2018-19 Senior Design projects

467 MECHANICAL PROJECTS

Professor Bai B5

The goal is to design, fabricate, and test an UAV that can exploit solar energy and atmospheric convection to extend flight duration, increase performance and reduce energy consumption. The design and fabrication shall be finished by the fall. And the Flight testing will be done in the spring.

Professor Baruh B3

Motorization of a Conventional Wheelchair - H. Baruh, Adviser

This project will build on a successful design project (2015-2016 and 2017-2018 academic years) to develop a conversion kit to convert a traditional wheelchair to a motorized one. The idea is to create a kit that can be installed on a wheelchair in less than two hours. It should also be possible to remove the motorization kit in an hour and to return the wheelchair to its original state. To this end, optimization of the motor size and battery capacity is required. The smoothness of the ride of the wheelchair are very important. Also, while the motorization kit is installed on the wheelchair, the rider should be able to ride the wheelchair in motorized as well as in human-powered form. The conversion kit has to be as lightweight as possible.

Professor Baruh B4

Drones in Tandem

This project will build on a successful design project (2017-2018 academic year) to develop a pair of drones that fly in tandem. The first drone will be human-operated and the second drone will follow or fly next to the first drone at a predetermined distance. The drones will have cameras, they will take pictures, and a commercial stitching software will be used to combine the two pictures. This way, the drones will be able to produce pictures of wider areas. Forest fires, natural disasters, and security emergencies are some of the applications. Furure applications involve having more drones flying in tandem.

<u>Professor Bottega B9</u>
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.

<u>Professor Bottega BW</u>
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<u>Professor Bilgen BA</u>
Multi-Mode Hybrid Unmanned Delivery System: Combining Fixed-Wing and Multi-Rotor Aircraft with Ground Vehicles

The goal of this project is to investigate novel concepts for a multi-mode unmanned aerial system. For example, a VTOL vehicle attached (docked) to a fixed-wing (i.e. STOL) vehicle. In this case, the fixed-wing aircraft does the long-distance “cruising.” Once the system within the vicinity of the delivery location, the multi-rotor will detach and will take care of the vertical movement for a controlled delivery to the ground. Navigation, planning, logistics, policy issues, docking/undocking, platforms etc. are all very interesting and relevant problems – such issues will be looked at by the design team. A multi-disciplinary senior-design team is anticipated.

The students should be very comfortable with at least one of the following: 1) Design and analysis software such as Matlab, Xfoil, AVL, Ansys, Solid Works, Siemens NX or other CAD packages, LabVIEW, etc.; 2) Simple analog or digital electronics such as resistors, capacitors, op-amps, microcontrollers (i.e. Arduino), simple wiring, etc.; 3) Fabrication techniques such as 3D printing, bonding, vacuum bagging, manual fabrication, etc.

All team members are expected to have an exceptional work ethic and dedication to the project. Students having a high course load in their senior year should consult Dr. Bilgen before applying. Students from all backgrounds who are interested in continuing to graduate school are highly encouraged to join. Please contact Dr. Bilgen via email to arrange a tour of the Smart Systems Laboratory.

Professor Bilgen BB

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Professor Bilgen BC

A Novel Quad-Copter “Drone” with Solid-State Rotors

The goal of this project is the design, analysis, fabrication and testing of a small quad-copter unmanned aerial vehicle (UAV) that utilizes smart materials to achieve control and improvement of performance of its rotor blades.
The team will design, fabricate and test multiple iterations of the solid-state rotors as well as power/sensing electronics and control algorithms. The prototypes will be implemented on a quad-copter for demonstration purposes.

The students should be very comfortable with at least one of the following: 1) Design and analysis software such as Matlab, XROTOR, XFOIL, AVL, Ansys, Fluent, Solid Works, Siemens NX or other CAD packages, LabVIEW, etc.; 2) Simple analog or digital electronics such as resistors, capacitors, op-amps, microcontrollers (i.e. Arduino), simple wiring, etc.; 3) Fabrication techniques such as 3D printing, bonding, vacuum bagging, manual fabrication, etc.

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Similar working models can be seen at the YouTube link below:
[http://www.youtube.com/watch?v=KxTJBp53nO0]

Professor Cuitino C3
Design for Manufacturing Bench Press Neck Guard

A recent patent (https://www.google.com/patents/US20150011367) has been granted to Mr. Andrew Schmidt for Bench Press Neck Guard. This is "a portable lifesaving device that prevents a falling weight bar from injuring the neck while a weightlifter performs a bench press...". Mr. Schmidt has developed the first prototype but there is the opportunity to introduce engineering concepts to concurrently explore shape and material options towards a simple, robust and economical product. The goals of this project are: to develop a conceptual design plan based on the current patent, to manufacture prototypes, to assess safety through testing and to evaluate cost options. The tasks of these project include conceptualization and design, numerical simulations, manufacturing, testing, communication (weekly meetings/presentations/reports). The deliverables are 1) periodic technical reports, 2) working prototype, 3) safety assessment study, 4) general audience material (presentation, video, brochures). This opportunity is open to students with strong interest towards bringing a product to market.

