2016-17 Senior Design projects

Professor Bagchi B1-B2

Biomematic flying and swimming (2 teams)

Description: The project aims to develop robotic/mechanical bird and/or fish

Professor Bai B5-B6

Professor Baruh B3

Autonomous UAV Design

In general, a UAV is flown by one controller, so that if a cluster of UAVs are to be operated, each requires its own operator. This project will provide a preliminary design for two (or more) UAVs that can be controlled by single operator. One UAV will be commanded by a human and the second UAV will be outfitted with a controller that will guide the second UAV to maintain a pre-determined distance from the first UAV. The project involves purchasing two off-the-shelf drones and outfitting these two UAVs with GPS devices and to modify the controller of one of the UAVs so that it receives commands form a computer and not a human. Students interested in this project should take the controls class (650:401) and develop familiarity with controls hardware.

Professor Baruh B4

Ballooning in High Altitude

In this project, students will take a commercially available balloon, such as a weather balloon, outfit the balloon with a GPS, and speed, pressure, temperature, humidity and density measuring devices, and also a camera, and launch the balloon for experiments for data collection and acquisition, modeling of the atmosphere and develop educational material to introduce ballooning to the aerospace engineering curriculum. This project will build on the results of a similar senior design project in 2015-2016 academic year.

Professor Benaroya B7

Team 1 – 5 people - Self–deployable lunar space elevator. This project requires a study of the Dynamics and Materials of such a structure and the possibilities of sending one in compact form to lunar orbit for self-deployment. Analysis and design as well as the fabrication of a reasonable prototype will be required.

Professor Benaroya B8

Team 2 – 5 people – Continuation of this semester's Senior Design Project for the design of an asteroid-capture spacecraft. We will continue the current year's project and improve capabilities. Project requires analysis, design and fabrication. Since we are continuing a prior project, an assessment is needed as to whether the current design will be improved or a new concept attempted.

Professor Bottega B9-BW

Wind Walkers

The section will be divided in to 2 groups. The 2 groups of 5 will design, build and compete for the fastest and most efficient wind driven *walking machine* under a given range of including sizes and materials. the two designs will compete at the end of the academic year. They will race over a specified distance and course.

Professor Cook-Chennault C1-C2

Stair Climbing Wheelchair (2 teams)

In the 2015-2016 academic year, a senior design team worked on designing and fabricating a stair climbing wheel chair assembly. The 2016-2017 senior design team topic will be to design and modify aspects of the existing design for improved performance with emphasis placed on design drivers identified by Dr. Cook-Chennault.

Professor Cuitino C3-C4

Professor Denda D1-D2

Bio-Inspired Flapping Wing Energy Harvester

Built on the latest in flapping flight research, the patent-pending technology at the core of this project has been shown to produce efficiencies higher than the best wind turbines on the market.
How? Recently, scientists discovered that birds use advanced flapping aerodynamics to move through the air up to 5 times more efficiently that man-made aircraft. The goal of this project is to use these recently discovered phenomena to efficiently harvest energy from the wind. Team members will design and construct their own wind energy harvester, then test its performance under different conditions. They will have access to CAD models of working prototypes that have been previously built and tested, and they will also have access to proprietary MATLAB programs which can predict efficiency before building the device.
Prerequisites: Hands on mechanical experience.
Other Recommended Skills: SolidWorks, Programming, Machining

Professor Diez D3-D4

Professor Drazer D5-D6

Professor Esfarjani E1-E2

Professor Gea G1-G2

Professor Guo G3-G4

Design and Analysis of Thermoelectric Devices With Energy Harvesting and Efficient Cooling (2 teams)

The thermoelectric effect is an interchange between temperature differences and electric voltage. A thermoelectric device creates voltage when there is a different temperature on each side. Conversely, when a voltage is applied to it, it creates a temperature difference. The term “thermoelectric effect” encompasses three separate effects: Seebeck Effect, Peltier Effect, and Thomson Effect. These effects are actively studied for use in valuable technologies, such cooling, energy harvesting, and power generation. Because the direction of heating and cooling is determined by the polarity of the applied voltage, thermoelectric devices are efficient temperature controllers as well. The objective of this project is to design, build, and analyze a small thermoelectric power generator with energy harvesting and effective cooling.

Professor Jaluria J1
Wind Energy System

Design of a system to demonstrate the use of wind energy to pump water. The system consists of the wind turbine, energy storage and arrangement to pump water to a given height. The wind may be simulated by means of an electric fan. The system is to be designed, optimized, fabricated and tested.

Professor Jaluria J2

Cooling System for Electronic Equipment

A cooling system for heat removal from electronic systems, such as Data Centers, is to be designed and fabricated to achieve temperature control of the devices. For a given high level of heat flux input, the fluid, geometry, and the cooling arrangement are to be designed. The requirements on maximum temperature and uniformity in the devices are to be met, within the space and cost constraints

Professor Knight K1

Groups K1 and K2

There will be two groups (K1 and K2) with a maximum of five students per group.

