HASP Student Payload Application for 2007

Payload Title:

HYPER-GEOCAM

Payload Class: (circle one)	Institution:	Submit Date:
Small	Texas A&M University - SEI	December 15, 2006

Project Abstract

The devastation left in the wake of such disasters as Hurricane Katrina, Rita, the Asian Tsunami or the 2005 Pakistani Earthquake made many in the scientific community realize that more effective, available and responsive data gathering methodologies are needed to respond to disasters of all sizes. Satellite imagery has been the traditional paradigm for gathering data in such situations; however these events showed that responsiveness of satellite imagery ranged from hours to days. The delay in access time to imagery is critical at two levels: First, it hampers the capability of first responders to map primary and secondary rescue objectives. Second, a large segment of the population not physically affected by the disaster spends significant effort obtaining information about the disaster for different reasons; stemming from finding relatives to evaluating property damage. While the second reason might not seem important to search and rescue efforts, it puts pressure on the telecommunication infrastructure of the affected areas, which are most likely affected by the disaster.

We expect to use the same GeoCam camera as used in the first HASP flight and innovate in several ways:

- provide a capability to perform some crude hyperspectral imaging by using the reflection of the scene of interest off a CD or a DVD. We are using CD/DVD disk because they have very small gratings that allows for a decomposition of light into several bands.

- provide an additional capability to process some information from an additional very small camera to stop GeoCam from taking photographs when too many clouds are present in the field of view

- provide a capability to image the sky in order to image atmospheric meteors, stars and orbital debris.

We expect to obtain between 4 and 16 GB of data, to be retrieved from camera SD card when the balloon is recovered. Depending on our capability to have enough memory, we expect to run the camera from 5 to 10 hours.

In order to disseminate the information gathered during the flight, our outreach plan consists in providing trajectory of the balloon on a Google Maps [6] and Google Earth [7] interface. We also expect to make the largest ever panorama/map and beat the current world record.

Team Name:	Team or Project Website:
GEOCAM	http://sei.tamu.edu/HASP/GEOCam

	Student Team Leader Contact Information:	Faculty Advisor Contact Information:
Name:	John Yezak	Igor Carron
Department:	Space Technology Center	Space Engineering Institute
Mailing Address:	3118 TAMU	3118 TAMU
City, State, Zip code:	College Station, TX 77843-3118	College Station, TX 77843-3118
e-mail:	jyezak@tamu.edu	i-carron@tamu.edu
Office telephone:	979-845-8768	979-845-8768
Cell:		
FAX:	979-847-8857	979-847-8857

HYPER-GEOCAM
A COTS Camera for Hyperspectral Imaging on High Altitude Balloons.

1.0 Project description

1.1 Introduction

The devastation left in the wake of such disasters as Hurricane Katrina, Rita, the Asian Tsunami or the 2005 Pakistani Earthquake made many in the scientific community realize that more effective, available and responsive data gathering methodologies are needed to respond to disasters of all sizes. Satellite imagery has been the trational paradigm for gathering data in such situations, however these events showed that responsiveness of satellite imagery ranged from hours to days. The delay in access time to imagery is critical at two levels: First, it hampers the capability of first responders to map primary and secondary rescue objectives. Second, a large segment of the population not physically affected by the disaster spend significant effort obtaining information about the disaster for different reasons; stemming from finding relatives to evaluating property damage. While the second reason might not seem important to search and rescue efforts, it puts pressure on the telecommunication infrastructure of the affected areas, which are most likely affected by the disaster.

