Rutgers University

Department of Mechanical & Aerospace Engineering

2020-2021 Senior Design Projects

14:650:487/488 Aerospace Engineering Design I/II

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AE PROJECT 1

Mechanical Bird

Advisor: Prof. Prosenjit Bagchi

Email: pbagchi@soe.rutgers.edu

WebEx Meeting Place: https://rutgers.webex.com/meet/pbagchi

Project Abstract: Building mechanical bird

Project Goals: Design and fabrication of a device that can fly like a bird

Project Envisioned Outcomes: Generation of aerodynamic thrust and lift using flapping wings.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design		☑			
Analysis		☑			
Hand tools		☑			
Traditional Machining		☑			
CNC machining	☑				
3D printing		☑			
Welding		☑			
Wiring		☑			
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)		☑			
Microcontrollers (e.g., Arduino)		☑			
Bonding	☑				
Processing (e.g., vaccum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab			☑		
Comsol			☑		
Python	☑				

Ansys	☑				
SolidWorks			☑		
Other CAD packages	☑				
Siemens NX	☑				
LabView	☑				
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program	☑				

AE PROJECT 2

Attitude Control System for Rocket Stabilization

Advisor: Prof. Haim Baruh

Email: baruh@soe.rutgers.edu

WebEx Meeting Place: https://rutgers.webex.com/meet/baruh

Project Abstract: Design an attitude control system that will stabilize a rocket when it is launched and during flight.

Project Goals: Using quaternions, develop and attitude control system for an object in flight. Then, build the circuitry, the electronics board, and mounts for attaching to a rocket. Calibrate the attitude control system and design it so that it will withstand the impact forces associated with landing, as well as vibratory forces associated with launch.

Project Envisioned Outcomes: The project will develop a computer-controlled small platform that is installed on a rocket. The platform has to be reliable and strong and be able to operate under harsh conditions.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design			☑		
Analysis				☑	
Hand tools			☑		
Traditional Machining		☑			
CNC machining	☑				
3D printing		☑			
Welding	☑				
Wiring			☑		
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)					☑
Microcontrollers (e.g., Arduino)					☑
Bonding		☑			
Processing (e.g., vaccum bag, autoclave)			☑		

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab					☑
Comsol					☑
Python					☑
Ansys				☑	
SolidWorks			☑		
Other CAD packages	☑				
Siemens NX	☑				
LabView	☑				
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program	☑				

AE PROJECT 3

Design Inflatable Deployable Lunar Habitat

Advisor: Prof. Haym Benaroya

Email: benaroya@soe.rutgers.edu

WebEx Meeting Place: https://rutgers.webex.com/meet/benaroya

Project Abstract: Design Inflatable Deployable Lunar Habitat

Project Goals: Compare design options, analyze, build.

Project Envisioned Outcomes: the lunar habitat.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design			☑		
Analysis			☑		
Hand tools		☑			
Traditional Machining		☑			
CNC machining	☑				
3D printing	☑				
Welding	☑				
Wiring	☑				
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)		☑			
Microcontrollers (e.g., Arduino)	☑				
Bonding	☑				
Processing (e.g., vaccum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab		☑			
Comsol	☑				
Python	☑				

Ansys		☑			
SolidWorks			☑		
Other CAD packages	☑				
Siemens NX	☑				
LabView	☑				
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program	☑				

AE PROJECT 4

Design and Testing of a Drone to Conduct Zero-G Experiments

Advisor: Prof. Onur Bilgen

Email: o.bilgen@rutgers.edu

WebEx Meeting Place: https://rutgers.webex.com/meet/ob126

Project Abstract: The goal of this project is the design, analysis, fabrication and testing of a small quad-copter unmanned aerial vehicle (UAV) to act as a platform to conduct Zero-G experiments. The team will design, fabricate and test multiple iterations of the vehicle, as well as develop necessary control algorithms.

