Report:	System Architecture
Submitted to:	Hongwei Goa
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Introduction

This report will detail the system architecture for the Weather Balloon Altitude Control Project. The report will first explain in detail the system architecture plan for the project, covering the major interfaces, their position in the assembly, and their function. This includes the flow tube, the gate valve, and the nozzle of the balloon, the main payload microcontroller, and the valve servo. This section will be divided into mechanical and electrical groups to clarify the nature of each system and its respective interfaces. The next section will cover the system interfaces together in a block diagram. This representation will provide better insight into the different sections, and how they interface. The next section will detail the sub-system interfaces. This includes the valve controller, any third party communication payload, and the commands uploaded by the user during flight. For this project, these are entirely electrical, and are explained below in more detail. Finally, the report will cover the user interface for this project. This will include any setup, handling or operational interfaces the user may encounter while using this system. For this project, user interface includes attaching the balloon to the valve, filling the balloon through the valve using the fill station, attaching the payload to the bottom of the valve, programming the microcontroller, and interfacing the user's existing communications payload to the valve controller.

System Architecture Plan

Mechanical:

The mechanical portion of the valve project will have 3 interface connections. The first will be an interface with the Helium fill station nozzle. This nozzle, when connected, will press a limit switch connected to the microcontroller. This controller, after reading the switch as being pressed, will activate the servo, and open the gate of the valve. This will allow for Helium to pass through the tube of the valve into the balloon, which is the second interface. The flow tube of the valve has been sized such that the nozzle of the balloon will fit over it snugly. The retention ring (a raised portion on the balloon end of the valve tube) causes the latex of the balloon nozzle to stretch, ensuring a gas tight seal between the valve and the balloon nozzle. The third interface on the valve project is the interface between the servo and the microcontroller. This allows the microcontroller to open or close the valve when its logic is instructed to do so.

- Interface between the bottom of the valve and the Helium fill nozzle
- Interface between the top of the valve and the balloon nozzle
- Interface between the valve gate servo motor and the microcontroller