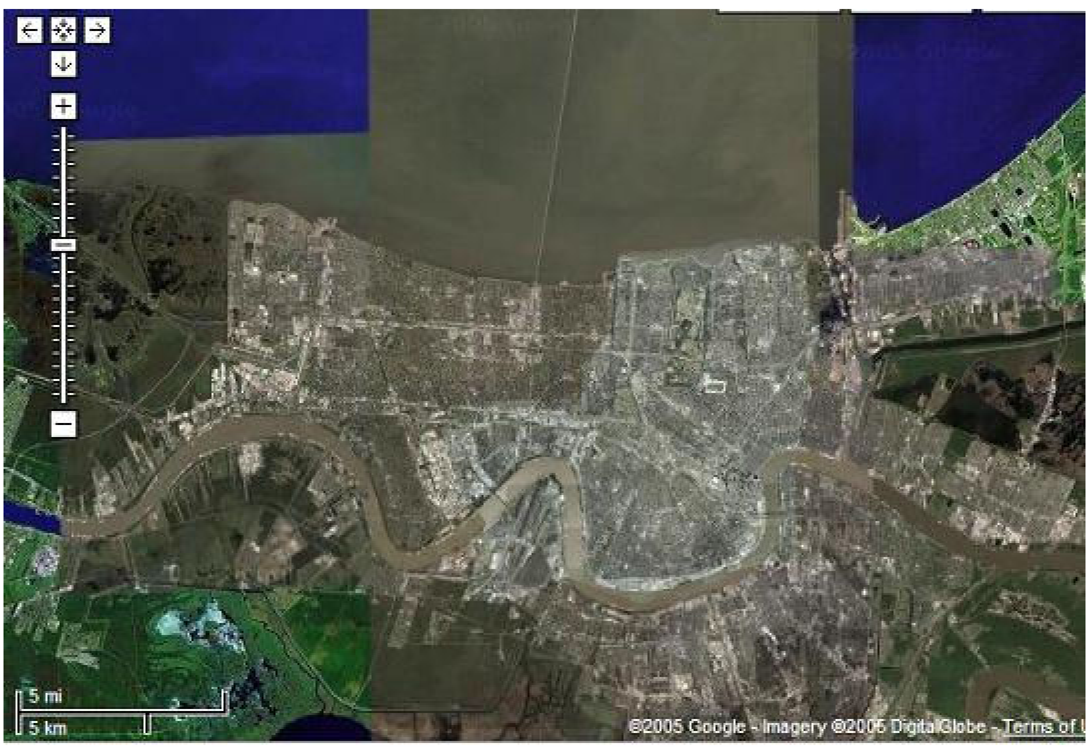


Figure 1: New Orleans taken from 120,000 feet (Courtesy Google Maps).

In the case of Hurricane Katrina, most people could not come back and check the status of their homes [5], nor could most people in positions of authority answer this simple question. The information bottleneck was partially relieved through the ability of Google Maps to provide more recent satellite information (thereby providing information real time to millions of people.) However, as pointed out before, satellites take hours to days to repositions and then to disseminate their information, in critical situations such as disasters of any scale, this lack of responsiveness is crutial to avoiding added loss of life.

High altitude balloons can be deployed in a matter of hours and provide emergency remote sensing thereby enabling first responder's situational awareness and give adequate trajectories to rescuers. It would also enable the diffusion of imagery to a large segment of the population looking for information thereby reducing the strain on the telecommunication system of the affected area.

During the first HASP flight in September 2006, we gathered more than 2 GB of useful data with GeoCam. This experiment proved our ability to gather data and provide a remote sensing map shortly after HASP had landed. After attending a UAV workshop on the subject of Unmanned Airborne Vehicle Imagery for Domestic Emergency Response & Natural Resource Survey [1], we realized that using only visible wavelengths would not be enough for search and rescue scenario as certain scenes generally have cloud covers, fumes, fires or hotspots. We believe that a low cost approach to hyperspectral imaging is necessary in order to enable a better situational awareness in those conditions.

1.2 The idea

We expect to use the same GeoCam camera as used in the first HASP flight and innovate in several ways:

- provide a capability to perform some crude hyperspectral imaging by using the reflection of the scene of interest off a CD or a DVD [2]. We are using CD/DVD disk because they have very small gratings that allows for a decomposition of light into several bands.

- provide an additional capability to process some information from an additional very small camera to stop GeoCam from taking photographs when too many clouds are present in the field of view

- provide a capability to image the sky in order to image atmospheric meteors, stars and orbital debris.

We expect to obtain between 4 and 16 GB of data, to be retrieved from camera SD card when the balloon is recovered. Depending on our capability to have enough memory, we expect to run the camera from 5 to 20 hours.

In order to disseminate the information gathered during the flight, our outreach plan consists in providing trajectory of the balloon on a Google Maps [6] and Google Earth [7] interface. We also expect to produce the largest ever panorama/map and beat the current world record using the autoapano [3] software we have used for the first HASP flight.

