DIVISION OF ENGINEERING PROGRAMS

Annual ENGINEERING DESIGN EXPO

Friday, May 6, 2022

New Paltz
STATE UNIVERSITY OF NEW YORK
School of Science & Engineering

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May 6, 2022

Hello and welcome to the 2022 Engineering Design EXPO! Our first live EXPO since 2019.

We are excited to get back to the energy surrounding an in-person EXPO. The culmination of a year's work, the EXPO is a celebration of the trials, tribulations, and triumphs of the design process. This year's celebration feels particularly special after such a challenging two years.

One of the positive developments to come from the struggles we all faced is our ability to share our Senior Design projects with a wider audience. For the past two years, the EXPO has been produced virtually. We have decided to continue to post the 3-minute project videos on our webpage at https://www.newpaltz.edu/engineering, along with a downloadable copy of this abstract book, allowing family, friends, alumni, and industry professionals the option to view the hard work of our students even after the EXPO is over.

At this time, I would like to extend a very special thank you to our 2022 Engineering Design EXPO sponsors:

- Central Hudson Gas & Electric Corporation
- Elna Magnetics
- Selux Corporation

Without the continued support of our generous sponsors, we would not be able to produce such professional projects and host this special event.

Congratulations to all our engineers. Please enjoy the 2022 Engineering Design EXPO!

Sincerely,

Kevin T. Shanley

Kevin T. Shanley, Ph.D.
Chair, Division of Engineering Programs

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SENIOR DESIGN II

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 a Duffing oscillator, a device capable of displaying chaotic motion. Such motion is characterized by extreme sensitivity to initial conditions: slight differences in initial conditions lead to very different behaviors at later times. This phenomenon is observed in various physical systems; studying it has benefits for engineering applications.

The oscillator itself is an inverted pendulum in the form of a narrow flexible 3D printed strip. One end is fixed in place. The other end is fitted with small permanent magnets situated between a pair of Helmholtz coils. The coils exert a periodically varying force on the magnets, causing the strip to oscillate. Much of the apparatus is 3D printed, including the forms on which the coils are wound. To capture the pendulum's movement, an infrared Time-of-Flight (ToF) laser range sensor is used in conjunction with a Raspberry Pi board that is programmed to analyze the pendulum's motion and display it graphically on a monitor. The completed project will be available for use by the SUNY New Paltz Physics Department as an educational tool in their Nonlinear Dynamics course.

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 State University of New York at 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 strain along a configuration of three perpendicular orientated pipes. Our project will seek to provide real-time strain characterization at six locations along an aluminum pipe configuration. A program contains an algorithm to determine strain using changes in resistance from the six strain gauges. The ADC (Analog to Digital Converter) onboard the microcontroller is used to determine the resistance of the strain gauge through a Wheatstone bridge configuration. By completing this project, this portable 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 an autonomous delivery robot started by a Senior Design Team in Spring 2020 for the SUNY New Paltz campus. The robot would be able to deliver packages such as online purchases, food, or textbooks to students and faculty at the doorstep of their building. This will help modernize SUNY New Paltz to keep up with advancing technologies. The robot came with limited mobility and navigation capabilities, making it not truly autonomous. Improvements to obstacle sensing, drivetrain power delivery, and navigation were made. A website was created to send an email to the delivery recipient with the pin to unlock the cargo storage and give access to the current location of the robot on campus. With these improvements to the previous group’s work the result is a secure, easy to use, and autonomous delivery system for 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)
Co-Advisor: Aaron Nelson

Abstract

A 3D printer was designed to print a mixture of two ceramic materials in slurry form with an adjustable material ratio as specified by the user. The main elements of the project consist of a mixing chamber, an extruding mechanism, Marlin firmware to interface with the control board, and custom-generated G-Code capable of designating material ratios and gradients throughout the print. Flame Atomic Absorption Spectroscopy (FAAS) was used for quantitative element analysis in extruded material samples to validate the expected material ratios. To our knowledge there are currently no consumer-grade 3D printers on the market capable of printing a mixture of two ceramic materials with specified proportionality at designated locations. This technology provides the user with complete control over the material properties at any given location on the part, broadening the scope of additive manufacturing applications.

