HASP Student Payload Application for 2008

Payload Title: Found In Space		
Payload Class: (circle one) Small Large	Institution: Tulane University	Submit Date: 12/18/07

Project Abstract

There are few fixed reference points in space, but one of the most robust is the background of stars. This truism has lead to the invention of the star tracker, a device that compares salient stars in a photographic image of a portion of space against a star catalog to determine the orientation of the camera and thus of the vehicle that carries it. There are star trackers available commercially, but they run from a half million to a million dollars and thus are prohibitively expensive for a small space venture with limited funding.

One such venture is the team that Tulane University's Sociocognitive Robotics Lab (and Igor Carron at Texas A&M University) has partnered with to win the Google Lunar XPrize. HASP provides our team with the ability to test a home-made COTS star tracker in conditions similar to those that it will encounter on its way to the Moon.

Team Name:	Team or Project Website:
Sociocognitive Robotics	www.tulane.edu/~robolab/HASP

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Found In Space

A low-cost star, sun and moon tracker,

which also looks down at the Earth

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1. Project description

1.1 Introduction

There are few fixed reference points in space, but one of the most robust is the background of stars. This truism has lead to the invention of the **star tracker**, a device that compares salient stars in a photographic image of a portion of space against a star catalog to determine the orientation of the camera and thus of the vehicle that carries it. There are star trackers available commercially, but they run from a half million to a million dollars and thus are prohibitively expensive for a small space venture with limited funding.

One such venture is the team that Tulane University's Sociocognitive Robotics Lab (and Igor Carron at Texas A&M University) has partnered with to win the Google Lunar XPrize. HASP provides our team with the ability to test a home-made COTS star tracker in conditions similar to those that it will encounter on its way to the Moon.

HASP also provides us with the opportunity us to test algorithms for other aspects of celestial navigation, such as identifying and tracking the sun and moon.

Finally, it lets us gather a high quality data set of images of ascent and descent, of which there are very few in existence.

1.2 The idea

We intend to use one camera pointing up (or perhaps to the side) to capture images of space and send them to an ARM9 processor for pattern recognition and location calculation, and transmit the result to the ground for comparison to the GPS signal of HASP to determine the accuracy of the star tracking system(s). A separate analysis of the data will extract the position of the sun and moon, though we will not process them for attitude determination. We will use another camera pointing down to capture images of the ground receding and advancing, which will either be stored on-board or sent to the ground.

1.3 Equipment

Building on the experience of Igor Carron's group at Texas A&M on pervious HASP flights, we do not propose sending ordinary commercial cameras, but rather a small payload (less than 1 kg) featuring four items on a circuit board in a casing:

- two CMOS camera modules
- an ARM9 processor, such as the Qwerk Robotics Controller
- a communications transceiver

The system will be turned on at the beginning of the flight and turned off at the end.

Since that the students performing the experiment are software not hardware engineers, the experiment concentrates on the integration and programming of the equipment listed above, and the analysis of the data that it collects. It also aims to evaluate different algorithms under realistic conditions of use. The intent is not to build the equipment, except for the housing and circuit boards that tie everything together. For this reason, we will use equipment that is either readily available or donated to us by the Lunar XPrize team.

1.4 Payload processing and data utilization

The processor will preprocess the images obtained from the upward-looking camera to convert them into various feature sets.

One set will be of star features for recognition by a counter-propagation neural network as described in Roberts & Walker (2005) and other algorithms that have been published or that we can get permission to use. The star field so-recognized provides the location of HASP at the point in time that the image was captured. This will be sent to the ground for comparison with the location as determined by the on-board GPS. In addition, a series of locations can be used to calculate the state vector of HASP.

Another set will be used to recognize and track the sun and moon. We are currently looking into the algorithms that are appropriate for this task, but they are considerably simpler than those involved in star tracking.

The processor will either store the images obtained from the downward-looking camera or transmit them directly to the ground.