Design Project
Each group will design a tabletop supersonic wind tunnel for educational demonstrations
Conceptual Design
A literature survey will be performed to assess the state-of-the-art.
Preliminary Design
A preliminary design will be completed by the eighth week of class and submitted to the instructor as a
report from each group.
Final Design
The final design including all drawings and specifications will be completed by the end of the Fall semester
and submitted to the instructor as a report from each group. The report will include all parts and budget.

Professor Lee L1

Developing a Food 3D Printer

Project Description: 3D printing refers to techniques to create three-dimensional (3D) physical objects directly from computer-aided-design (CAD) models by joining materials in a layer-by-layer fashion. A wide variety of materials have been used for 3D printing, including polymers, metals, ceramics, and composites. In this project, we aim to develop a compact, affordable, and sanitary food 3D printer, which will allow one to print food in creative shapes and colors to add value and joy for special occasions. Multiple nozzles will be integrated to be able to inject multiple ingredients such as cookie dough, bread paste, and chocolate.

This is a great opportunity for students who seek for hands-on experience in mechanical design, instrumentation, and programming. The project involves (1) design and machining of mechanical components (40%), (2) programming for automation and process planning (40%), (3) characterizing rheological properties of various food ingredients (10%), and (4) cooking (10%)

Prerequisites: Familiarity with instrumentation and microcontroller programing (Labview, Arduino, Python, or other similar platform that drives motors/stages from PC), CAD software (AutoCAD, SolidWorks, etc), basic machining skill, basic understanding of material behavior.

Professor Lee L2

Continuous 3D Printing on a Rotating Platform

Project Description: 3D printing refers to techniques to create three-dimensional (3D) physical objects directly from computer-aided-design (CAD) models by joining materials in a layer-by-layer fashion. Despite the freedom to manufacture highly complex objects, most 3D printers can print one object at a time. Inspired by mechanism of digital data storage devices such as CD and HDD where extremely large amount of digital data is rapidly written and accessed, we will develop a new 3D printer capable of printing multiple objects rapidly and continuously on a rotating platform.

This is a great opportunity for students who seek for hands-on experience in mechanical design, instrumentation, and programming. The project involves (1) design and machining of mechanical components (40%), (2) programming for automation and process planning (40%), (3) characterizing rheological properties of polymer resin (20%).

Prerequisites: Familiarity with instrumentation and microcontroller programing (Labview, Arduino, Python, or other similar platform that drives motors/stages from PC), CAD software (AutoCAD, SolidWorks, etc), basic machining skill, basic understanding of material behavior.

Professor Lin L3-L4 (2 teams)

To build a cell-incubator to be used on a microscope stage, so that cells/tissue can be observed within a micro-environment with controlled temprature. A possible optional module can also be added to provide gas (CO_2) perfusion. A programmable, feed-back control loop is the key to the design. Both heating and cooling are considered.

Professor Liu L5-L6

Professor Mazzeo M1-M2

Professor Muller M3-M4

Professor Norris N1-N2

Vibration and Modal Testing (2 teams)

The purpose of the project is to develop simulation and data acquisition technology capable of obtaining vibration characteristics of a realistic object. The objective is to obtain agreement between measured and computed modal frequencies, and use this to characterize material properties. Simulation will be based on COMSOL FEA analysis. The measurement instrumentation will use a Data Acquisition (DAQ) board, LabVIEW, an accelerometer, and an impulse hammer. In this project students will construct an instrumental set-up to experimentally identify modal characteristics of a complex structure, such as a bell.

Professor Pelegri P1-P2

Professor Shan S1

Bottle rockets: We would like to design and construct record-breaking rockets based on water and compressed air in soda bottles. Possible design goals include highest altitude record, lifting a payload, or multi-stage rockets.

Professor Shan S2

Water guns for Girls Scouts Juniors: The Girls Scouts in NJ and PA go on an annual rafting trip on the Lehigh River. The girls come well-armed to do battle with water guns. We would like to design and construct new, motorized water guns for Troop 60802 (Grades 4-5) so that they can defend themselves.

Professor Shojaei-Zadeh S3-S4

UAV Landing on Uneven Surfaces

Professor Singer S-5

Passive Bandpass Earmuffs

Team will be tasked to modify existing earmuff designs to incorporate a band pass: i.e. a single frequency where sound can be heard. The purpose of such a design is to (a) facilitate communication while (b) maintaining the protective nature of the headset, (c) without requiring any active electronic components. The ideal final product should maintain safe/comfortable conditions at ~160 dB and allow for communication at a selected band in the human hearing range at a level of ~80 dB. Early stages of the project will involve acoustic simulations to arrive at the design, while later stages will involve the construction of the earmuffs.

