2017-18 Senior Design projects

Projects marked open do not require an sp# to register.

Professor Bagchi B1

Biomematic flying and swimming (2 teams)

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

Professor Bagchi B2

Biomematic flying and swimming (2 teams)

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

Professor Bai B5 OPEN

The sky provides the perfect phenomena to glide through the air with ease. This phenomena, thermals, are columns of heated air randomly scattered throughout the atmoshpere. The XL Radian 2.6m glider has been modifi ed with an APM 2.6 Autopilot to detect thermals and utilize them to maneuver from point to point in order to save energy.

Professor Bai B6 OPEN

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Professor Baruh B3

Motorization of a Conventional Wheelchair

This project will build on a successful design project (2015-2016 academic year) 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 is a very important factor. Also, while the motorization kit is installed, 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

Aircraft Conflict Resolution Cataloger

This project will be conducted in collaboration with the Federal Aviation Administration. The end product of this project will be the development of a software tool to help identify and catalogue the conflict resolution events that occur in the National Aerospace System at altitudes over 18,000 ft by matching the predicted alerts and trajectories with evidence of physical maneuvers and recorded clearances (i.e. recordings of air traffic control communications to the aircraft) that result in the removal of the alert and changes to the predicted trajectory. The development of the software tool will require some dynamics simulations as well. Please note: Substantial experience with Matlab programming is required to implement this project. Also, because the project will involve frequent trips to the FAA, U.S. citizenship is required to facilitate the entry into the FAA buildings.

Professor Benaroya B7

Inflatable-Deployable Structures for the Lunar Surface:

Concepts will be developed and designed, addressing the environmental issues we find on the lunar surface. In addition to the environmental issues, there are the structural fabrication, deployment, and rigidizing the inflatable part of the structure.

Professor Benaroya B1 650:487 Aerospace students

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Professor Bottega B9

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 Bottega BW

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Professor O Bilgen BA

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. As a bigger challenge, the design team will also look at issues if such system is to be used beyond line-of-sight. For example, a design challenge is to use the system between Rutgers University in New Jersey, and Old Dominion University and Virginia Tech in coastal and southwestern Virginia respectively. Navigation, planning, logistics, policy issues, docking/undocking, platforms etc. are all very interesting and relevant problems – all issues will be looked at by the design team. A multi-university 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, Ansys, Solid Works, AutoCAD 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 O Bilgen BB

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.

The students should be very comfortable with at least one of the following: 1) Design and analysis software such as Matlab, Ansys, Solid Works, AutoCAD 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 O 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, Ansys, Solid Works, AutoCAD or other CAD packages, LabVIEW, XFOIL, AVL, Fluent, 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.

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

Professor O Bilgen BD

Design and Testing of a Small Scale Smart-Material Based Solid-State Aircraft

This is a multi-disciplinary project based on the design, analysis and testing of a small solid-state ornithopter that uses only smart materials to achieve flight. Electrical (EE), Mechanical (ME) and Aerospace Engineering (AE) students will work together in a multi-department senior design team. The students will design, fabricate and test several different iterations of the smart material based composite aircraft as well as power/sensing electronics and control algorithms.

No aircraft design background required; however the students should be comfortable with at least one of the following: Design and analysis software (MatLab, Mathematica, Ansys, Solid Works, AutoCAD or other CAD packages, LabView, XFOIL and AVL etc.), simple analog and digital electronics (resistors, capacitors, op-amps, microcontrollers, simple wiring, etc.), fabrication techniques (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.

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Professor O Bilgen BE

A Solid-State Fully-Active Smart-Material Based Prosthetic Arm

This is a multi-disciplinary project based on the design, analysis and testing of a solid-state smart material based prosthetic arm. Electrical (EE) and Mechanical (ME) Engineering students will work together in a multi-department senior design team

Professor Callegari C1

Professor Callegari C2

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. Smith 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 DeMauro D7   OPEN

Two groups will compete against each other in the design of an aircraft capable of flying up to a pound of payload into the air and landing. The aircraft must be lightweight and cost efficient. Design considerations for the aircraft include its aerodynamics, stability and control, structure, and the ability to complete a required mission. The first semester will specifically focus on the design and analysis work; the second semester will focus on building each plane. By the end of the first semester, the groups are expected to produce detailed working drawings, 3D CAD drawings, and a 3D assembly drawing. Tolerances must be provided on the working drawings.