Team 5

Quadcopter Drone Design

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

Advisor: Dr. Ghader Eftekhari (EE)

Abstract

Drones have recently started growing exponentially in both popularity and effectiveness, creating a need for more affordable drones for commercial and recreational purposes. The design team collaborated to analyze and construct an operational quadcopter by initially creating the schematics and developing the plans for the drone during Senior Design I. Then throughout Senior Design II the drone was modified to be capable of basic flight. In addition to programming and adjusting the drone's flight capabilities, additional innovations and modifications have been incorporated into the final drone design phase, therefore improving it and allowing more 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 with an FS-X6B receiver. The drone will use four 3D printed propellers powered by four brushless 3-phase AC motors running on a 12V Li-Po battery that is operated remotely using a controller. The drone will be using an STM 32 F405 Matek microcontroller for operation, programmed using C and iNav. The purpose of this project is to improve on current drone designs, think of new drone technology and additions that have not yet been done while keeping the drone cost effective. The drone will also serve as a learning tool by providing an opportunity to work on a project that encapsulates multiple fields of engineering, design and development. Drones fulfill many roles and have 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

The purpose of this project is to have a cooler that can hold items in cold temperature while maintaining said cold temperature. This iteration of the cooler chamber ran on solar power, as well as maintaining voltage, and current input maintenance. It can also be powered by a 12-volt battery that is supplied by the solar panel used in the project. In this project, the Thermoelectric Cooler (TEC) was manually constructed by six Peltier's in the sense of having the highest temperature supply the TEC can supply. Along with measuring the temperature distribution, the voltage and current inputs are monitored using a display module to calculate the amount of power the TEC needs to dissipate the energy inside the cooler chamber. This project cooler design includes the use of MDF particle board as well as the use of a foam insulator to maintain the temperature inside the cold chamber. The principles of heat transfer and thermodynamic fundamentals are used to guide this project's data collection.

Team 7

Programmable Charger for the 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 focused on the steps and series of events to successfully design a programmable charger for the development of new batteries. The goal was to design a closed-loop system that would 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; charging techniques for different batteries; and the Darlington power 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 normally require a crank to open manually and are one of the few most commonly implemented windows to a building. The system implements an electrical circuit which incorporates a thermistor and comparator to regulate the voltage output and power a DC motor. The motor will provide the mechanical torque required to turn a gear-linkage system, which simulates the opening and closing of a window. SolidWorks was used to demonstrate how the linkage opens and closes, how the gears interact with each other, and how the DC motor is fixed in place via a housing. Additionally, MATLAB code was also created to perform a force analysis, circuit diagrams were used to model how the circuit powers the motor, and ANSYS was used to perform a transient thermal simulation for temperature variance in a modeled room.

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

Two solar-powered Stirling engines are designed and analyzed: one is an alpha configuration; the other is a beta configuration. The beta configuration is a single cylinder containing a power piston and a displacer piston, and the alpha configuration has two cylinders containing a power piston in each. The heat source is solar radiation. Through convection, the cylinder is heated. The temperature difference, due to the heat source, is the driving force that powers the Stirling engine. 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. The flywheels of both Stirling engines are connected to a DC generator, using a belt-pulley system, to power an iPhone charger.

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 aluminum-nitrite material, which is then transferred by an aluminum fin to the copper heat pipe. To transfer the heat both conductively and convectively, an insert was cut into an aluminum block in which the copper tip is placed. This was done because piping over the top and bottom of the now-heated block allows the fluid to pass over the surface and extract heat energy from a large surface area, causing the required expansion. A coiling system of brake line was used to lead the fluid upward into a bell siphon system. Upon reaching a certain volume, a flushing action is triggered to send the fluid down over the paddles of a water wheel, with the rotational motion harnessed by a generator. The captured energy will then be sent through three full-bridge rectifiers and a regulator circuit to get a DC voltage measurement. Lastly, the fluid continues to flow down, collecting in a reservoir and cooled using a radiator. This is done to preserve a temperature difference so that expansions can reoccur from re-heating in the following cycle. The cycle is regulated by a ball valve at the bottom of the structure, directly connected to a float switch that varies in resistance based upon the volume of fluid within the reservoir. Thermistors are placed around the structure to monitor the temperatures and store it such that the microcontroller data can be viewed on a mobile device via Bluetooth. The purpose of this project is to use a renewable source of solar energy to generate electricity in an efficient manner with the least amount of waste. 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