1.3 Equipment

We propose a small payload (less than 1 kg) featuring three items on top of the casing:

- a Canon S3 IS camera
- a small stepper motor (R/C) and an attendant microcontroller board allowing a mirror to switch the field of view of the camera from a nadir view to a side view.

- a small mirror/CD/DVD set up allowing for hyperspectral imaging

The camera will be turned on at the beginning of the flight. The only command going through the HASP bus will allow the control of the mirror /CD/DVD inclination.

1.4 Payload processing and Data Utilization

During the course of the project, members of the team will:

- continue to updatethe website and blog dedicated to this payload.
- test different parameters for the camera settings (frame rate, compression,brightness histograms) as well as thermal issues.
- provide safety documentation to HASP management as needed.
- continue to attend meetings in Louisiana and New Mexico for integration and balloon launch.
- use several image processing techniques on the visible and hyperspectral data collected during the flight and report on the best techniques to be used for Balloon data.
- display data on a website using interfaces like Zoomify [4], Google Maps and Google Earth.

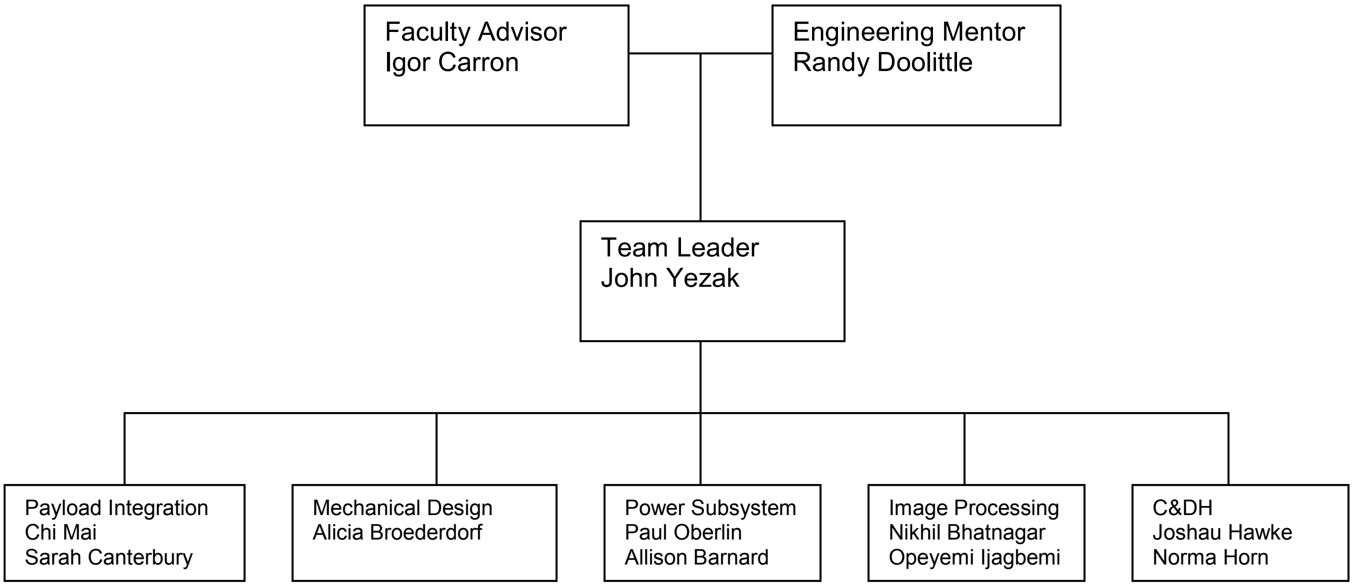
2.0 Team Structure and Management

2.1 Team Contact Information

Faculty Advisor	Dr. Igor Carron	i-carron@tamu.edu
Engineering Mentor	Randy Doolittle	heinrich-krupp@tamu.edu
Student Team Leader	John Yezak	jyezak@tamu.edu
Student Members	Allison Barnard Paul Oberlin John Quinones Alicia Broederdorf Karen Villatoro Chi Mai Francisco de la Garza Opeyemi Ijagbemi Katherine Westhoff Joshua Hawke Nikhil Bhatnagar Sarah Canterbury Norma Horn	

