which a mass or masses can be added. The rotating system behaves differently according to the weight and location of the mass or masses. The system will be able to spin up to 2500–3000 rpm. As a safety precaution, this will be at least halved using gears. The design is a horizontal system with a shaft long enough to place 2–3 weighted disks, accelerometers mounted near the two bearings to measure acceleration, a tachometer to measure speed, a motor and belt driving the shaft and a motor controller to change the speed. The multiple disks allow for multiple planes to be balanced. This all will be connected to the data acquisition unit which will feed into the graphical user interface. The system will be able to fit on a 4-foot by 2-foot base with the components firmly mounted. The purpose of this project design is to provide an apparatus for students to use in a lab setting to observe the behavioral differences between static and dynamic balancing. This is important because in real world applications, such as car tires and plane propellers, unbalanced systems can cause unwanted vibrations and strains that can be dangerous.

Team 12

Pendulum with Adjustable Damping for Dynamics Lab

Logan Matty (ME), Kyle DeSilva (EE), Jordan Moyers (ME), Justin Pollak (ME)

Advisor: Dr. Heather Lai (ME)

Abstract

System dynamics is a challenging course for mechanical engineering students. A Dynamics Lab apparatus for student use will be designed to make some of the topics easier to understand. The lab being created will focus on a pendulum that will display the effects of damping due to air resistance and contact friction. The pendulum will consist of a clamping system that will apply a variable normal force that will affect the coefficient of friction. The electrical components consist of an encoder to measure the angular displacement and motion of the swinging object and a force sensitive resistor (FSR) that will measure the force applied from the clamp. This data will be collected through a National Instruments Data Acquisition (NIDAQ) device. The data will be displayed through MatLab with the use of a Graphical User Interface (GUI) to provide a visual of the data being collected. With students being able to see a direct correlation between real life motion and data, we hope that they will have a better understanding of the damping topic within System Dynamics. Our group has finished making a prototype of the pendulum with 3D printed parts, circuitry for the FSR and a layout of the GUI. With further testing of the prototypes we will have a better understanding of the revisions we may have to look into for the final design of the pendulum, the accuracy and placement of the FSR within the clamping system and a general flow of the lab procedure in correlation with the GUI.

Team 13

Saddle Locking Mechanism for Pacer Gait Trainer

Matthew Querrard (ME), Carlos Juarez-Avila (ME), Brett Hanson (ME), Kevin Newell (ME)

Advisor: Dr. Heather Lai (ME)

Stakeholder: Rifton Equipment-Peter Hinkey

Abstract

Rifton Equipment, Rifton NY, is a leader in manufacturing of high-quality adaptive equipment for people with disabilities. They specialize in equipment for individuals with low mobility, consisting of a variety of custom equipment such as the Pacer Gait Trainer. The Pacer Gait Trainer is an assistive device that is like a walker but provides support that helps children who struggle with inferior mobility. Furthermore, the Pacer Gait Trainer provides dynamic weight bearing, shifting and proper positioning to allow for natural movement when walking. Through the Pacer Gait Trainer, children can become independent walkers without depending on someone else. The target for the project is to redesign and improve the saddle locking mechanism currently used by Rifton. Moreover, the locking mechanism requires a low tolerance fit to properly attach to the gait trainer due to the slight manufacturing variations in the frame. A low tolerance fit creates lateral and horizontal movements that can interfere with the user's experience. To improve the users experience, the team has redesigned key components of the locking mechanism, utilizing brainstorming sessions and computer-aided design. The team has created four differing designs to combat the same problem in which one will be chosen and continued until a successful solution is achieved. Throughout the project, it was determined that there is more than one solution to a problem, as the team has presented multiple solutions to address the stated problem. Such information is vital to the success of the project, as it establishes the problem at hand, as well as a baseline for designs and improvements. Furthermore, it is planned to utilize this information to continuously update and enhance the redesign, while retaining the fundamental features. It is also of interest to plan a meeting with the stakeholder to review the differing design iterations, as well as decide upon a design that best suits the problem needs.

Team 14

Autonomous Book Locating Library Robot

James Williams (ME), Ravneet Aujla (CE), Benjamin Drillings (EE),
Lauren Brondum (ME), Lillian Cusanelli (ME)

Advisor: Dr. Mahdi Farahikia (ME)

Co-Advisor: Professor Anthony Denizard (CS)

Abstract

The Autonomous Library Robot Project is a joint project between the Engineering and Computer Science (CS) departments at SUNY New Paltz. Dr. Pham (Computer Science) is leading the Smart Library Initiative that will introduce a multitude of advanced technology into the library which this is a part of. This robot is specifically intended to identify any books that are out of place. In order to hold all the cameras needed, the robot will have a base that is one and a half feet long, one foot wide and a foot and a half tall. In addition, it will have two poles extending seven feet off the ground supporting seven cameras intermittently placed. A motor control system to work in conjunction with depth sensors was designed and is planned to be fabricated in tandem with the base. The engineering team learned that a system can be improved without redesigning the whole product concept. Instead, they focused on improving several individual functions which, in turn, greatly improved the whole robot.

According to the project proposal, the next step for the engineering team is to debug the systems implemented in the robot this semester and begin automating the different processes and systems used by the robot. This includes adding a battery charging system and a user interface to ease complications when operating this robot.

Team 15

Portable Hydroelectric Generator

Spencer Blumenthal (ME), Liam That (ME), Jason Roy (EE), Matthew Logel (ME)

Advisor: Dr. Rachmadian Wulandana (ME)

Abstract

A portable hydroelectric generator is to be designed, iterated and improved upon throughout the course of the year. This Generator will produce clean renewable energy in a non-invasive manner for the environment, by allowing remote power generation anywhere there is water that experiences a change in height. This will be achieved by taking the conditions of an actual hydroelectric dam and recreating them in a way that it is more compact and easier to transport. The first semester focused on getting a working prototype, with the analysis of voltage and power outputs. Once power outputs are analyzed on the prototype, the second semester will focus a lot more on optimizing the generator with new parts and redesigns. As a part of New Paltz Engineering Senior Design I & II (SD1 & SD2) courses, the project is to be completed according to the project plan previously proposed.

Notes:

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