Professor Cook-Chennault C4
Energy Harvesting and Structural Health Monitoring for the Rutgers Football Stadium

The goal of this project is the design, analysis, fabrication and testing of a smart material based energy harvesting and structural health monitoring system for the Rutgers Football Stadium (as well as for other civil structures such as wind turbines, bridges and buildings.) The team will utilize piezoelectric materials and other types of devices to sense and harvest environmental energy. The team will design, fabricate and test several different iterations of various devices as well as power/sensing electronics and control algorithms. The prototypes will be tested on the Rutgers Football Stadium.

Professor DeMauro D7 ME
GoFly Competition

Professor Denda D1
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 Denda D2
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Professor Drazer D5

This project will integrate mechanical engineering and rehabilitation science. We have constructed the VRACK (virtual reality cycling kit) it contains sensorized pedals, handlebars and a heart rate monitor that are interfaced with a virtual environment. We also have commercial pedals from garmin that interface with the virtual environment, this project will find the middle ground solution between our VRACK (now outdated) and the commercial option (too expensive). Sensors, 3 d printing and making it all works for persons who have had a stroke.

Professor Guo G3

Building Devices for Harvesting Solar Energy and Desalination

The amount of solar irradiation on earth's surface is gigantic, but most of which remains unutilized while we keep depleting traditional fossil fuels. Photovoltaic (PV) or solar cells convert light energy into electricity. The yearly installation capacity of solar photovoltaic facilities has seen a continuous significant increase worldwide in recent years. Solar energy is also used for natural illumination and water and space heating. 97% of the water on the Earth is salt water. Water scarcity is among the major problems to be faced by human beings. Solar desalination is a technique to desalinate water using solar energy.

In this project, you could bring in some "wild" ideas to design and build a device for solar energy harvesting or for solar desalination. For example, you may consider harvest solar energy for illumination and water heating via a smart window, build a small solar cell power generator, or design a solar desalination device. The objective of this project is to design, build, and analyze a device for solar energy harvesting or water desalination for engineering practice of natural renewable resources.

Professor Guo G4

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Professor Lee L1
3D Printing with Novel Materials

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 new 3D printer and process, with which one can print non-traditional materials. Examples may include chocolate, cookie dough, recycled material from plastic bottles, and many others.
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 (30%), and (3) characterizing material properties of printing materials (30%).
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 with Moving Platform

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
A conveyer-belt based sorter for sorting recycled metal shreds

Copper, aluminum, and steel are valuable metals result from shredding used house appliance parts such as refrigerator condensers. The shredder typically generate shreds with the size of centimeters. This project will design a belt-and-switch-based technology to spread the shreds from a heap, and to sort them for further processing. This project will involve smart industrial and mechanism design to achieve the goal of alignment and sorting. We may start by employing platforms such as provided by vention.io (visit the website for images).

Professor Knight K1

Professor Mazzeo M1
Cable-driven device for assisting people with eating

Professor Mazzeo M2
Pressure or cable-driven robotic arm

Professor Mazzeo M7
Thermoset-based additive manufacturing for flexible devices

Professor Mazzeo M
With the School of Communication
System for aiding in preventing binge drinking

Professor Muller M3

Our design group will develop a small sensor using 1-d vibrations to measure load and use patterns for squirrel cage induction motors. Sensor will be magnetically coupled, battery powered, interact directly with the internet and have only a start/stop switch.

Professor Malhorta M5
3D printing from dust

As we start to venture into space again, there is a need to develop technologies for rapid fabrication of housing using resources that are available on planets (e.g., sand and rock). This project will develop a 3D printer that is capable of building solid structures (on a small scale) based on a binder-jet type system but using sand as a base material.

Learning Opportunity: This is a great opportunity for students who seek experience with advanced additive manufacturing techniques. The project involves (1) Design and integration of mechanical components (50%) (2) Control integration for automation of the process (50%)

Desired qualities: Some familiarity with 3D printing and controller instrumentation programing (Labview, Arduino, or other similar platform that drives motors/stages from PC), CAD software (AutoCAD, SolidWorks, or others), basic machining skills.

Professor Malhorta M6

Testing conductive interconnects on fabrics and polymers under mechanical deformation for flexible electronics.