Professor SingerS-6

Roll-to-Roll Electrospray Deposition

Team will be tasked with building a roll-to-roll apparatus to continuously deposit thin films onto a non-conductive substrate. Compared to other modes of spray, electrospray deposition can produce highly uniform films due to the electrostatically driven production of monodisperse nano/microdroplets; however, the electrostatic nature of the process leads to issues with non-conductive substrates. A successful project will incorporate strategies to mitigate repulsion issues and simultaneonsly allow for substrate heating for post-treatment and homogenization of the films. Early stages of the project will focus on the design of a system that incorporates these features, while later stages will involve construction and testing the resulting deposition system.

Professor Weng W1

High Strength, Light Weight Spherical Pressure Vessel with Fiber-Reinforced Composites

Project Description:

For space applications or other environments where both light weight and high strength are essential factors for consideration, fiber-reinforced polymer composites often provide one of the best choices as compared to traditional materials such as steel or aluminum. In this project, we will first learn the basic principles of fiber reinforced composites, and then apply them to construct a spherical pressure vessel subjected to a prescribed internal pressure. For optimal design, an in-plane isotropic laminated construction needs to be sought for. Through analysis based on the stiffness and strength of fibers and polymer matrix, an optimal design will be developed. Based on this conceptual design, we will then proceed to build the pressure vessel with multi-layered isotropic configuration. The critical design factors are to build the strongest and largest possible vessel within the allocated budget so that it can contain the maximum amount of substance under high pressure without burst. The developed pressure vessel will be tested, and its functions will be compared with those of stainless steel.

Professor Weng W2

High Strength, Light Weight Cylindrical Pressure Vessel with Fiber-Reinforced Composites

Project Description:

For space applications or other environments where both light weight and high strength are essential factors for consideration, fiber-reinforced polymer composites often provide one of the best choices as compared to traditional materials such as steel or aluminum. In this project, we will first learn the basic principles of fiber reinforced composites, and then apply them to construct a spherical pressure vessel subjected to a prescribed internal pressure. For optimal design, an in-plane orthotropic laminated construction needs to be sought for. Through analysis based on the stiffness and strength of fibers and polymer matrix, an optimal design will be developed. Based on this conceptual design, we will then proceed to build the pressure vessel with multi-layered cross-ply configuration. The critical design factors are to build the strongest and largest possible vessel within the allocated budget so that it can contain the maximum amount of substance under high pressure without burst. The developed pressure vessel will be tested, and its functions will be compared with those of stainless steel.

Professor Yi Y1-Y2

Professor Zebarjadi Z1-Z2

Professor Zou Z3

Plant-centered Mobil Sensing Network for Environmental Mapping

In this project, we are exploring, for the first time, a mobile robot network each carrying a plant to sense and map the gas composition of a given environment. The idea is to utilize the plant as the sensor of the environmental gas composition (for example, the CO_2/O_2 composition of the environment), and utilize the mobile robot to facilitate, amplify, and strengthen the sensing function and performance of the plant. The goal is to acquire and maintain a real-time mapping of the environmental gas composition. This project is built upon the success of IndaPlant senior design project in previous years. The task of your team is to utilize three mobile robots based on the arduino microcontroller each with light sensing (using solar panels), subject detection (using sonar sensors), and wireless communication between them to: (1). Build the sensing system for detecting the environment gas and related plant biochemical/biophysical reactions and integrate to the arduino system of each robot, and establish and characterize the sensing capability of each Indaplant; (2). Build the control system to plan, control, guide, and coordinate the motion of the robot network, guided by the plants, to measure the CO_2/O_2 composition of a closed environment; And (3). build the wireless communication system so that the environment mapping information can be shared and reported to the user in real-time.

Professor Zou Z4

Flying UAV for 3-D Environmental Mapping and Monitoring

In this project, we aim to build a plant-centered drone to exploit, for the first time, the sensing capability of plant in 3-D environment. The idea is to use an unmanned autonomous vehicle (UAV) to carry a plant and fly around to sense and thereby, map the gas composition (e.g., the CO_2/O_2 composition) of that environment. The flying motion and operation of the drone will be autonomous, and should serve and be guided by the sensing function of the plant. Such a plant-centered flying drone can potentially find applications in a wide variety of areas (Use your own imagination here!). This project is built upon a previous senior design project where a remotely-controlled UAV platform has been designed and built. The tasks of your team in this project are to: (1). Build the sensing system to detect the environmental gas and the biophysical/biochemical reactions of the plant, and integrate it into the robot system of the UAV; and (2). Design and build the control system to guide the motion of the UAV to, autonomously, sense and measure the gas composition of a closed environment (e.g., a room) in real-time.