The major requirements for the aircraft are:

1. Fixed-wing
a. No delta wing or sweep
b. May be tapered
c. The fuselage may be as thin as desired
d. Single engine propeller
2. Only the vertical and horizontal tails may be symmetric airfoils
a. You have the option to have a canard, but keep in mind that it may be trickier!
b. Provide justification for the selection of the wing airfoil shape
3. Ability to carry up to 1 lb of candy
4. Ability to drop the payload when in the air
5. Take-off and land under its own power
6. Can perform a coordinated turn
7. The wingspan of the aircraft cannot be larger than 3 feet

Therefore, the mission profile for each plane includes taxi, takeoff, climb, cruise, drop payload, descent, and landing, with at least one banked turn. Each plane will be judged based on how they meet the criteria, how their planes perform compared to each other (maximum weight, flight speed, etc.), and the total budget. Also, justifications must be provided for design choices, such as airfoil selection, aspect ratio, tail design, etc. Groups are expected to give weekly project updates via PowerPoint. It is highly encouraged that students have taken are will be taking aerodynamics and flight dynamics. Use of programs like XFoil is encouraged.

Professor DeMauro D1 650:487 Aerospace students

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Professor Denda D1

Bio-Inspired Flapping Wing Energy Harvester (2 groups)

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

Bio-Inspired Flapping Wing Energy Harvester (2 groups)

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.

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Professor Diez D3

Design and Fabrication of a multirotor or a fix wing small unmanned air vehicle capable of performing one of the following three missions. (1) Increase fly endurance for long term missions up to 24 hrs by using solar cells; (2) Collocate propellers in such a fashion to imitate a hover bike (if scaled up this could carry a person similar to the Star Wars hover bike); (3) add a vertical wing to a multirotor for increase endurance and range.

Professor Diez D2 650:487 Aerospace students

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Professor Drazer D5 OPEN

Designed for the delivery of emergency supplies in hostile environments, 'The Germanator 650' is built from the bottom-up to achieve maximum lift and effi ciency. It utilizes a glow plug engine to sustain one hour fl ight and the bay door design will enable infl ight delivery of a one kilogram package

Professor Drazer D6 OPEN

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Professor Guo G3

Device Design for Harvesting Thermal/Solar Energy

You have a few options for choice in your device design. For example, you may consider harvesting solar energy via a smart window, or creating a thermoelectric power generator, or any other forms of energy conversion. 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 objective of this project is to design, build, and analyze a device for thermal or solar power generator with practical applications.

Professor Guo G4

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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 650:487 Aerospace students

Design of Model Rocket Engine Thrust Stand

Introduction and Eligibility
There will be two groups (K1 and K2) with a maximum of five students per group. The groups are open to Aerospace Engineering majors only.

Design Project
Each group will design a tabletop test stand for measuring the thrust of a model rocket engine.

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.

Fabrication and Testing
Fabrication and testing will be performed during the Spring semester. All tasks will be completed by the end of the twelfth week.

Final Report
The final report from each group will be due during the last week of class.

Tasks

The following tasks will be performed: 1) design of test stand including Graphical User Interface, 2) CAD model of test stand, 3) fabrication and validation of test stand, 4) maintain up-to-date budget within the limit set by the Department, 5) maintain Sakai website with all results.

Meetings

There will be weekly meetings with the instructor. For each group, one member will make a 15 min Power-Point presentation including the following information: 1) Tasks accomplished during the previous week, 2) Tasks assigned for the next week (each person named), 3) Technical challenges and questions. The presenter for each group will rotate among the entire group.