A key component of flexible electronics on fabrics and polymers is the conductive interconnect, composed typically of copper or silver material in patterns. The goal of this project is to develop a desktop scale test-setup that can measure dynamic changes in conductivity of such interconnects while the polymer or fabric substrate is under mechanical deformation, and correlate these changers to the strain on the substrate. We will design and integrate existing designs for electrical probe stations with mechanical deformation stages that subject the substrate to controlled uniaxial, biaxial and twisting deformation. Pre-fabricated interconnects and conductive films will be provided.

Learning Opportunity: This is a great opportunity for students who seek experience with mechanical design, instrumentation and programming. The project involves (1) Design and machining of mechanical components (40%) (2) Programming and control integration for automation of the test setup (40%) (3) Characterization of conductivity evolution and strains during deformation (20%).

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

Professor Norris N1

To design, fabricate and test a dynamic vibration absorber rig that can be used by MAE students to demonstrate vibration control theory for minimizing machine vibration. The final product will include a controllable variable-speed drive, an unbalanced rotating disc, compressive springs, and an adjustable mass. The rig should be robust and able to operate with large vibration amplitude without wear. Design and testing will identify the most likely source of failure , and will come up with strategies for operational improvement. A basic but instructive example of a dynamic vibration absorber rig is http://bit.do/443_4

Professor Pelegri P1
Lightweight Carbon Fiber Automotive Wheel

The goal of the carbon fiber wheel is to reduce wheel weight by 30% while maintaining stiffness, compared to a currently available aluminum alloy wheel. This project serves as a preliminary study in design and manufacturing for the future of Rutgers Formula Racing.

Professor Pelegri P2
Drop Tower Impact Testing System

A machine is designed to test material impact response for a wide range of applications. The machine will be more cost effective than its competitors while retaining the quality and accuracy of performance and data acquisition. The electronic data acquisition system and the high speed cameras will be set up during the 2018-2019 project.

Professor Shan S1
Aerostat wind turbine:
Students will design and build a tethered blimp-bone wind turbine for power generation.

Professor Singer S-5
High-Power Spatial Light Modulator

The team will be tasked with building a spatial light modulator capable of manipulating high-power lasers through the use of hybrid lithographic patterning.This will involve assembly of the optical system, simulation of its operation, and demonstration of the technology for later scaling into a complete system.

Professor Scacchioli S7
Professor Scacchioli S8

Professor Tse T1
Mechanical horse to practice equestrian riding
Horses have natural gaits such as: walk (4 beat), trot (2 beat), canter (3 beat), and gallup (4 beat). A rider needs to be able to learn/ride these different gaits. This project involves designing and building a device to help a rider practice riding the gaits, including the

transition from trot to canter, while 'off-horse'. Moreover, horseback riding is known to have therapeutic effects in stroke and other disabled patients because of the balance and rhythms involved. Such a device would help these people as well.

Professor Weng W1

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

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 cylindrical 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 Weng W2

W2: High Strength, Light Weight Spherical Pressure Vessel with Fiber-Reinforced Composites

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 Yi Y1

Autonomous robotic grinder

Description: The team will work to design, fabricate and test an autonomous robotic grinder for concrete surface floors in construction or civil infrastructure systems. Ideally, the project requires knowledge of mechanical design, electronics and embedded systems and extensive program skills.

Professor Yi Y2

Development of autonomous robotic systems for plant disease detection and rehabilitation

The team will work to design, fabricate and test an autonomous robotic system for plant disease detection and rehabilitation. The team will work with plant biologists to develop a fast, effective, efficient robotic solution to detect, identify and treat plant diseases.

Professor Zou Z3

An UAV-UGV-Integrated System for A School of Moving Plants in 3-D

In this project, we aim to integrate a group of ground robotic carts (UGVs) with a group of drones (UAVs) to enable a school of plants to cooperatively work together as a team to explore and survive in a 3D environment. The UAVs and UGVs each will carry a plant, to empower the plants not only the 3-D mobility, but also the intelligence to maximize their ability to survive and grow in harsh environment. The idea is to utilize the UAVs to guide and optimize the ground UGVs in the search of seek resources (e.g., light or water) and avoid dangers (e.g., harsh condition, harmful insects) for the plants in 3-D. The UAVs and UGVs shall work autonomously to “understand” the status and “feelings” of the plants, and sense and estimate the environment conditions in real-time, and then work together in a cooperative manner to seek the optimal actions for resource seeking and danger avoidance. This project is built upon previous senior design projects where three UAVs and three UGVs have been built with limited communication and autonomous (for UAVs) capabilities. The tasks of your team in this project are to: (1). Integrate the UAVs and UGVs together for autonomous path seeking and path planning in 3-D; (2). Design and implement optimal resource seeking algorithms; and (3). Demonstrate that the team can cooperatively seek resources and avoid danger all by themselves optimally.