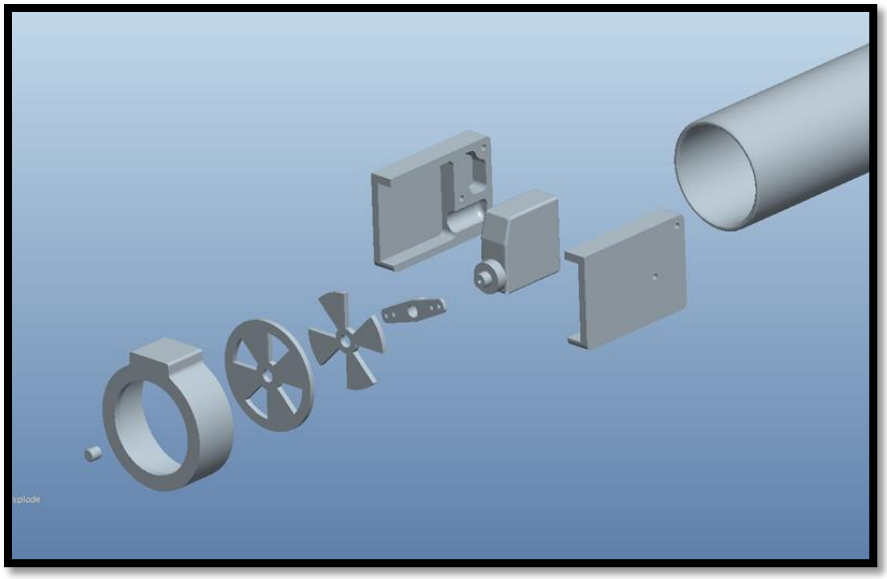


Figure 1: Exploded CAD model of the Valve geometry

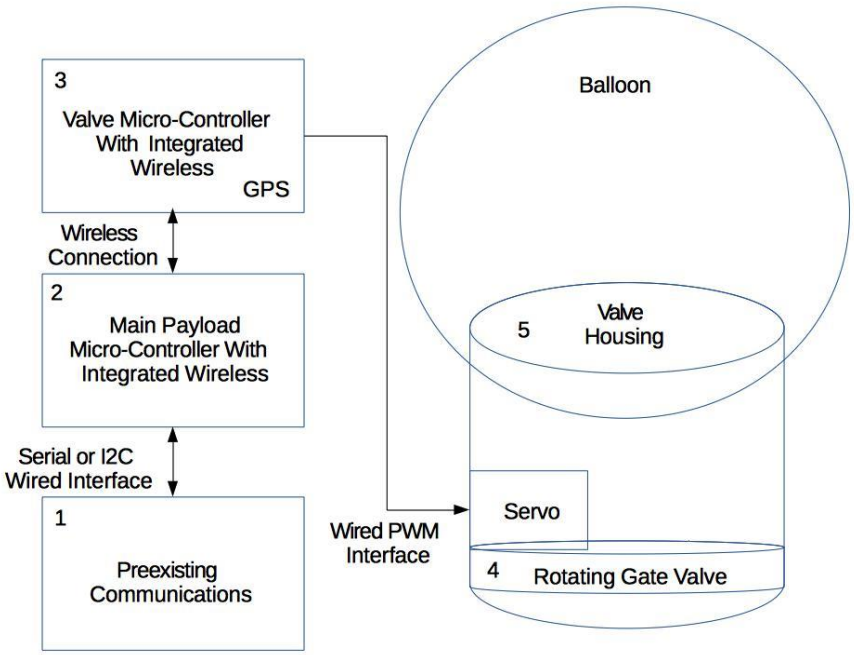
Electrical:

The electrical portion of this project will consists of interfaces between electrical components, mechanical components, and the user. The first interface will be the interface between the customer's communications system and the microcontroller in the main payload. This is interface will have user selectable options: serial, I2C, and or some digital control lines. The user will be able to send commands and receive data via these this interface. The next interface is the interface between the main payload micro-controller and the micro-controller on the valve. This interface is going to be a wireless connection. This is achieved with the microcontrollers' built in radio. Next the valve microcontroller interfaces to the servo that controls the valve gate with a pulse width modulated signal. The user will interface with the microcontrollers by connecting the microcontroller to a computer via USB cable and uploading their desired code.

- Interface between the user's communication system and the main payload micro-controller
- Interface between the main pay load and the valve micro-controller
- Interface between valve micro-controller and the valve servo
- Interface between the user and the microcontrollers

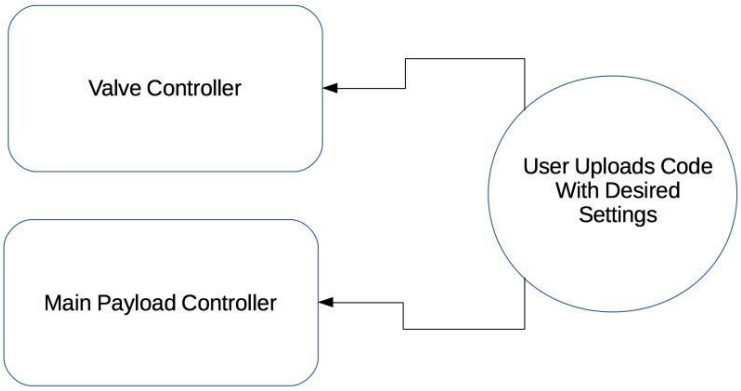
System Interfaces

The following figure shows the different components of the system and how they interface together.



