Final Year Project Proposal

Project Title:
Airborne Sampling/Sensing of Distal Volcanic Ash

Supervisor:
Maan Alkaisi

Industrial Sponsor:
Defence Technology Agency (DTA)

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1. Project Overview

After a volcanic eruption, volcanic ash (VA) stratifies into distal clouds that pose a great risk to the engines of aircraft operating within them. While civil aviation is able to reroute flights, military operations may require aircraft to operate within or near the cloud. Current flight advice is dictated by the density of the volcanic ash. However, there is evidence that other VA characteristics such as particle size distribution (PSD) and chemical composition affect the risk to aircraft engines. The current VA cloud measurements involve the use of combining satellite imagery with weather prediction models to determine the area of coverage by the VA cloud, but lack information about the altitude of the cloud.

The Defence Technology Agency (DTA) require a low cost method for intercepting a VA cloud at aircraft operating altitudes up to 40,000 feet. The solution is to intercept the cloud and take altitude and density measurements. Other measurements that may be useful include the PSD and chemical composition. It will also be necessary to take a physical sample for later lab analysis. The solution's sensor package is to be recoverable and reusable. The proposed solution is to deploy a UAV via weather balloon to the desired altitude whereupon the UAV is released. An autopilot flies the UAV through the cloud, collecting samples before returning safely to the ground. Ground communication is necessary to provide a live feed of the data collected.

2. Administration

Meetings with the project supervisor and sponsor are to be held weekly at 3pm on Fridays. The client will be present largely via Skype as the DTA is located in Auckland. The sponsor plans to visit in person at least once during the project or when necessary. Meetings will serve to regularly update the sponsor and supervisor on progress, whereas important questions will be directed via email. Contact within the group will largely be through Facebook and in person via informal meetings. Both a group chat and group page have been set up on Facebook to facilitate quick and easy communication between members. The group will use Trello, a web tool used for organising projects into simple lists. A Github repository and Google Drive are used for version control and document sharing.

3. Project Components

The initial focus is on developing the sensor and sampling payload. Hence this area of work was split between the members of the group. The secondary objective is to develop the UAV platform which is also split between group members. This is summarised in Table 1 below. This gives each individual two set tasks they are responsible for completing, with the emphasis on completing the sensor and sampling payload first.

Table 1: Task breakdown of project components

	Mike	**Jamie**	**Ryan**	**Jake**	**Parth**
Sensor Payload	VA density	VA sample	Sensor CPU	Particle size	Chemical composition
UAV Platform	Communications	UAV	Autopilot	Power management	Modelling

4. Specific Tasks and Timeline

The main priority is for the sensor payload to be developed as this dictates the UAV platform design. The sensor system is expected to be the most difficult due to the lack of existing research/ products as these sensors are not designed for airborne operation. The system design should be completed by early April so that specialised parts can be ordered and delivered in time for development. Figure 1 gives an initial estimate for the project timeline.

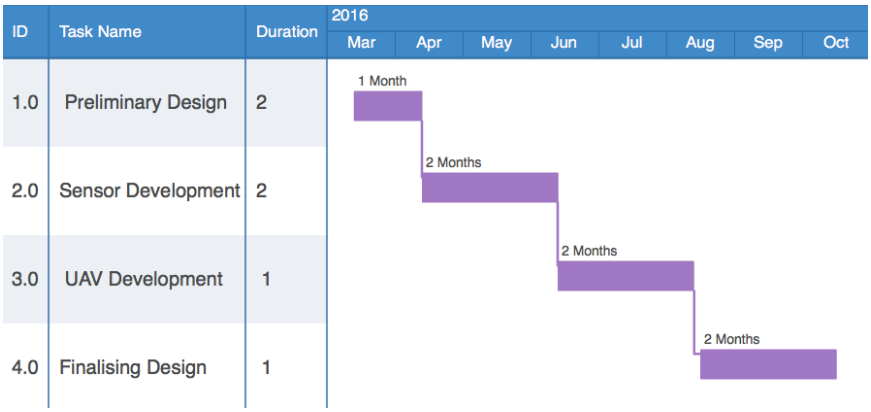

Figure 1: Gantt chart showing the proposed timeline for the project.

5. Budget Summary

The team is expected to produce a low cost and reliable solution, reducing the possible approaches that can be proposed to the client. The ECE department has provided $500 for this project. The client is willing to provide some resources as well as costs of up to a few thousand dollars. The main aspects of the budgeting are: equipment, shipping and testing costs which are detailed below.

Equipment- tools required to obtain the objective of the project
Payload sensors: barometer, VA density, altimeter, CO2, SO2, air speed and temperature sensors. Sample collector and particle size analyser.
UAV: airframe, weather balloon, GPS, autopilot, control system.
Testing- tools required to test and measure the reliability of the equipment
Wind tunnel, ash samples, pressure and temperature testing.
Shipping- Cost of getting the items delivered
Majority of the equipment used can be easily shipped to Christchurch inexpensively. The UAV airframe itself may pose a higher cost depending on its size.

Initial costing is indicated in table 2 based on existing commercial off the shelf components.

Table 2: Costing estimate of project

Payload Sensors	Radiosonde	Air speed	CO2	SO2	CO	Totals
	US$20	US$55	US$100	US$181	US$70	US$426
UAV	Airframe	Weather balloon	GPS/Compass	Autopilot		
	US$150	Free from DTA	US$90	US$200		US$440