Team Address: Space Engineering Institute
Texas A&M University – MS 3118
College Station, TX 77843-3118
Team Phone: 979-845-8768
Team Fax: 979-847-8857

2.2 Team Structure/Organizational Chart



2.3 Timeline/Schedule

Item	Description	Date	Dec 15	Jan 16	Feb 16	Apr 15	May 1	May 15	Jun 1	Jun 15	Jul 1	Jul 15	Aug 1	Aug 15	Sep 1
1	Application Submission	December 15, 2006													
2	Requirements Definition	January 16, 2007													
3	Payload Design	February 16, 2007													
4	Components Selection	February 16, 2007													
5	Prototype Imp	April 15, 2007													
6	Design Review	May 15, 2007						X							
7	Flight Build	May 15, 2007													
8	System Integration Test	June 1, 2007													
9	HASP Payload Integration	July 10, 2007										X			

3.0 Payload Specifications

3.1 Budgets

Power Budget (watts)	
Camera	6
Comm	1
Motor	2
Power Converters	3
Total	**12**

Weight Budget (grams)	
Camera	320
Frame	400
Mirror	70
Motor	70
Comm/Boards	100
Total	**960**

4.0 Technical Drawings

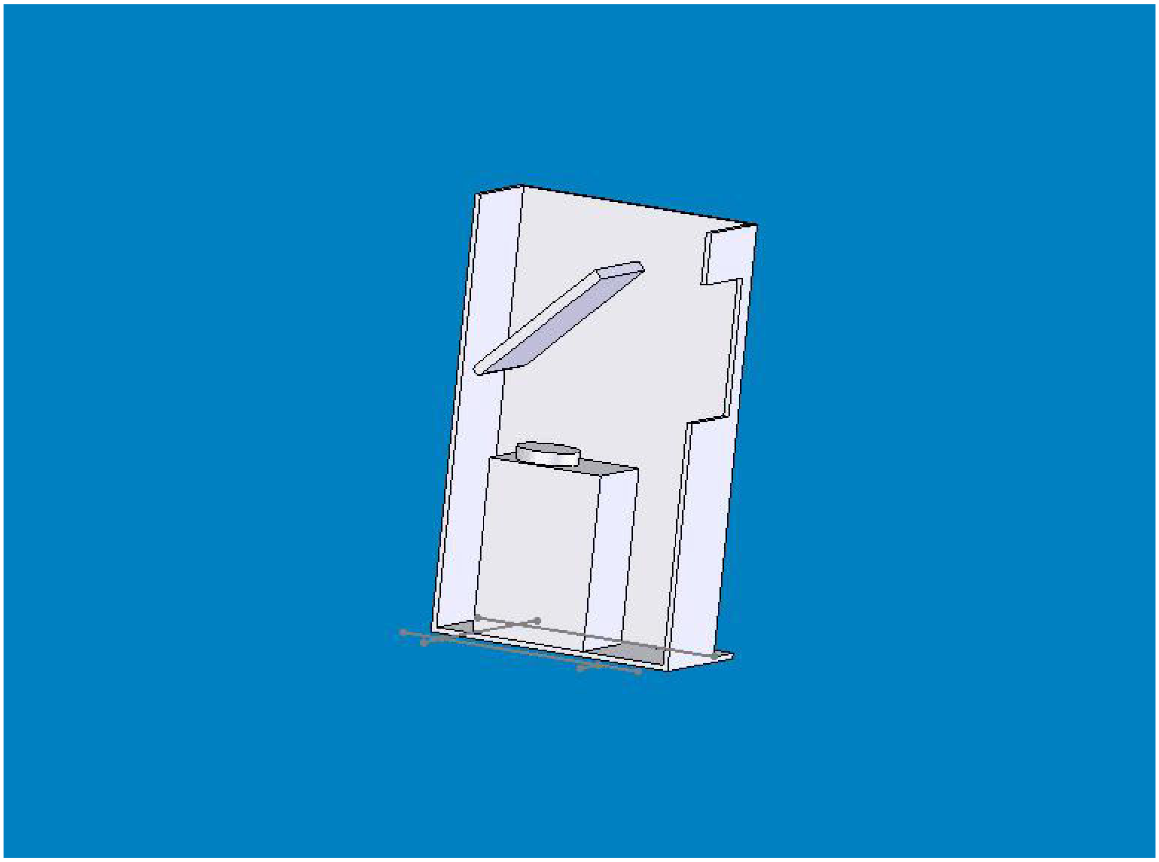


Figure 2: Solidworks view of the Hyper-GEOCAM payload.