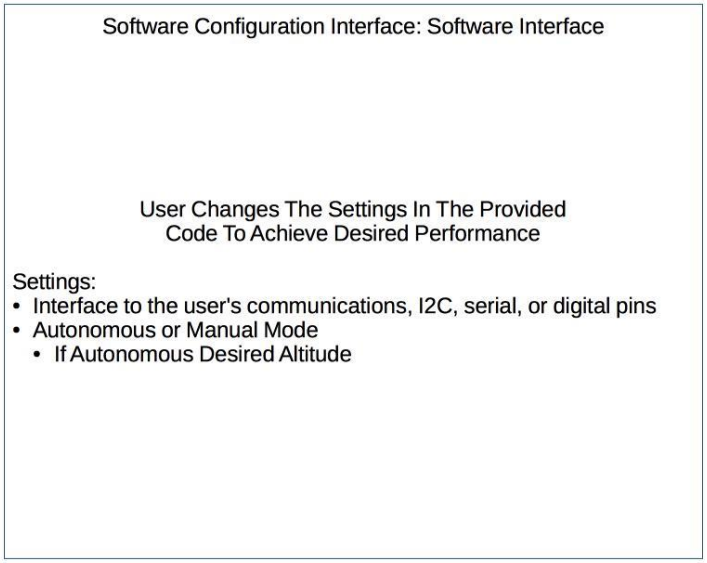
Sub-System Interfaces

Software Configuration Interface: Physical Interface

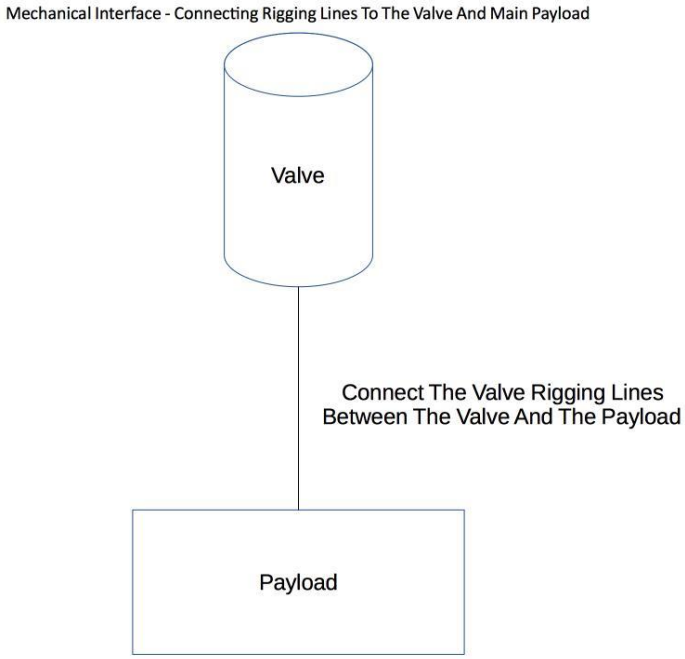


Software configuration interface: physical interface - The physical interface of the software configuration interface describes the electrical connection of the programming cable with the main

payload controller. The user must plug a USB cable into their computer and connect the other end with the main payload microcomputer. A label or graphic will guide the user to the correct location for the programming cable. The software will use the main payload controller to (wirelessly) update settings on the valve controller so a second cable or programming step is not needed.

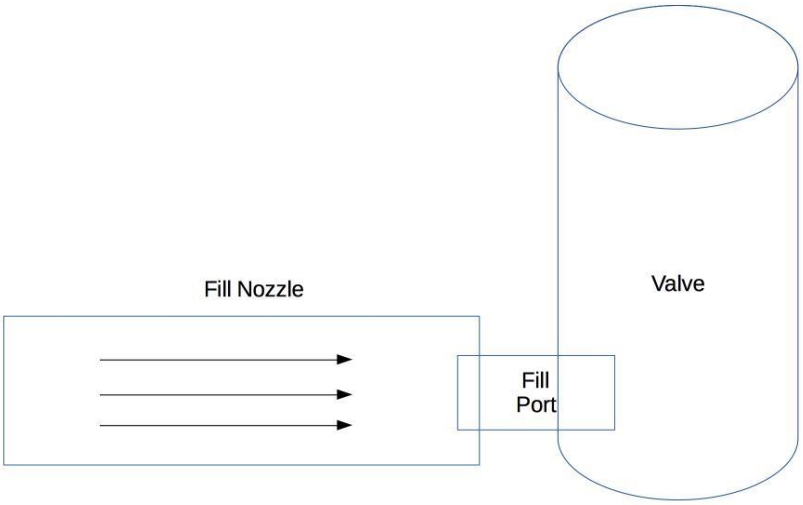


Software configuration interface: software interface - The software configuration interface is used to program the main payload controller with the settings selected by the user. This interface consists of a graphical user interface running on the customer-provided computer and any setup or installation required to get the software running. The user must interact with the software to select their desired settings.



