Project Definition Document

Aerospace Senior Projects (ASEN 4018 & 4028)
Fall 2003 and Spring 2004

1.0 Information

1.1 Project Title

CamCube: A small surveillance satellite

1.2 Project Customers

Currently none.

2.0 Background and Context

The Hubble telescope requires annual repairs in order to maintain the accuracy of the scientific data it provides. In wake of the Columbia shuttle disaster, all subsequently launched shuttles are required to dock at the International Space Station (ISS) so the condition of the heat tiles on the shuttle can be thoroughly inspected to ensure a safe reentry into the Earth's atmosphere. Since there is not enough propulsion onboard the shuttle to visit both the ISS and the Hubble telescope, the former has received priority from NASA and therefore Hubble will not be maintained for the duration of its mission.

In order to avoid degradation in the quality of the science data received from Hubble, we have proposed a small surveillance satellite with a camera as the primary payload to effectively and efficiently observe the heat tiles on the space shuttle. This would eliminate the need for the shuttle to dock at the ISS and allow for additional scientific experiments and maintenance tasks to be performed.

3.0 Objectives

3.1 Overall Objective

The overall objective of the proposed project is to conceive, design, fabricate, integrate, test and verify a small satellite with a camera as the primary payload to observe the condition of the heat tiles on the space shuttle. The performance of the satellite will be tested using methods such as launching on a high altitude telemetry balloon, attaching the satellite to a 3-axis gimble, or simulating the space environment in a thermal-vacuum chamber.

3.2 Carrier Integration

3.2.1 Objective

The CamCube satellite will incorporate the structural specifications set forth for the CubeSat satellite. The payload will then be integrated to this platform. CamCube will have the ability to send telemetry and photographic data and receive commands from the base station on the Space Shuttle.

3.2.2 Discussion

This greatly simplifies the design process since the structural specifications have already been determined by the CubeSat project. The focus then falls upon the integration of the separate subsystems.

3.3 Attitude Control

3.3.1 Objective

The CamCube satellite will have a 3-axis, free-flying (not tethered) attitude control system that will establish and maintain orientation of the satellite with respect to the Space Shuttle. A number of flight control options are being considered based on further research.

3.3.2 Discussion

Once the flight control system is determined the maneuvering capabilities of the satellite will be then be decided.

3.4 Space Shuttle Inspection

3.4.1 Objective

The CamCube satellite will have a camera with a resolution of TBD to determine if a flaw size of minimal value TBD is present on the heat tiles of the space shuttle.

3.4.2 Discussion

The outcome of the compromise between cost and resolution of the camera will help dictate the distance from the shuttle that the satellite will operate.

3.5 Communications

3.5.1 Objective

The CamCube satellite will be able to transmit camera still images to a receiver on the Space Shuttle. There will be a wireless RF link between the two communication subsystems.

3.5.2 Discussion

The distance between the two wireless links will be small and therefore the required size and gains of the receivers and transmitters will also be relatively small.

3.6 Shuttle Interfacing

3.6.1 Objective

The Camcube satellite will adhere to all safety requirements set forth by NASA.

3.6.2 Discussion

These requirements will be thoroughly researched and the mission will be modified as necessary.

4.0 Anticipated Engineering Expertise

Technical Expertise	How Applied
Mechanical Design	Develop conceptual and detailed solid 3D models of the device components
Electromechanical Actuators	Actuator and propulsion subsystems
Electronics	Design of the actuation, payload, and RF subsystems
Data Acquisition Software	Real-time measurement subsystem
Control Software	Real-time control subsystem (as needed)
Mechanical Fabrication	Part machining
Electronic Fabrication	Analog and digital electronic subsystems
Wireless Communications	Design of receivers and transmitters, along with the integration of a wireless RF link.
Orbital Dynamics	Develop orbital model of CamCube and Space Shuttle Orbiter.
Thermal	Analyze thermal performance
Payload	Develop payload which meets requirements.

5.0 Resources

5.1 Facilities

Possibility of use of Thermal-Vac chamber at either LASP (Laboratory for Atmospheric and Space Physics) or Ball Aerospace.

5.2 Additional Advisors

Chris Koehler

5.3 Funds

Will make proposals to Undergraduate Research Opportunity Program and the Engineering Excellence Fund for grants. In addition to these possible sources of funding, we have a $4,000 departmental grant.