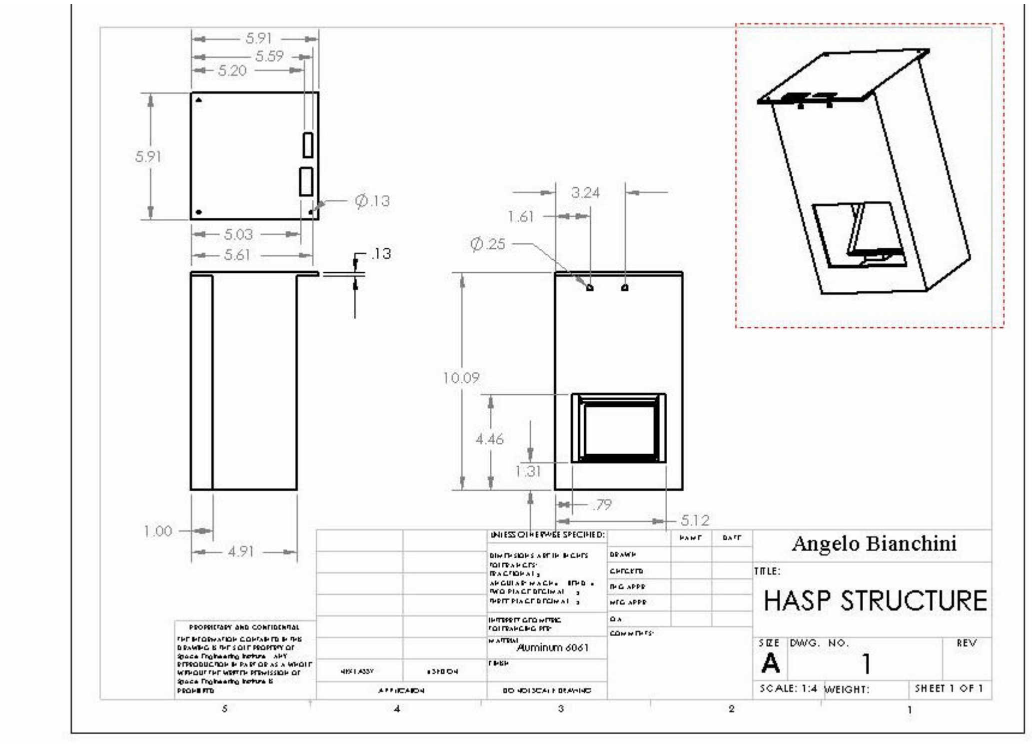


Figure 3: Detailed view of the Hyper-GEOCAM payload.

Figure 4: Canon Camera S3 IS

5.0 References

[1] Franky De La Garza, Jay Gerber, Sara Guest, Raymond Mendoza, Ramon,Rivera, Karen Villatoro, Pamela Withrow, Angelo Bianchini, Randy Doolittle, John Yezak, Ramon Rivera, Igor Carron, Pedro Davalos, "GeoCam - An off-the-shelf Imager for Rapid Response Remote Sensing Monitoring", Workshop on Unmanned Airborne Vehicle Imagery for Domestic Emergency Response & Natural Resource Survey, Lafayette, Louisiana, December 13-14, 2006.

[2] CD spectrometer, http://www.cs.cmu.edu/~zhuxj/astro/html/spectrometer.html

[3] *Autopano Pro software, http://www.autopano.net*

[4] *Zoomify software, http://www.zoomify.com*

[5] Summary of all known Google Maps mashup for Katrina, http://googlemapsmania.blogspot.com/2005/09/summary-of-all-known-google-maps.html

[6] http://maps.google.com/

[7] http://earth.google.com/