Hyper-GEOCam

Space Engineering Institute
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Payload Specification and Integration Plan

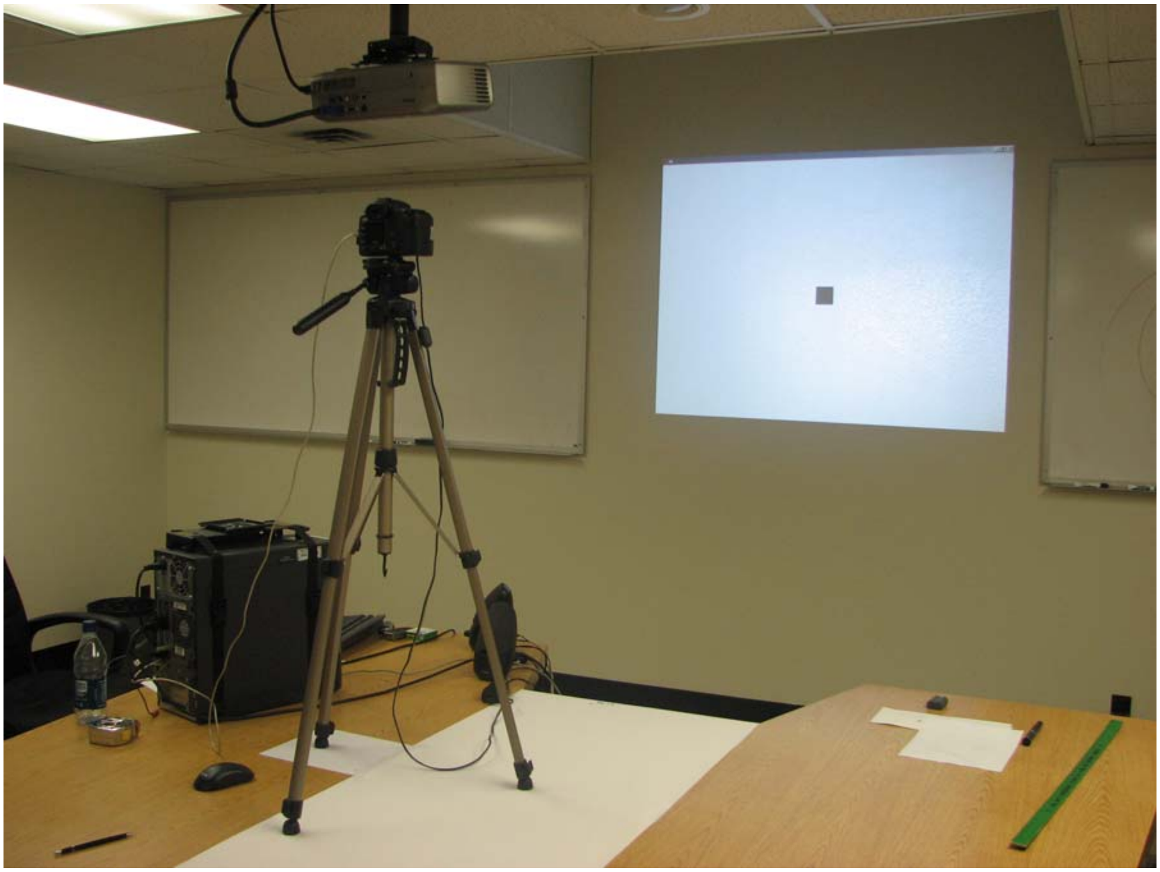
Introduction

This document defines basic specifications for our payload: Hyper-GEOCam (Payload ID: 6). Since our project is still in the design stage, some of these numbers are best guess estimates. If any of these numbers cross over our current estimates and exceed specified limits, we will immediately consult with HASP management.

Theory

As we researched our project to make some decisions about the components to be used, our mentor directed us toward the possibility of potentially producing hyperspectral images with a small conversion to a generic DSLR. The mathematical theory being the idea is called “Compressed Sensing” [1]. The first known example of hardware using this technique is the “Single Pixel Camera” at Rice [3]. A second one is the random lens imager at MIT [2]. Our goal is to implement this latter technology and produce the first images from 120,000 feet of this new kind of sensor.