Professor Knight K2

Design of Model Rocket Engine Thrust Stand

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Design Project
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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 OPEN

Design of an on-stage, micro-climated controlled cell incubabor

We will design and implement a micro-climate (temperature, humidity, CO_2, etc) controlled incubator for cell culturing, incubation, and observation on a microscope stage. The heating power will be supplied by electricity. The control will be realized via feed-back electronic circuits and algorithms. The incubator housing will be rapid-prototyped.

Professor Lin L4 OPEN

Design of an on-stage, micro-climated controlled cell incubabor

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Professor Liu L5 OPEN

Design a heat exchanger of maximum power/cost performance

We have two reservoirs of water of different temperature 10K. If cold water is pumped through a pipe immersed in the hot water, heat exchange occurs through the pipe wall. Let Q be the amount heat exchanged per unit time, and C be the cost which includes the cost of pumping cold water to flow (assume the heat exchanger will operate 50 years) and material cost of the pipe. The performance factor is defined as

$$P=Q/C.$$

The project is to design, build, and demonstrate the pipe with maximum performance factor P. The design parameters include the length, diameter and thickness of the pipe. The material is chosen to be copper.

The design may be applied to build thermoelectric electricity generator of better

Professor Liu L6 OPEN

Design a heat exchanger of maximum power/cost performance

We have two reservoirs of water of different temperature 10K. If cold water is pumped through a pipe immersed in the hot water, heat exchange occurs through the pipe wall. Let Q be the amount heat exchanged per unit time, and C be the cost which includes the cost of pumping cold water to flow (assume the heat exchanger will operate 50 years) and material cost of the pipe. The performance factor is defined as

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Professor Mazzeo M1

A battery-free, wireless load sensor to monitor compressive and bending loads acting on structural components using RFID technology. The sensor consists of liquid metal stored in a silicone tube that deforms under a load, causing its resistance to increase. The change in resistance is proportional to the applied load and is measured with a vector network analyzer.

Professor Mazzeo M2

Repair in space is a daunting task that can be remedied by the use of our 3D printer utilizing a 2 part, carbon fi ber reinforced composite silicone material. Bringing the repair shop with you on your voyage to the stars alleviates unnecessary trips back to Earth.

Professor Mazzeo M7

Design and Fabrication of Elastomeric Actuators

Professor Muller M3

With the advent of microprocessors, factories globally are now
able to enter Industry 4.0, combining computers and automation to
create "Smart Factories." Our project uses a Raspberry Pi to monitor
system status, communicates to users wirelessly via cloud, and creates
a simple, inexpensive retrofi t to existing plants.

Professor Muller M4

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able to enter Industry 4.0, combining computers and automation to
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a simple, inexpensive retrofi t to existing plants.

Professor Malhorta M5

Title: Developing a seamless process for integrating functional nanomaterials inside polymer objects during 3D printing

Description: Integration of functional nanomaterial-based devices inside 3D objects has applications in biomedical, structural and manufacturing sectors. A feasible and scalable approach for manufacturing such smart structures is to integrate existing methods for nanoparticle printing, recently developed rapid-flash-lamp annealing of nanoparticles, and conventional 3D printing within a single seamless system. This project aims to develop a prototype to demonstrate the feasibility of this approach. We will integrate existing tools for aerosol-jet deposition and flash-lamp annealing of conductive nanoparticles with conventional polymer 3D printing. Further, the conductivity of the embedded nanoparticle films will be characterized as a function of deformation of the 3D object and temperature evolution during printing.

Learning Opportunity: This is a great opportunity for students who seek experience with advanced additive manufacturing techniques. The project involves (1) Design and machining of mechanical components (40%) (2) Programming and control integration for automation of the process (40%) (3) Characterization of temperature and conductivity evolution during and after the printing process (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 behavior and thermodynamics.

Professor Malhorta M6

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

Description: 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 OPEN

CBF: Cheaper, Better Faster. Adapting inexpensive devices and optimized computational codes to develop cheaper, better and faster mechanical measurements.

