DEFN-14-189

PROJECT DEFINITION

APPROVALS

ROLE	NAME	SIGNATURE	DATE
Project Manager	Gilberto Hernandez		04/28/2015
Advisor	Dr. Manuel Gamero		[mm/dd/yy]

[Insert Logo]

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UCI CubeSat II

Revision History

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-	Initial Release	04/28/2015	Gilberto Hernandez

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1 PROJECT OVERVIEW

1.1 Executive Summary

The goal of this project is to build a 2U Cube Satellite to conduct an air pollution study, test electrospray thrusters, and test a thermal radiator which is in cooperation with the Spacecraft Thermal Team. Some constraints with this project are going to be operating in low earth orbit, controlling the satellite with the electrospray thrusters, and to be able to power the satellite with deployable solar panels.

Electrospray thrusters are operated in one of two modes: droplet emission or ion emission. Their propellant delivery systems are very different: electrospray thrusters in droplet emission mode have a pressurized propellant tank, an internal feed line with a relatively high hydraulic resistance, and shut off and/or regulating valves; on the other hand, electrospray thrusters in ion emission mode are based on the wetting of the emitter surface by the propellant, coupled with the electric field action to control the flow (passive feed). The simplicity of passive feed has important benefits in spacecraft with highly constrained mass, volume and power budgets such as CubeSats. Concretely, it is evident that for six-axis attitude control it is the only viable option for low cost spacecraft such as CubeSats. Thus, if the advantageous properties of electrospray thrusters in droplet emission mode (e.g. high thrust to power ratio compared to ion emission mode, and the possibility of working at varying specific impulse at optimum thrust density) want to be used in CubeSats, a new and simple passive feed system must be developed.

This technology has been developed and have started testing a prototype in a vacuum chamber. Results show that the same thrust can be obtained in comparison to commercial electrosprays. Now, it is crucial to tests that this technology works in space conditions as designed. A CubeSat is the perfect platform to test it and check if the specifications may vary after a long utilization time. Moreover, attitude control is also essential for most space missions. It is usually carried out by momentum wheels, but a three axis momentum wheel system requires one full CubeSat unit for itself. On the other hand, a spacecraft with main propulsion can do a huge new range of missions. Electrospray thrusters can provide both attitude control and main propulsion, allowing us to reach the desired orbit to photograph the exact point on the Earth and it also allows us to maintain the correct orientation and orbit during all the spacecraft life.

A thermal radiator will manage heat transfer between the satellite and space. In order to withstand the drastic temperature ranges encountered in space, the thermal sub team will make use of a variable surface emissivity radiator as the primary source of thermal heat rejection and absorption. An electro-chromic material coating, Titanium Oxide, will be used on the CubeSat. This coating has the ability to change emissivity properties when a voltage potential is introduced, meaning that varying the voltage will allow the coating to absorb and reject heat keeping the CubeSat within the required operating range of the equipment.

The monitoring of aerosol pollution and its flow over parts of Asia will be the final experiment conducted with the UCI Cube SAT II group. Aerosol pollution primarily stems from smog released from automobiles, which is dangerous towards human health and destroys crops in outlying areas. For example, parts of northern India have seen rice crop yields cut in half due to two main aerosols, black carbon and ground level ozone. Black carbon emissions from automobile exhaust. Ground level ozone is a secondary pollutant. U.S. embassies in Beijing and Shanghai reported PM2.5 measurements as high as 480 and 355 micrograms per cubic meter of air respectively," NASA writes. "The World Health Organization considers PM2.5 levels to be safe when they are below 25." As aerosol pollution continues to grow, it must be monitored to help predict the danger to outlying areas.

Designing and manufacturing a 2U CubeSat that will power, and support these experiments will be the team's primary goal for the first year.

2 PROJECT DETAIL

2.1 Project Objective(s)

Objective 1 – Monitor Aerosol Pollution and its flow over parts of Asia.

The CubeSat will orbit in LEO to take images of cloud movement and coloration over parts of Asia. Aerosol pollution primarily stems from smog released from automobiles, which is dangerous towards human health and destroys crops in outlying areas. In tracking the coloration and flow the team can access possible solutions to reduce such pollution or suggest concepts to help migrate the pollution away from central areas of life.

Objective 2 – Design, Manufacture, and Test electrospray thrusters

Electrospray thrusters in ion emission mode are based on the wetting of the emitter surface by the propellant, coupled with the electric field action to control the flow (passive feed). The simplicity of passive feed has important benefits in spacecraft with highly constrained mass, volume and power budgets such as CubeSats. The advantageous properties of electrospray thrusters in droplet emission is its high thrust to power ratio compared to ion emission mode, and the possibility of working at varying specific impulse at optimum thrust density makes it very versatile in CubeSats, a new and simple passive feed system must be developed. The designed and tested results show that the same thrust can be obtained in comparison to commercial electrosprays. Now, it is crucial to tests that this technology works in space conditions as designed. A CubeSat is the perfect platform to test it and check if the specifications may vary after a long utilization time. Electrospray thrusters can provide both attitude control and main propulsion, allowing us to reach the desired orbit to photograph the exact point on the Earth and it also allows us to maintain the correct orientation and orbit during all the spacecraft life.

2.2 Scope Details

Design, test, and manufacture a 2U CubeSat with Aluminum 6061 casing and electrospray thrusters. Obtain a camera lens and chip that satisfies the resolution regulations. Also obtain rechargeable batteries that can withstand vacuum conditions. Design a circuit including the rechargeable batteries and GaAs solar panels.

2.3 Project Milestones

Milestone Name	Target Date	Comments
Material Selection and Design of 2U	3/20/2015	
Designed and Tested Solar Panel Circuit	6/5/2015	
Designed and Tested Electrospray Thrusters	6/5/2015	
Designed and Tested Power System	6/5/2015	

2.4 Project Team

#	Name	Project Role	Email	Phone	Standing	Units
1	Gilberto Hernandez	Project Manager	Gilberh1@uci.edu	(310)4658278	Senior	2
2	Laia Ferrer Argemi	Electrospray Thrusters Researcher	ferreral@uci.edu		Graduate Student	1
3	Thi Anh Le Tran	Structures Team Lead	thiat@uci.edu		Junior	1
4	Joseph Leonor	Solar Panel Team Lead	jleonor@uci.edu		Junior	1
5	Diane Phung	Power Team Lead	Phungd1@uci.edu		Senior	1
6	Josh Christopher Baldwin	Member	jcbaldwi@uci.edu		Senior	1

2.5 Project Costs Estimation

Project Expense	Comments	Est. Amount ($)
		$
	Total	*[Sum Total]*

2.6 Resource Estimation

Name	Est. Hours	Rate ($/hr)	Est. Total ($)
Total	*[Sum total]*		*[Sum Total]*

[Estimate the number of hours from number of credits plus expected additional time as necessary. Estimate the hourly rate base on project role and steering role.]

3 Project Risks and Communication

3.1 Risk Mitigation Plan

Risk	Severity	Probability	Mitigation
Freezing in Space	High	Low	Ensure the Thermal team has met all regulations and has completed testing.
Structurally sound	High	Low	FEA analysis completed and testing is completed by NASA.

3.2 Communication Plan

Communication Type	Audience	Frequency	Responsibility
Weekly Meetings	Everyone	Weekly	Project Manager
Group Email	Everyone	Bi-weekly	Project Manager

4 Additional Project Details

The project is funded directly from the units that the students are enrolled in.