μHab

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***Abstract*—A project definition for the μHab project. μHab is the term the HAB team has been using to describe a smaller balloon and payload than is typically used by the group (1200 grams). However, this project expands upon the term with the main goal of minimizing costs that go into building and launching a HAB.**

I. Introduction

SPEX has launched three High Altitude Balloons (HABs) to date. The motivation for a launch is to educate students on engineering, test experiments in a near space-like environment, and to have fun in the process. The HAB team within SPEX aims to launch a balloon at the end of every full semester.

Traditional HAB launches are very expensive for the SPEX team. A large 1200g balloon can cost, at a minimum, over 125USD. Helium tank fills, which these launches require a full fill, can cost over 200USD. These two costs are a definite non-reusable resource. An avionics package consisting of a COTS Arduino, breakout sensors, and a large battery pack can easily add up to over 90USD. The avionics hardware can be reused, but every launch should be assumed a one time only use of hardware due to high risks of losing the payload.

II. Primary Objective

μHab will reduce the magnitude of these three large costs that make frequent HAB launches unaffordable for undergraduate research. A smaller, simpler, more focused payload will result in cheaper avionics hardware costs. A lighter payload also doesn't require such a large balloon, enabling a cheaper, smaller balloon and orders of magnitude less helium use per launch.

III. Secondary Objectives

Educational benefit is a very large secondary objective of μHab. This project shall be designed to be engineered in a fashion that teaches both established senior members and new greenhorn SPEX members alike.

Electrical hardware design is a skill that many members have shown a desire to pick up. Design of the PCB shall be simplistic and incorporate a few different important skills for engineering in the electrical hardware domain.

Embedded software is another useful skill that many students in the Computing skill aren't taught formally. Arduino development and embedded C software engineering skills will be obtained from writing code for the avionics board.

IV. Benefit to SPEX

Each of the objectives grant their own benefit to SPEX. Cheaper launch costs allow for more SPEX funding to be allocated to other projects while not sacrificing the quality of HAB launches significantly.

Educational benefit, while not the primary benefit, could be the largest benefit. PCB design has always been a very in demand with low supply skill. Embedded software is required for almost every large project. Arduino software design is a great stepping stone for software oriented people into the world of embedded. Avionics design in C would be the final transition, from Arduino into the real world application of embedded software.

A. Accessibility

In regards to the software half, Arduino is a very approachable language. There is a vast amount of libraries out there already for interfacing with ancillary hardware such as sensors or memory. The C portion to come at a later date (or in parallel) will be quite a bit more difficult; it requires a ton of datasheet reading, innovative code (not taking from examples), and customizing toolchains.

PCB design accessibility is a lot more restricted. Members that have had PCB design classes (4th-5th year Electrical Engineers) or have experience from co-op will be able to contribute to the design.

V. Implementation

Documentation for each step of the respected engineering paths is required. It is important during the implementation aspect to retain problems experienced and the solutions used to overcome.

A. Deliverables

- Bill of Materials for Hardware
- PCB schematics
- Arduino software source files
- C software source files
- Fully assembled balloon, parachute, and payload

B. Milestones

Electrical:

- 2 weeks — PCB design
- 1 week — PCB reviews
- 1 week — Order hardware
- 1 week — PCB assembly
- 1 week — PCB testing

Arduino software:

- 1 week — gather libraries needed
- 1 week — plan out software design and flow
- 2 weeks — write software
- 1 week — test software
- 1 week — neaten up software

C software:

- 1 week — prepare standard development environment
- 1 week — plan out software design and flow
- 4 weeks — create drivers
- 8 weeks — write software
- 2 weeks — test software
- 1 week — neaten up software

VI. Externalities

A. Prerequisite Skills

Covered in Accessibility.

B. Faculty Support

μHab should be able to be completely engineered by students. Faculty support could be helpful for hardware testing. Also access to surface mounting labs would need to be gained through faculty as well.

C. Funding Requirements

As the purpose of the project is to minimize costs of launching a HAB to the fullest extent, funding requirements will be minimal. PCB print costs should be free due to a HAB sponsorship. Lighter balloons can cost less than 25USD, Helium price is hard to calculate but will also be significantly cheaper.

D. Long-Term Vision

The boards for μHab can be used for a few different cases.

One idea is the possible sale of these boards as a kit to other groups as a fundraiser for the HAB team. These boards could be used for other projects as well as their nature is simple and can be applied in many situations for tracking. The design can be taken and upgraded to work with a larger multipurpose HAB.