The underlying result of “compressed sensing” is as follows: most signals in nature have sparse decomposition (the reflective spectrum of oxygen for instance has so much peaks for instance). Given the sparsity of the decomposition of signal, the whole field of “compressed sensing” shows that one can randomly acquire these signals with (a very low) sampling rate proportional to the sparsity of the signal itself. With most hyperspectral cameras there is the need to reduce the amount of information gathered while it is being gathered not after. With our set-up, we are going to obtain more data, by gathering less. This sounds odd, but the crux of the process is primarily based on the calibration of the random lens imager. We have already begun the setup for this calibration which is soon to be automated in order to produce thousands of calibration images. By using a computer and projector we will flash pictures on a screen in front of the random lens imager that will take pictures as the views change. Once this process is complete we will be able to take any output from the random lens imager and by going backwards reproduce the actual image. Since our random material is reflecting light according to its wavelength, the random separation of the bands is inherent in our process. Calibration images will be undertaken at different wavelengths. Current technology already allows for the gathering of signals with less than pure frequency content. Using the ability to put several frequencies together in one spike, allows one to retrieve directly compressed samples. In this way several light frequencies combined can provided us with hyperspectral data that will be used to reproduce the images afterward.



[1] Compressed Sensing resources: http://www.dsp.ece.rice.edu/cs/
[2] Random Lens Imaging: http://dspace.mit.edu/bitstream/1721.1/33962/2/MIT-CSAIL-TR-2006-058.pdf)
[3] Rice one pixel camera, http://www.dsp.ece.rice.edu/cs/cscamera/

Mechanical/Structural

Hyper-GEOCam has a different purpose than GEOCam-Reflight (GEOCam-R) and therefore will be flying a different camera. This simplifies a number of things. On the mechanical end there will be very little happening. This camera will be stationary, without zoom, and has updated features that will allow us to take pictures via an electronic switch.

Structurally this camera should be easier to secure. While fabrication has not yet started, the plan is to secure the camera by three points. The first being the center mounting hole normally used to mount the camera to a tripod. The second and third will be the two strap loops. Both mounts are designed to easily support the camera's weight and therefore when combined should be more than enough to sustain a 10 G vertical shock. Pictures and their descriptions can be found attached to this document to help show what was explained above.

As an added safety, the viewing hole cut in the bottom plate will not be big enough for the camera to fit through. A Nastran analysis will be provided later but we expect similar margin of safety as the ones in GeoCam-R and GeoCam. However, we are confident that the margin of safety will exceed the one obtained for GEOCam-R since we are supporting a similar weight by three points instead of only two. Note: The weight estimates below are based partly off of pieces used in GEOCam-R since we have not yet fabricated the new pieces for this project.

Weight Estimates

Part(s)	**Weight (grams)**
Outer shell of containing box	314
Top of box and attached power board	235
Camera and lens	790
Battery adapter	62
Additional Braces	100
Total	**1501**

Since this weight is over 1 kg (the limit for this type of payload), we are asking for a waiver.

Power

GEOCam-R will be consuming power from HASP. The 28 volts given will be converted to 12 and 5 volts using voltage converters. The 5 volts will be used to provide power to our microcontroller while the 12 volts will be further reduced to 7.8 volts using a voltage regulator and used to power our camera. We are also considering painting part of the box black in order to retain warmth during the flight.

Attached to the end of this document are schematics of the power conversions that were used for last year's GEOCam which will be only slightly modified to produce 7.8 volts instead of 7.4 volts. The schematic for the microcontroller is also shown (it was previously used for controlling servos), but for this project it was slightly modified to go to a relay instead. This relay will create a short and act as an electronic switch triggering our camera to take pictures at a desired interval.

Communications

There are no current plans to have any uplink or downlink communications.

