Software Requirements Specification

for

CubeSat

Version 1.0b approved

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Revision History

Name	Date	Reason For Changes	Version
Team CubeSat	9/18/2018	1st Draft	1.0a
Team CubeSat	10/27/2018	2nd Draft	1.0b

1. Introduction

1.1 Purpose

1. Outline the Software Capabilities of CubeSat
    a. Receive commands from the Ground System (GS)
    b. Execute commands
    c. Process sensor data to autonomously determine actions
    d. Interpret sensor/image data
    e. Service another CubeSat

2. Detail the all components related to CubeSat:
    a. *Ground System (GS):*
    Shall -
        i. Receive data from the CubeSat
        ii. Send commands to the CubeSat
        iii. Display a User Interface (UI) to manage/visualize data
    b. *Space Simulator (SimPlat):*
    Shall -
        i. Receive move commands from the CubeSat
        ii. In case of an emergency, receive a stop cmd from GS

3. Provide additional information for Other Non-Functional Requirements:
    a. *Hardware:*
        i. Processing Device:
            1. Raspberry Pi 3 Model B+
        ii. Sensor Types:
            1. Proximity
            2. Camera
        iii. Communication Types:
            1. WiFi
            2. LoRaWAN/Zigbee
    b. Performance
    c. Security

1.2 **Document Conventions**

Typographical Conventions:	Details:
Bolded Font	Introduces a new section
Italicized Font	Important components inside a hierarchy
Underline Word	Emphasizes importance
Bullet Points	Explain the details to a given hierarchy

1.3 **Intended Audience and Reading Suggestions**

Intended Audience:	Refer to: (Section #)
Project Managers (PM)	1.X - 6.X
Developers (Devs)	2.X - 4.X
Testers	2.X - 4.X
Users	2.6

**This document was meant to be read in sequential order*

1.4 Product Scope

1. *The Software Products Produced:*

GS - will be used to control the CubeSat in Low Earth Orbit (LEO) to de-orbit decommissioned satellites (Target) and space debrises

a. GS's Functionality:

i. Interpret proximity sensor data to approach/avoid objects, process camera image data and understand what it's looking at, send/receive thruster status, control deorbit mechanism, communicate status and receive commands from GS.

ii. Provide one-way communication between GS and CubeSat

iii. Compare action/response data of CubeSat

iv. Provide telemetry and control of CubeSat. Ability to compare data from both to evaluate accuracy of motion and synchronicity.

SimPlat - will use CubeSat's commands to simulate motion in space.

b. SimPlat's Functionality:

i. Provide one-way communication from CubeSat

ii. Read real-time signals from CubeSat:

