

Spring 2021 Project Descriptions

Introduction:

This document contains different startup projects that students will work on throughout the course of the semester. The projects for this class were developed to maximize student learning while giving students the opportunity to create an impact for the company (yes, the work you do will be used and taken seriously by the startups!).

It is important to read the project descriptions carefully because when applying for the course through the online application, you will need to specify which projects you are interested in working on. You can name as many projects you are interested in. Your chances of being selected in the class do increase if you are interested in more projects so do keep that in mind. As a reminder, please choose projects based on the work you are interested in doing rather than the company name.

It is okay if you do not understand everything about the project you interested in (ie. if there are terms that you have not heard of that are in the project description). After students are enrolled in the course, they will be given more details on their respective projects. Some projects are intentionally vague and once students meet with their startup representative, they will receive a lot more guidance.

Lastly, please know that even if you do not have the technical skills or background desired for a specific project, it is completely okay! As long as you are willing to put in the effort to learn, you will be fine and are encouraged to apply. If you have any questions about the project descriptions or the application, you can email newspace.decal@gmail.com.

Project 1: ML-Enhanced Computer Vision Change Detector System for Satellite Images Analysis

Company Introduction

Spacept is an open innovation company, taking a friendly and collaborative approach to solving some of the world's most challenging problems. Some of these problems include infrastructure inspection, climate change and the risk of wildfires. The company's mission is to "fuse satellite images with AI to prevent power outages and fires sparked by falling trees and storms" (spacept.com). Their "solution saves lives and reduces CO2 emissions while also radically reducing time and cost for infrastructure inspection" (spacept.com).

What You Will Work On

The aim is to develop a prototype product that will undergo a pilot study with a US-based company following the end of the course.

In this project, you will:

- Explore various machine learning techniques (shallow and deep ML, supervised, semi-supervised and unsupervised models), building a ML-enhanced change detector applied to satellite images. The change detector will spot oil on the ocean surface and assess damage to cities following a natural disaster (flood, storm, fires, and earthquakes).
- Carry out business related activities to maximize impact of the technical solution (ie. develop/adapt business strategy and carry out customer mapping and development) utilizing the best practices and principles applied today in startups.

What you do specifically during the semester will depend on your interests, passion and areas where you would like to develop knowledge. Lastly, students will also have an opportunity to collaborate with another team from the University of Cambridge if they desire.

Who We Are Looking For

Python coding and/or business experience and willingness to learn quickly is necessary. Machine learning experience in particular applied to computer vision would be very useful. GIS experience or working with satellite data is a bonus. A strong interest in making an impact on climate change using machine learning is necessary. You are self-motivated, driven and perpetually curious. Students will work remotely entirely, but will interact with the CTO over weekly syncs over virtual coffees, bi-weekly hack-together sessions.

Project 2: Pricing and Distribution Plan Development for Space-Based Solar Power

Company Introduction

Virtus Solis is working on space-based solar power with 100% availability beamed to the Earth, 5x cheaper than existing renewables. Specifically, the company is developing a utility-scale space solar power system generating energy that is available to customers all the time, anywhere on the planet via a clean, low-intensity microwave beam that penetrates clouds, rain, and snow and is available even in darkness. This is the first solar power system capable of making electricity at a fifth the cost of baseload or non-dispatchable renewable alternatives. The system is designed to massively scale with identical meter-scale power sub-satellites and ground-receiving rectennas produced and ground tested on an assembly line. On orbit assembly amounts to linking the sub-satellites together in an array, lofted by commercial launchers. We intend to be a global energy utility disrupting the entire \$8T energy industry and driving the fossil fuel industry to non-competitiveness.

What You Will Work On

You will help identify initial markets and the related orbits, pricing and a temporal and spatial distribution plan for the Minimum Viable Product.

In this project, you will:

- Investigate the factors driving costs for peaking power plants that back up renewable energy sources as well as the trade offs for energy storage
- Knowing the underlying factors of conventional renewable energy resources, the students will compare those limitations to space based power distribution (specifically that the orbital deployment will have 12 hour hang times once a day over opposite hemispheres but can beam power to any ground installation in the field of view with re-aiming times on the order of 15 seconds).
- Compare the factors driving the pricing for Virtus Solis to available revenue and identify specific markets spatially and temporally (daily and seasonally) to deliver power to at costs below conventional solutions to establish a market hold in order to make this new technology viable as it scales.
- Derive a distribution plan that maximizes revenue for a Minimum Viable Space Solar Power satellite array of 100MW capacity.

The analysis of orbits, existing costing, potential pricing for space based solar and a distribution plan are the deliverables for this project.

Who We Are Looking For

Any student with a strong interest in the economics of businesses and technical solutions to the world's biggest challenges are welcome. This will be a research-heavy project with numerical analysis of costs and orbital mechanics.

Project 3: Commercialization Plan for In-space Propellant Delivery Service

Company Introduction

Orbit Fab is building Gas Stations in Space™, creating the on-orbit infrastructure needed for a bustling in-space economy that will support humans in space. Within 12 months of its founding, Orbit Fab had secured venture funding, two launches, and built flight hardware to the harshest safety ratings for NASA's crewed systems. In the company's second year, Orbit Fab became the first private company to supply the ISS with water and locked in contracts with Air Force, NASA and commercial customers to mature all the technology: the Satellite Gas Cap™, Self-Driving Satellite™ kits, and of course the world's first satellite propellant depot (scheduled for launch in mid 2021). In their third year the company is laying the foundations for the Fuel Factory in Space™.