Integration and Logistics

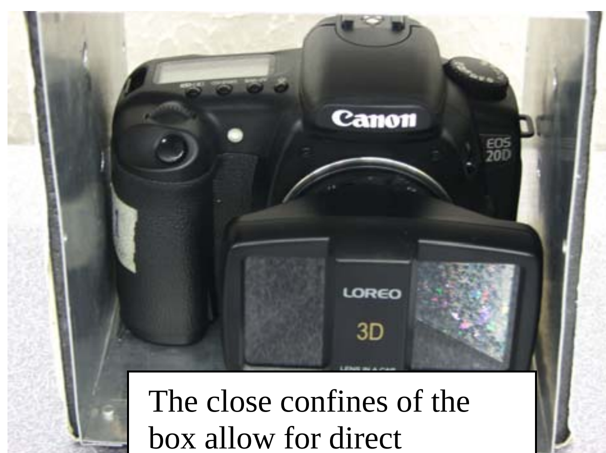
We would like to integrate this project directly before or after integrating GEOCam-R. As stated previously in the GEOCam-R Payload Specification and Integration Plan we would like to have our integration as late as possible during integration week (hopefully in the range of July 26-28) with Friday, July 27th, being our first choice. We can be flexible with the exact date since we will probably be driving up the day of integration and then driving back (Palestine is only a 2 hour drive away). The afternoon would probably be the best time for us to integrate, starting around 2:30 pm and ending around 3:30 or 4:00 pm, but again, we can be flexible in this area. At this point, the integration team leader (John Yezak, jyezak@tamu.edu) will probably be the only person to attend the integration. If additional participants are coming we will notify the HASP management in advance.

On the day of integration, we plan to bring in our project fully assembled and ready to be attached to HASP. Once attached to the HASP structure we would like to have power turned on to our project by HASP management and shortly after we will switch our manual toggle switch to the 'on' position. Once the project is fully powered we will observe the camera's actions to ensure that it is operating correctly. After the camera completes a couple of cycles taking pictures, we will then request to have the power cycled a couple of times by HASP management to confirm that our project will sustain a short-term power loss and still continue to take pictures. Once this is complete all power to the project will be turned off and Hyper-GEOCam will be disassembled to show the HASP management the internal workings of our project, check that pictures were actually taken, and erase the pictures that are there. Once approved, the project will be reassembled, tested once more to ensure it was properly assembled, and then handed over to HASP management to be shipped to Ft. Sumner, New Mexico. Note: an integration checklist has been attached to the end of this document.

Structural Pictures and Descriptions

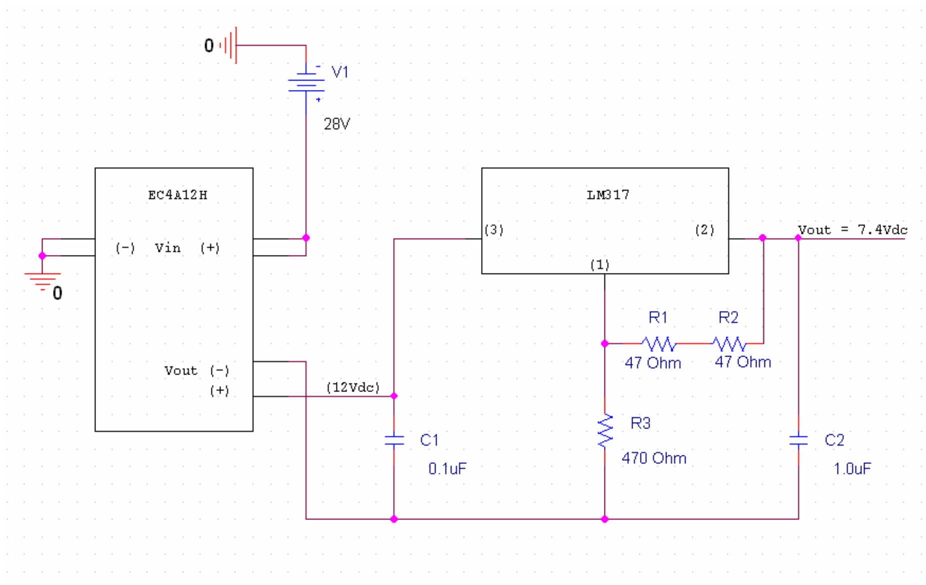
Strap loops and center mounting hole.

The hole in the bottom plate only needs to be as big as the lens (the part outlined in red).