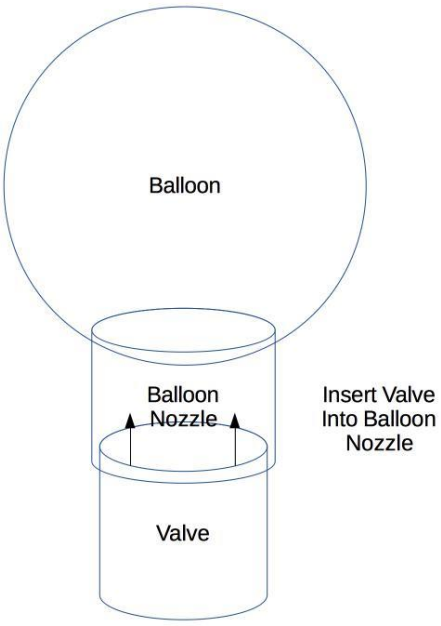
Mechanical interface: connecting rigging lines to the valve and main payload - The mechanical interface between the valve and main payload requires the user to physically couple their payload to the helium valve hardware. The rigging lines used will be provided by the customer however our product will provide hard mounting points to securely attach these lines to the valve.

Mechanical Interface - Attaching Helium Fill Nozzle To The Valve Fill Port

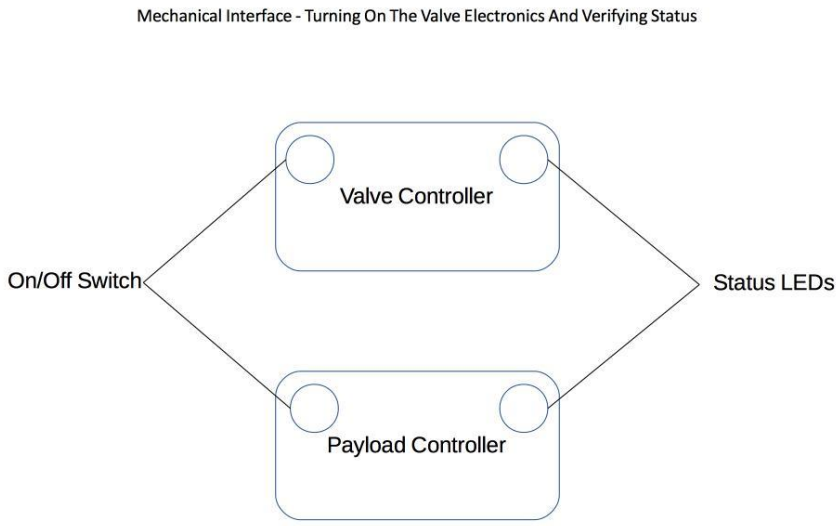


Mechanical interface: attaching helium fill nozzle to the valve fill port - The mechanical interface between the fill nozzle and fill port requires the user to physically connect a fill nozzle from their helium tank and regulator to the fill port of the valve assembly. The user must then operate their helium filling equipment to fill the latex weather balloon as needed.

Mechanical Interface - Inserting Valve Hardware Into Latex Weather Balloon



Mechanical interface: inserting valve hardware into latex weather balloon - The mechanical interface between the customer's latex weather balloon and the valve assembly requires the user to mechanically insert the valve sub-assembly into the balloon nozzle. Once the valve has been inserted to a reference mark the customer must secure the valve to the balloon using zip-ties or other similar means.