The development of Matlab, Comsol, and other software packages allows the same type of digital analysis on a laptop that used to be (10 to 20 years ago) reserved for very expensive analog equipment. At the same time, manufacturing has dramatically reduced the price of measurement devices. The team project will brainstorm to develop new uses of this unused computational and measurement potential. Vibration characterization will be the initial focus: The group will adapt cheap (approx. 2$) but versatile accelerometers to measure dynamic properties of materials and structures, and write GUIs to communicate the data.

Recommended: Some knowledge and appreciation for vibration, dynamics, and Matlab.

Professor Norris N2 OPEN

CBF: Cheaper, Better Faster. Adapting inexpensive devices and optimized computational codes to develop cheaper, better and faster mechanical measurements.

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Recommended: Some knowledge and appreciation for vibration, dynamics, and Matlab.

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The students will utilize a piezoelectric sensor to control a shape-memory alloy actuated solid-state prosthetic device. The prosthetic device will consist of solid-state smart-materials and will not have any conventional mechanical devices such as motors, linkages or gears. The students will design, fabricate and test several different iterations of the structure as well as power/sensing electronics and control algorithms. This project will complement current research within the medical field.

No specific subject background required, however students should be comfortable with design and analysis software (MatLab, Mathematica, Ansys, Solid Works, AutoCAD or other CAD packages, LabView, etc.), simple analog and digital electronics (resistors, capacitors, op-amps, microcontrollers, simple wiring, etc.), fabrication techniques (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 Pelegri P1

Design of a Humane Squirrel Repelling Water Gun Robot

The cute squirrels that live in the trees and play on our lawns love to dig our flower pots. During this project a robot equipped with a water gun and machine vision will be designed and prototyped. The specific goals of this project entail: 1) design a robot to shoot bursts of water at a squirrel at a distance of 20 ft, 2) enable robotic vision covering a wide angle, 3) enable recognition of a squirrel within 5 sec, 4) enable rotation of the robot about two axis, and 5) fabricate and successfully test the above mentioned system.

Professor Pelegri P2

By invitation only

<u>Professor Shan S1</u>

Title: Pond Cleanup

Design a floating, amphibious, or flying craft to clean up floating debris like milk jugs from a pond, and deposit the cargo on land (ideally in a trash can).

<u>Professor Shan S2</u>

Title: Pond Cleanup

Design a floating, amphibious, or flying craft to clean up floating debris like milk jugs from a pond, and deposit the cargo on land (ideally in a trash can).

<u>Professor Singer S-5</u>

Metamaterials for Photothermal Microwave Heating

Team will be tasked to demonstrate targeted heating of metamaterial resonators using household microwave sources (*e.g.* oven magnetron) with an aim to create localized convective flows. This will require optimization of geometry and materials to maximize thermal conversion while keeping the targeted resonance. Team will incorporate infrared thermometry to assess the efficacy of their designs. Early stages of the project will involve finite elements simulations of the target structures while building the imaging setup. Later stages of the project will involve the fabrication and testing of the metamaterial structures.

<u>Professor Singer S-6</u>

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 Scacchioli S7 OPEN

The objective of this project is to design a racing robot that can perform several tasks, including staying on track and avoiding obstacles by curving and self-crossing racetrack at certain speeds through the use of optical sensors. Students will use a 1/10th-scale car platform and a CPU board. They will determine the optimal strategy for meeting the project's goal by designing appropriate sensors, electronics, and control algorithms. In this project students will have the chance to use their knowledge (or learn about) controls, realtime embedded software, power electronics, filtering and signal processing, microcontrollers, and electromechanical systems in designing a racing robot. This experiment will then be included, as demo, in the laboratory activities of the new established course for Rutgers UG students, "Introduction to Mechatronics."