The students should be very comfortable with at least one of the following: 1) Design/analysis and programming software such as Matlab, Xfoil, AVL, E-Calc, Mission Planner, Ansys, Solid Works, Siemens NX or Other CAD packagess, LabVIEW, etc.; 2) Simple analog or digital electronics such as resistors, capacitors, op-amps, microcontrollers (i.e. Arduino, Raspberry Pi), wiring, soldering, 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 from all backgrounds who are interested in continuing to graduate school are highly encouraged to join. Please contact Dr. Bilgen via email (o.bilgen@rutgers.edu).

Project Goals: The goal of this project is the design, analysis, fabrication and testing of a small quad-copter unmanned aerial vehicle (UAV) to act as a platform to conduct Zero-G experiments.

Project Envisioned Outcomes: The team will design, fabricate and test multiple iterations of the vehicle, as well as develop necessary control algorithms..

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design			☑		
Analysis			☑		
Hand tools		☑			
Traditional Machining	☑				

CNC machining	☑				
3D printing	☑				
Welding	☑				
Wiring		☑			
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)		☑			
Microcontrollers (e.g., Arduino)	☑				
Bonding	☑				
Processing (e.g., vaccum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab			☑		
Comsol	☑				
Python	☑				
Ansys	☑				
SolidWorks		☑			
Other CAD packages		☑			
Siemens NX	☑				
LabView	☑				
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program	☑				

AE PROJECT 5

A Novel Quad-Copter "Drone" with Solid-State Rotors

Advisor: Prof. Onur Bilgen

Email: o.bilgen@rutgers.edu

WebEx Meeting Place: https://rutgers.webex.com/meet/ob126

Project Abstract: 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/analysis and programming software such as Matlab, Xfoil, AVL, E-Calc, Mission Planner, Ansys, Solid Works, Siemens NX or Other CAD packagess, LabVIEW, etc.; 2) Simple analog or digital electronics such as resistors, capacitors, op-amps, microcontrollers (i.e. Arduino, Raspberry Pi), wiring, soldering, 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 from all backgrounds who are interested in continuing to graduate school are highly encouraged to join. Please contact Dr. Bilgen via email (o.bilgen@rutgers.edu).

Project Goals: 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.

Project Envisioned Outcomes: 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.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design			☑		
Analysis			☑		
Hand tools		☑			
Traditional Machining	☑				
CNC machining	☑				
3D printing	☑				
Welding	☑				
Wiring		☑			
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)		☑			
Microcontrollers (e.g., Arduino)	☑				
Bonding	☑				
Processing (e.g., vaccum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab			☑		
Comsol	☑				
Python	☑				
Ansys	☑				
SolidWorks		☑			
Other CAD packages		☑			
Siemens NX	☑				
LabView	☑				
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program	☑				

Additional Requirements and Information:

Link to similar projects: http://www.youtube.com/watch?v=KxTJBp53nO0

AE PROJECT 6

Highly Agile Vertical Take-Off and Landing Drone

Advisor: Prof. Laurent Burlion

Email: laurent.burlion@rutgers.edu

WebEx Meeting Place: https://rutgers.webex.com/meet/lb823

Project Abstract: Highly agile Vertical Take-Off and Landing drone

Project Goals: The objective of the project is to design and build a drone equipped with both tilting rotors (for vertical takeoff) and a main wing. In addition to the design, special attention will be paid to transitional maneuvers and the possibility of using precise positioning equipment to fly the drone in open fields.

Project Envisioned Outcomes: The project is the continuation of the "VTOL" projects 2019-2020. The team will improve the initial design by improving the tilting rotors, adding a very accurate positioning system, and performing real flight tests indoors and outdoor.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design				☑	
Analysis			☑		
Hand tools			☑		
Traditional Machining			☑		
CNC machining		☑			
3D printing			☑		
Welding	☑				
Wiring			☑		
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)			☑		
Microcontrollers (e.g., Arduino)				☑	
Bonding	☑				
Processing (e.g., vaccum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab			☑		
Comsol	☑				
Python			☑		
Ansys	☑				
SolidWorks			☑		
Other CAD packages	☑				
Siemens NX	☑				
LabView	☑				
E-Calc	☑				
AVL			☑		
Xfoil			☑		
Machine vision program	☑				

Additional Requirements and Information:

Require Raspberry Pi basic knowledge

AE PROJECT 7

Drone Hunter

Advisor: Prof. Laurent Burlion

Email: laurent.burlion@rutgers.edu

WebEx Meeting Place: https://rutgers.webex.com/meet/lb823

Project Abstract: Drone Hunter

Project Goals: The goal of the project is to design and build a drone capable of automatically tracking (using vision based control) and/or neutralizing an unauthorized drone.