Mechanical interface: turning on the valve electronics and verifying status - The valve electronics require a mechanical interface between the user and the product activation switches. The user must physically actuate the power switch to turn on the valve electronics. Once the electronics have powered up the user must verify proper operation using status LEDs located on the valve hardware.

User Interfaces

The user interfaces for the balloon valve system consist of two main components: the mechanical assembly and construction of the valve with the balloon, and the electrical connections and configurations required to operate and program the system. This section will describe the human factors required for proper operation of both components. This will include any part of the valve system which a human must touch or interact with to properly operation our product.

The first main component of the user interface will be those related to the mechanical and physical valve assemblies. First the valve housing assembly user interface will be detailed (which connects to the latex weather balloon), then the main payload subsystem interface (which is used to interface with the customer's tracking system) will be detailed.

The valve housing assembly will likely have the most human contact over all other systems in our product. The valve housing assembly has three main sub-interfaces: connection of the latex weather balloon to the valve, attaching or detaching the helium fill nozzle, and turning the system on and verifying operation.

Attaching the latex weather balloon will be a critical step requiring the user to physically insert the valve into the balloon nozzle. As we are designing the valve hardware to fit within a standard Kaymont weather balloon this operation should not require heavy exertion by the user. The user must hold the latex weather balloon nozzle in one hand, and guide the valve assembly into the balloon nozzle with the other hand. Once the valve is inserted far enough into the latex balloon (indicated by a reference mark) they will need to secure the balloon to the valve using zip-ties to ensure the balloon does not slip off during use. The user must then physically couple their main payload to the valve using their own rigging materials. The valve will provide hard mounting points which the user may use to affix nylon rope (or similar) as required.

The second mechanical interface will be between the helium fill nozzle and the valve (which has already been inserted into the latex balloon). This consists of attaching a helium fill tank (which the user must supply and know how to operate) to the valve such that the balloon may be inflated. As the valve itself starts in the closed position the user will be able to fill the latex balloon with the valve assembly already assembled. Our product will supply a fill nozzle or adapter which will connect to the customer's helium tank using industry standard hardware. The user must physically couple the helium fill tube (connected to their helium tank and regulator) to the valve assembly and ensure it is connected securely before turning on the helium flow through the regulator. Once the balloon has been filled to customer specifications the user will then need to decouple the helium fill tube from the valve assembly.

The third and final mechanical interface will be turning on the system and verifying it is operational. Both the main payload controller and the valve assembly will have electronics which must be activated prior to use. The product will have a switch or other method used to turn on each device and status LEDs which indicate proper operation. Activating the system will require that the user manipulates the activation mechanism and also observes the status LEDs which appear.

The electrical connections and software configurations are the other primary interface with our product. These components will be used to configure the microcontroller for proper operation and ensure the customer's systems can properly communicate data with our product.

The electrical connection is the physical coupling of the main payload controller with the client's tracking and communication system. The main payload controller will contain data ports or screw terminals which the user must electrically connect to their system (if this functionality is to be used by the client). This may involve the user providing their own cables and tools (such as screwdrivers) to mechanically couple these devices. A protocol datasheet will be provided with the product which will describe how the user must communicate (through their tracking and communication system) with our product. The user must be able to interpret this protocol and configure their own equipment as needed for this data link.

The second electrical and configuration user interface will be the software graphical user interface used to configure the product to the user's requirements. This software must be executed on the user's computer by either downloading it from a location we specify or installing it from a CD or flash drive provided with the product. The software will provide meaningful labels or instructions guiding them through the process of configuring the valve electronics. The user will select or enter various settings into the software according to their needs, such as manual or autonomous mode and the desired float altitude. Once all settings have been entered the user will connect a USB cable to their computer (which is provided with the valve system) and the other end of the cable into the main payload controller. This

will start the software programming of the user selected configurations onto the microcontroller of the main payload controller. Labels or other indicators will be present on the main payload controller which will help the user select the correct port to plug the programming cable into. A graphical alert will instruct the user when the programming process is complete, after which they may unplug the programming cable. Status LEDs will provide some low level indication of configuration and operating status.