Professor Scacchioli S8 OPEN

The objective of this project is to design (analytical and numerical) and build (hands-on) platforms (control computers and physical systems) for visualizing control theory applied to real-world engineering problems. Application field is multi-disciplinary with emphasis placed on electro-mechanical and electro-magnetic systems. Possible experiments that can be built under this project are the "Ball and Beam" (https://en.wikipedia.org/wiki/Ball_and_beam), the "Cart and Pole" https://en.wikipedia.org/wiki/Inverted_pendulum), and the "Magnetically Levitated Sphere (https://en.wikipedia.org/wiki/Magnetic_levitation)". Each experiment is unstable, visually appealing, instructive, and technically challenging. Teams of students will design, build, test, and document mechanical hardware, sensors, actuators, computer interface, and real-time software to construct the platform. These experiments will then be included, as demos, in the laboratory activities of the new established course for Rutgers UG students, "Introduction to Mechatronics."

Professor Tse T1

Training Devices for Improving/Refining Baseball Player Mechanics

Prof. S. Tse and Coach S. Olson
Baseball is a skill sport where optimum mechanics and techniques are necessary to achieve ultimate success on the playing field. Each year, the American Baseball Coaches Association hosts a convention and trade show to award Best of Show

certificates by Collegiate Baseball for innovative products. It is the goal of this design project to develop and manufacture a (some) novel training-device prototype(s) that would fit in such a category. Tentatively, the project(s) would concentrate on behavioral aspects of hitting and pitching. For example, a mechanical device would be developed focusing on swing plane in hitting, which will provide instantaneous feedback to reinforce hitting mechanics that ensure that the swing is in the proper path and sequence. Another example would be to develop a mechanical device to work on throwing motion, not only to improve pitch delivery, but also to save elbows from injury. More than one design group may be formed.

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

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 is asked to design, fabricate and test an autonomous robotic grinder for civil infrastructure applications. The robotic grinder should be operated autonomously or remotely controlled by human operators to grind any concrete surface in buildings, bridge decks or parking lots, etc. The team will work on both the mechanical, electrical and computer systems design of the robotic grinder.

Professor Yi Y2

Autonomous robotic grinder

Description: The team is asked to design, fabricate and test an autonomous robotic grinder for civil infrastructure applications. The robotic grinder should be operated autonomously or remotely controlled by human operators to grind any concrete surface in buildings, bridge decks or parking lots, etc. The team will work on both the mechanical, electrical and computer systems design of the robotic grinder.

Professor Zou Z3 OPEN

A Robotic-enabled Intelligent Moving School of Plants

In this project, we are developing and exploring a mobile robot network each carrying a plant and to work cooperatively as a team to maximize the survivability and healthy of the plants in an unknown and potentially hazardous environment. The idea is to equip the plants with mobility, environment sensing (e.g., light, temperature, and vision) and communication capability (wireless communication), and allow and help the plants to communicate and share information with each other about the environment, to seek resources (e.g., water, light) and/or avoid dangers (e.g., harsh temperature and/or harmful insects), thereby, turning the group of plants into a group of social "animal-like" subjects. This project is built upon the success of IndaPlant senior design projects and plant-centered mobile robot network in the last three years. The task of your team is to further enhance the function and capability of 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, and investigate their teamwork capability in different environment conditions through optimization and artificial intelligence strategies.

Professor Zou Z4 OPEN

UAV-enabled Intelligent Flying School of Plants

In this project, we aim to build a group of plant-centered drones to enable the group of plants to cooperatively work together as a team to explore and survive in a 3D environment. The idea is to create a group (three) of unmanned autonomous vehicles (UAV) each carrying a plant and fly around to seek resources (e.g., light or water) and avoid dangers (e.g., harsh condition, harmful insects) through collaboration. The flying motion and operation of the drones will be autonomous, and should serve and be guided by the sensing function of the plant. Such a plant-centered flying school of plants 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 an autonomous UAV platform has been designed and built. The tasks of your team in this project are to: (1). Build two more UAV platforms each with the sensing and autonomous maneuvering capability; (2). Equip the three UAVs with wireless communication capability among them; and (3). Demonstrate that the team can cooperatively seek resources and avoid danger all by themselves.