Orbit Fab is developing a ground refueling system that will produce rocket fuel locally and on-demand. The space industry is growing rapidly, and the way that space companies use propellant is changing. In the future, this system will help the satellites' owners' overcome the limit of insufficient fuel after launching, thus giving the owners more freedom to control their probes' orbit.

What You Will Work On

Orbit Fab has the opportunity to create a new product line to augment its in-space propellant delivery service based on technology licensed from one of the world's leading universities.

In this project, you will:

- Perform market research as well as identify and speak with prospective customers to determine the market potential for the system and how it will meet specific clients' needs (product market fit and market validation).
- Develop a commercialization plan that will introduce the product offering to the market. This could include a business canvas model and/or market entry strategy.
- Incorporate all progress into a PowerPoint presentation for the final deliverables.

More details about the final deliverables will be decided between the consulting team and the startup once the class starts.

Who We Are Looking For

We are looking for students who are interested in space exploration and enjoy a fast-paced startup environment. Students of all backgrounds are welcome if they possess determination and an interest in the project.

Project 4: Economic Study on MK2 Fenris Engine for Launch Market Decision Makers

Company Introduction

Mountain Aerospace Research Solutions (MARSEngines.com) has invented, developed and tested a new generation of rocket engines that has performance which vastly exceeds current propulsion solutions. We are engaged in transforming space access. Interestingly, the CEO and Co-Founder Aaron Davis has a degree in Intelligence with an emphasis in SOLIC (Special Operations/Low Intensity- Conflict) and spent 10 years working in that field. Nothing other than his curiosity and tenacity have made the company come to life. Mountain Aerospace Research Solutions is on the cusp of a major break out with the release of their new engine.

What You Will Work On

Mountain Aerospace Research Solutions is looking to better understand the global economic impact of launch vehicles optimized for their engine.

In this project, you will:

- Learn and apply knowledge of the constraints of the rocket equation (and the current limitations it places on orbital access) to develop a mission profile based on the new performance of the MK2 Fenris engine. The mission profile will entail a study of the forces and costs involved in inserting payloads to LEO (Low Earth Orbit).
- Develop a working framework of the economics of space and the future impact that the MK2 Fenris engine will have on the global economy by comparing and contrasting future methods of space access using the MK2 against the current methods.

The ultimate deliverable will be conducting and writing the first academic study on the implications of the MK2 Fenris engine to help guide decision makers in the current and future launch market. Specifically, this report may be read at the highest levels of the DOD (U.S Department of Defense), NASA, etc. It will also be read by investors and potential customers. The data generated will inform real world decisions and will stand as a benchmark to measure actual results in the future.

Who We Are Looking For

Any student that has a passion for space exploration and wants to be part of a one-of-a-kind study should participate in this project.

Project 5: Phased Antenna Solutions for Sub-Orbital Space Launches

Company Introduction

bluShift Aerospace is a NewSpace company with the goal of democratizing space by building rockets to send small satellites to space at an affordable cost. In fact, the company is on track to be the first space company in the world to commercially launch a rocket based on a bio-derived fuel. The company specifically places importance on sustainable launch practices and its bio-derived fuel “also mitigates the detrimental impact on the environment that traditional liquid and hybrid rocket motors can have” (blushiftaerospace.com). The company currently has 4 different rocket models: Stardust Gen. 1, Stardust Gen. 2, Starless Rogue, and Red Dwarf.

What You Will Work On

bluShift Aerospace is looking to explore and analyze the options of developing a lightweight phased antenna array to transmit telemetry data from launch vehicles to one or more ground stations for its sub-orbital space launches. Phased antenna arrays provide the unique ability to direct RF transmissions while requiring no mechanical structures to direct the antenna’s signal.

In this project, you will:

- Study and understand how phased arrays work, and how they are an integral part of revolutionizing modern communications.
- Research and summarize other means of communications and frequency bands used in for telemetry in sub-orbital and orbital launches. Determine what frequency bands, data rates, transmission power can be used for data transmission in rockets without special permission from the FCC or an Amateur Radio license for distances of up to 400km (line of sight) with a minimum bandwidth of 128kbps.
- Determine how far away a ground station needs to be from the launch location to reliably receive data
- Ensure that the RF signal will not interfere the exhaust gases of the rocket
- Research, analyze and recommend options for ground stations (identify and assess novel approaches that improve signal and communication reliability)
- Research and present off-the-shelf products that can be used to create a lightweight phased antenna array capable of active direct RF transmission to one or more ground stations

The ultimate output of this project will be a summary based upon the findings and analysis of the research stated above to provide bluShift with a recommendation on if a phased antenna is an economical, cost competitive, reliable and lightweight approach for communicating telemetry data, what equipment to use in the launch vehicle and the ground station, and cost and complexity comparison with other telemetry

technologies for high altitude rocket launches.

Who We Are Looking For

Students with an engineering, technical, business, or economics backgrounds are encouraged to apply for this project. Any student interested in research-based analysis of modern technology will find this study a rewarding experience. Phased arrays are rapidly being deployed today in applications such as 5G communications, satellite applications, ultrasound scanners, and automotive radar. An understanding of the fundamentals principles Phased Arrays is integral to modern life- today they are what keep you connected to the internet when you drive down the highway at 80 mph, and tomorrow they may become our tether to orbital launch vehicles.

EE16A, EE16B, fundamental Physics experience preferred. This is a conceptually heavy project, and background in EE117/118 other upper division electrical engineering courses a major benefit.