2. TEAM STRUCTURE AND MANAGEMENT

2.1 Team Contact Information

Faculty Advisor	Dr. Harry Howard	howard@tulane.edu
Student Team Leader	Michael Woodman	mwoodman@tulane.edu
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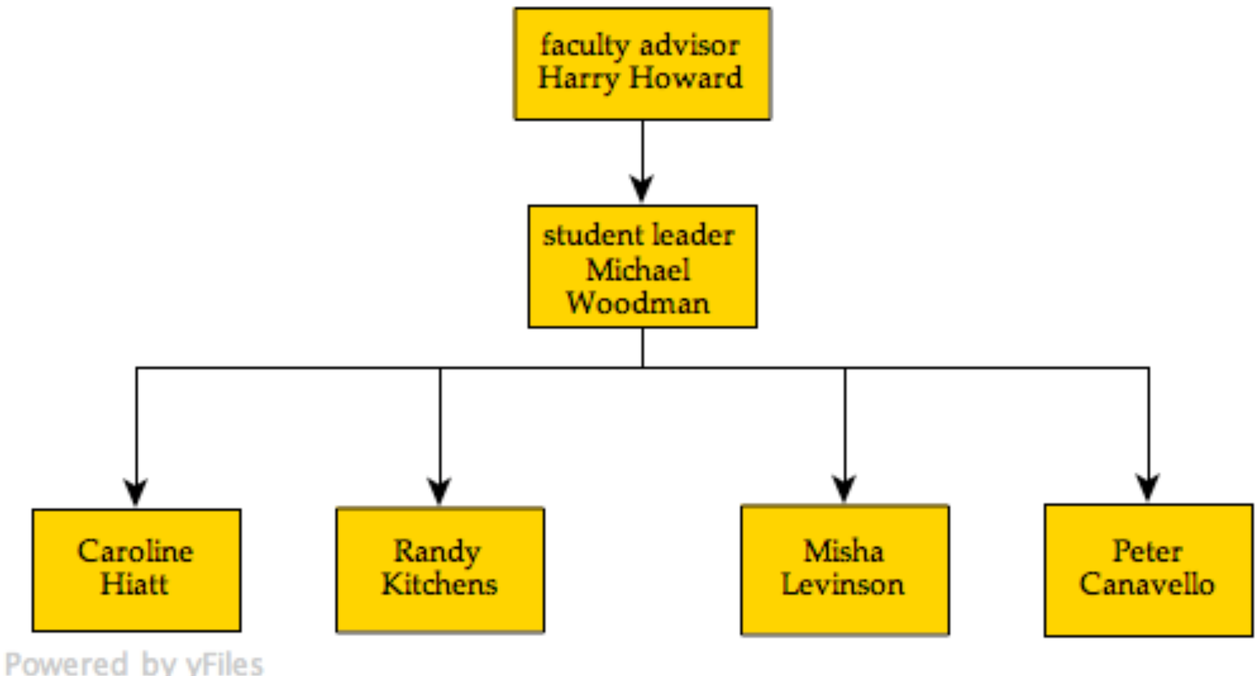
2.2 Team structure/Organizational chart



2.3 Timeline/Schedule for 2008

Item	Description	Date	1/15	2/1	2/15	3/1	3/15	4/1	4/15	6/22	6/28	9/1
1)	Application submitted	12/18/07										
2)	Selection announced	1/15										
3)	Requirements defined	2/1										
4)	Payload designed	2/15										
5)	Components selected	3/1										
6)	Prototype made	3/15										
7)	Design reviewed	4/1										
8)	Flight build	4/15										
9)	System integration test	6/22-8										
10)	HASP payload integration (if no problems)	6/28										
11)	Launch	9/1										

3. PAYLOAD SPECIFICATIONS

3.1 Budgets

3.1.1 Power Budget (watts)

Camera	0.0002
Controller	5
Transceiver	1
Total	~6

3.1.2 Weight Budget (grams)

Camera	10
Controller	335
Transceiver	10
Boards	30
Housing	300
Total	685

4. DRAWINGS

We are working on the drawings, but some of our parts are still not specified since they depend on input from the Lunar XPrize team that we are working with.

5. REFERENCES

Roberts, Peter J., and Walker, Rodney A. 2005. Application of a Counter Propagation Neural Network for Star Identification. *Proceedings AIAA Guidance, Navigation, and Control Conference and Exhibit, San Francisco, CA*.

Qwerk robotics controller
http://www.charmedlabs.com/index.php?option=com_content&task=view&id=29