When a rotating system's center of mass does not coincide with the axis of rotation the result is an unbalanced system. This can create dangerous situations such as unbalanced car tires and plane propellers. Dynamic balancers are used to prevent this by identifying a system's unbalance and locating where counterweights should be placed to balance the system. This system will operate between 500-1000 rpm. The apparatus consists of a horizontal shaft long enough for 2 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 control the speed. The accelerometer is connected to the data acquisition unit which feeds into the graphical user interface. This interface will allow the user to input locations of the weights, calculate the acceleration and force caused by any unbalance, and tell the user a location for a counterweight if it is not balanced. The system is firmly mounted to an 80-20 aluminum base and roughly 2 feet by 1 foot. The base sits on rubber shock absorbers to prevent the entire system from moving and to allow for better accelerometer readings. This makes the system safer to use as it will not be able to move across the lab table while experiencing vibrations due to unbalance. There are other safety measures in place such as a shatterproof transparent safety cover with a door on the top to provide access as well as a switch to power off the motor at any time. The purpose of this project is to provide an educational bridge for students in a lab setting to observe the behavioral differences between static and dynamic balancing.

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 without a practical foundation to understand the theory behind the data. A Dynamics Lab apparatus for student use can be used to make some of these topics easier to understand. The pendulum will display the effects of damping due to contact friction. The pendulum consists 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 of the swinging object and a force sensitive resistor (FSR) to measure the force applied from the clamp. This data is collected through a National Instruments Data Acquisition (NIDAQ) device. The data is interpreted and displayed through a Graphical User Interface (GUI) made with MatLab to provide a visual of the data being collected. An instruction manual for the instructor as well as the lab description for the students will be developed. This lab will provide students with the opportunity to see a direct correlation between physical motion and digital data, which will allow for a greater understanding of the equations that define the motion.

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 is a leader in manufacturing high-quality adaptive equipment for individuals with disabilities. Rifton's Pacer Gait Trainer is designed for patients with limited mobility and is especially designed to allow users to achieve individual movement without assistance. The Pacer Gait Trainer provides dynamic weight-bearing, shifting, and proper positioning to allow natural movement when walking. The target of the Senior Design Project is to reduce the movement and sound produced by Rifton's Pacer Gait Trainer locking mechanism when attached to the main frame. Prior to Senior Design II, the focus was to redesign the overall locking mechanism to reduce low fit tolerances observed throughout the assembly process. Various redesigns were created utilizing multiple moving components wherein one design was chosen through the use of design decision matrices. With consideration from the stakeholders, feedback, and design constraints, the developed models were not feasible to manufacture. After careful observations and measurements, it was determined that when the locking mechanism was attached to the frame and pushed back and forth, it made contact with the frame at distinct locations. The contact locations were caused by slight manufacturing variations within the frame, as it undergoes a casting process and hand machining, introducing error between each frame. To limit the movement and sound emitted from the locking mechanism against the frame, two components were modified and prepared to be injection molded; an insert running parallel along the top of the locking mechanism and another running parallel along the length of the locking mechanism. The material consists of a mixture of two injection moldable elastomers, with a shore durometer grade of 95A. Prototyping of the two components was completed utilizing 3D printing through the Stratasys J735 PolyJet, wherein the material chosen – Vero and Agilus, shore 85A – was tailored to match the material properties of the injection molded material. Upon application of the 3D printed components, it was found that movement and noise generated by the locking mechanism within the frame was reduced.

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 SUNY New Paltz Engineering and Computer Science departments. Dr. Pham of the Computer Science Department is leading the Smart Library Initiative that will introduce a multitude of advanced technology into the library including the Autonomous Library Robot. This robot is specifically intended to identify out of place books. 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. Using this knowledge, the engineering team focused on the moving base of the robot for this iteration of the project.

The robot has a base that is one and a half feet long, one foot wide, and a foot and a half tall. A motor control system was designed to use depth sensors in order to control its route and movement. Mechanical Engineering students worked on the base's frame and tread wheel configuration while the Electrical and Computer Engineering Students worked on automation of the robot through wiring, depth sensors, and code.

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 was redesigned, and improved upon, throughout the course of the semester. 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 is more compact and easier to transport. The first semester focused on getting a working prototype, with the analysis of voltage and power outputs. During the second semester, the Hydroelectric Generator was improved by changing the turbine blade design to increase RPM, which in turn increases power generation. Furthermore, the hose system was replaced with more secure pipes to ensure the success of siphon. Finally, the electrical systems needed to be enhanced to generate a higher and more stable power output by implementing a capacitor and potentiometer to the 3-Phase Rectifier circuit used to convert our AC power output to a DC power output.

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