Project Envisioned Outcomes: The project is the continuation of the "Drone Hunter" 2019-2020 project. The team will improve the initial design by making the drone more agile, speeding up image processing algorithms and performing real flight tests.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design			☑		
Analysis			☑		
Hand tools			☑		
Traditional Machining		☑			
CNC machining		☑			
3D printing			☑		
Welding	☑				
Wiring			☑		
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)			☑		
Microcontrollers (e.g., Arduino)			☑		
Bonding	☑				
Processing (e.g., vaccum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab			☑		
Comsol	☑				
Python	☑				
Ansys	☑				
SolidWorks			☑		
Other CAD packages			☑		
Siemens NX	☑				
LabView	☑				
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program			☑		

Additional Requirements and Information:

Familiar with the raspberry Pi

AE PROJECT 8

Delta Wing Candy Drop

Advisor: Prof. Edward DeMauro

Email: ed451@soe.rutgers.edu

WebEx Meeting Place: https://rutgers.webex.com/meet/ed451

Project Abstract: Halloween, Christmas, Easter, Valentine's Day, Mother's Day; all great holidays for candy! You love giving candy to your friends and family but hate the mess and chaos! Also, giving out candy takes so much time; who wants to deal with all of that? THERE HAS TO BE A BETTER WAY!!! Presenting: Operation Delta Wing Candy Drop!

Two groups will compete against each other in the design of a DELTA WING aircraft capable of flying up to a ¼-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.

Project Goals: The major requirements for the aircraft are:

1. DELTA WING FLYER
    a. Sweep angle must be greater than or equal to 65-degrees
    b. The fuselage may be as thin as desired
    c. Must be capable of flying at "high angles of attack"
2. Ability to carry up to 0.25 lbf of candy
3. Ability to drop the payload when in the air
4. Take-off and land under its own power
5. Can perform a coordinated turn
6. The wingspan of the aircraft cannot be larger than 3 feet

Project Envisioned Outcomes: 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. Each PowerPoint will be required to summarize the previous week's progress and provide a list of short-term goals for the coming week. It is highly encouraged that students have taken are will be taking aerodynamics and flight dynamics.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design			☑		
Analysis			☑		
Hand tools		☑			
Traditional Machining			☑		
CNC machining		☑			
3D printing	☑				
Welding	☑				
Wiring			☑		
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)			☑		
Microcontrollers (e.g., Arduino)		☑			
Bonding	☑				
Processing (e.g., vaccum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab			☑		
Comsol	☑				
Python	☑				
Ansys	☑				
SolidWorks			☑		
Other CAD packages			☑		
Siemens NX			☑		
LabView	☑				
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program			☑		

AE PROJECT 9

Persistent Drone Weather Monitoring

Advisor: Prof. F. Javier Diez

Email: diez@soe.rutgers.edu

WebEx Meeting Place: https://rutgers.webex.com/meet/diez

Project Abstract: Persistent drone weather monitoring

Project Goals: Develop a drone that can flight tethered continuously for 24hrs for weather monitoring

Project Envisioned Outcomes: Demo a drone that can achieve the project goals.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design				☑	
Analysis		☑			
Hand tools			☑		
Traditional Machining		☑			
CNC machining		☑			
3D printing		☑			
Welding		☑			
Wiring			☑		
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)				☑	
Microcontrollers (e.g., Arduino)				☑	
Bonding		☑			
Processing (e.g., vaccum bag, autoclave)		☑			

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab				☑	
Comsol		☑			

Python				☑	
Ansys		☑			
SolidWorks			☑		
Other CAD packages			☑		
Siemens NX		☑			
LabView			☑		
E-Calc			☑		
AVL		☑			
Xfoil			☑		
Machine vision program			☑		

AE PROJECT 10

Table Top Subsonic Wind Tunnel II

Advisor: Prof. Doyle Knight

Email: doyleknight@gmail.com

WebEx Meeting Place: https://rutgers.webex.com/meet/ddknight

Project Abstract: The project is the design, fabrication and demonstration of a table top subsonic wind tunnel measuring the lift and drag on an airfoil, air velocity, temperature and pressure.