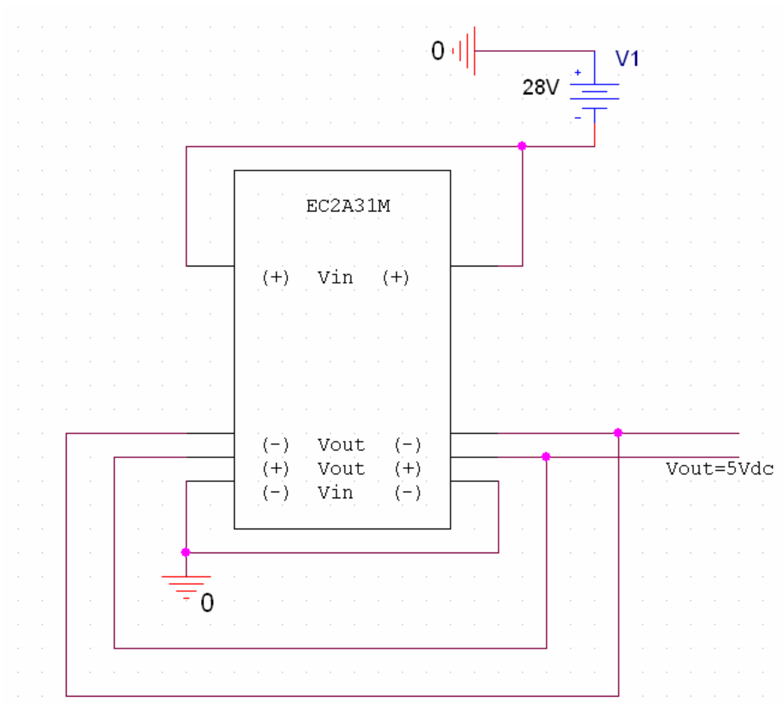


The close confines of the box allow for direct attachment to the camera without need for additional framework.

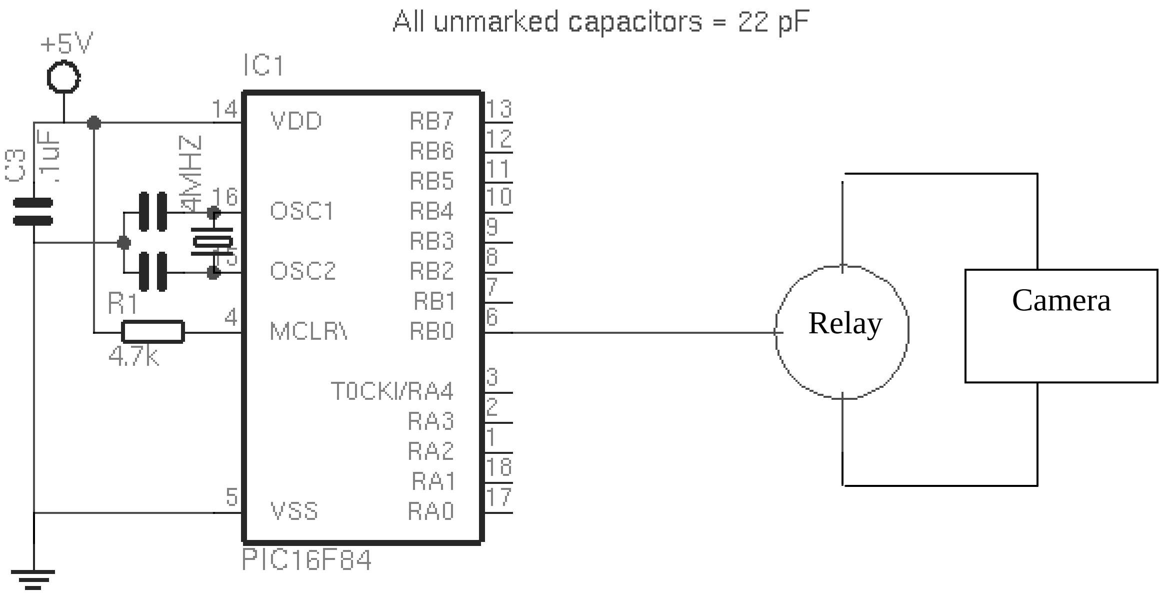
Schematics



Schematic 1: 28V-7.4V Design Layout



Schematic 2: 28V-5V Design Layout



Schematic 3: Microcontroller for Camera Trigger

Integration Checklist

Camera Operation

- The camera successfully powers on.
- The camera takes pictures at the desired interval.
- When power is cycled by the HASP management, the camera resumes normal operations.

Camera Disassembly/Reassembly

- Pictures were taken and stored on the SD card.
- All pictures are erased before reassembly.
- Camera still operates correctly after reassembly.

Project Limits

Official weight: ___________________

Peak Current Usage: ___________________