Project Goals: Completion and demonstration of the table top subsonic wind tunnel.

Project Envisioned Outcomes: Demonstration of ability to design, manufacture and validate table top subsonic wind tunnel.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design	☑				
Analysis			☑		
Hand tools			☑		
Traditional Machining			☑		
CNC machining		☑			
3D printing			☑		
Welding	☑				
Wiring			☑		
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)			☑		
Microcontrollers (e.g., Arduino)			☑		
Bonding			☑		
Processing (e.g., vaccum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab				☑	
Comsol			☑		

Python	☑				
Ansys			☑		
SolidWorks			☑		
Other CAD packages	☑				
Siemens NX	☑				
LabView			☑		
E-Calc			☑		
AVL	☑				
Xfoil	☑				
Machine vision program	☑				

AE PROJECT 11

In-Space Manufacturing and Repair

Advisor: Prof. Aaron Mazzeo

Email: aaron.mazzeo@rutgers.edu

WebEx Meeting Place: by schedule

Project Abstract: In-space manufacturing and repair

Project Goals: Modify a conventional 3D printer to extrude thermosetting materials into a damaged region of a structure.

Project Envisioned Outcomes: 3D printer that can do the above

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design	☑				
Analysis	☑				
Hand tools	☑				
Traditional Machining	☑				
CNC machining	☑				
3D printing	☑				
Welding	☑				
Wiring	☑				
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)	☑				
Microcontrollers (e.g., Arduino)	☑				
Bonding	☑				
Processing (e.g., vaccum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab	☑				
Comsol	☑				
Python	☑				
Ansys	☑				

SolidWorks	☑				
Other CAD packages	☑				
Siemens NX	☑				
LabView	☑				
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program	☑				

Additional Requirements and Information:

See article by Mazzeo in
https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20160000456.pdf

AE PROJECT 12

Fleet of Mobile Ground Robot and Drone Plants

Advisor: Prof. Qingze Zou

Email: qzzou@rutgers.edu

WebEx Meeting Place: https://rutgers.webex.com/meet/qzzou

Project Abstract: n this project, we are creating a fleet of mobile plants combining both ground robots and drones working cooperatively together to seek resources and maximize the plants survivability in an unknown and potentially hazardous territory. 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 a few years. The task of your team is to further enhance the function and capability of three mobile robots, develop autonomously-flying drones, and make the robots and drones working together in real-time for territory exploration.

Project Goals: Creating a fleet of mobile plants combining both ground robots and drones working cooperatively together to seek resources and maximize the plants survivability in an unknown and potentially hazardous territory.

Project Envisioned Outcomes: Built upon the success of IndaPlant senior design projects and plant-centered mobile robot network in the last a few years, the team is asked to further enhance the function and capability of three mobile robots, develop autonomously-flying drones, and make the robots and drones working together in real-time for territory exploration.

Students Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Design		☑			
Analysis		☑			
Hand tools		☑			
Traditional Machining		☑			

CNC machining	☑				
3D printing		☑			
Welding	☑				
Wiring		☑			
Simple analog or digital electronics (e.g., resistors, capacitors, op-amps)			☑		
Microcontrollers (e.g., Arduino)			☑		
Bonding	☑				
Processing (e.g., vaccum bag, autoclave)	☑				

Software Expertise:

	None	Beginner	Intermediate	Serious Hobbyist	Professional
Matlab		☑			
Comsol	☑				
Python			☑		
Ansys	☑				
SolidWorks	☑				
Other CAD packages	☑				
Siemens NX	☑				
LabView		☑			
E-Calc	☑				
AVL	☑				
Xfoil	☑				
Machine vision program			☑		