1. Interpret intended motion

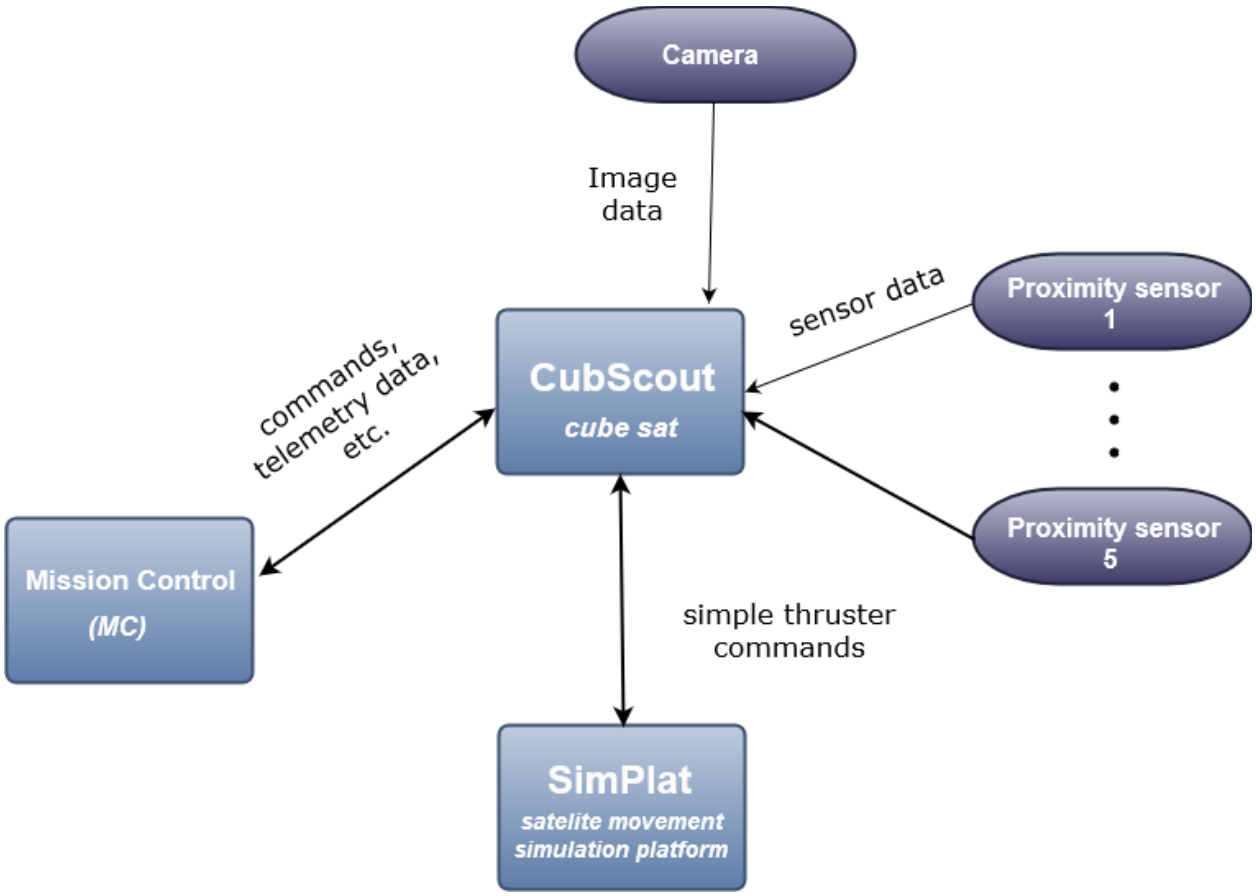
2. Move to simulate motion in space

1.5 References

Aerospace Corporate University Affiliate Program - CubeSat Test Platform Project Description

2. Overall Description

2.1 Product Perspective



2.2 **Product Functions**

Function Name:	Sub-Components:	Description:
User Interface	Display	Displays CubeSat's Controls and Statuses
	Movement Prediction	Interprets Sensor Data to predict CubeSat's next action
	Image Recognition	Interpret live camera feed to detect objects
	Data Transfer	Send commands to the CubeSat

2.3 **User Classes and Characteristics**

Basic knowledge of using computers is necessary to use this web application. Knowledge of how to use a mouse or keyboard and internet browser is necessary to navigate the user interface.

As of right now only the administrators interact with the web portal. They manage the overall system.

**In the future, functionality of this system will be divided among multiple users. Admin will spread the responsibility of controlling the CubeSat to different users groups. Each user group will have specific components that they are responsible for. User groups will be added as needed.*

User Type:	Description:
Admin	Controls entire system
Co-Admin	Maintains system controls

2.4 Operating Environment

The software will be web-based, meaning it will be accessible by browser.

2.5 Design and Implementation Constraints

Constraint:	Component Type:	Description:
SimPlat	Hardware	Attempts to imitate movement in space.
Camera	Hardware	1080p quality may be too high resolution. Down-scaling may need to be applied.
Image Recog.	Software	Lack of data due to the reduced frame rate or pixel density.
Data Transfer	Hardware	Data transfer speeds may be too low to stream 1080p video. May need to reduce fps.
Time Delay	Hardware	There will be a delay in time. Actions may be impacted.
Thrusters	Hardware	Thrusters will be simulated by lights. No actual propulsion system will be used.

2.6 User Documentation

User manual/instructions available online at:
http://www.Eaglescout-csula.com/help

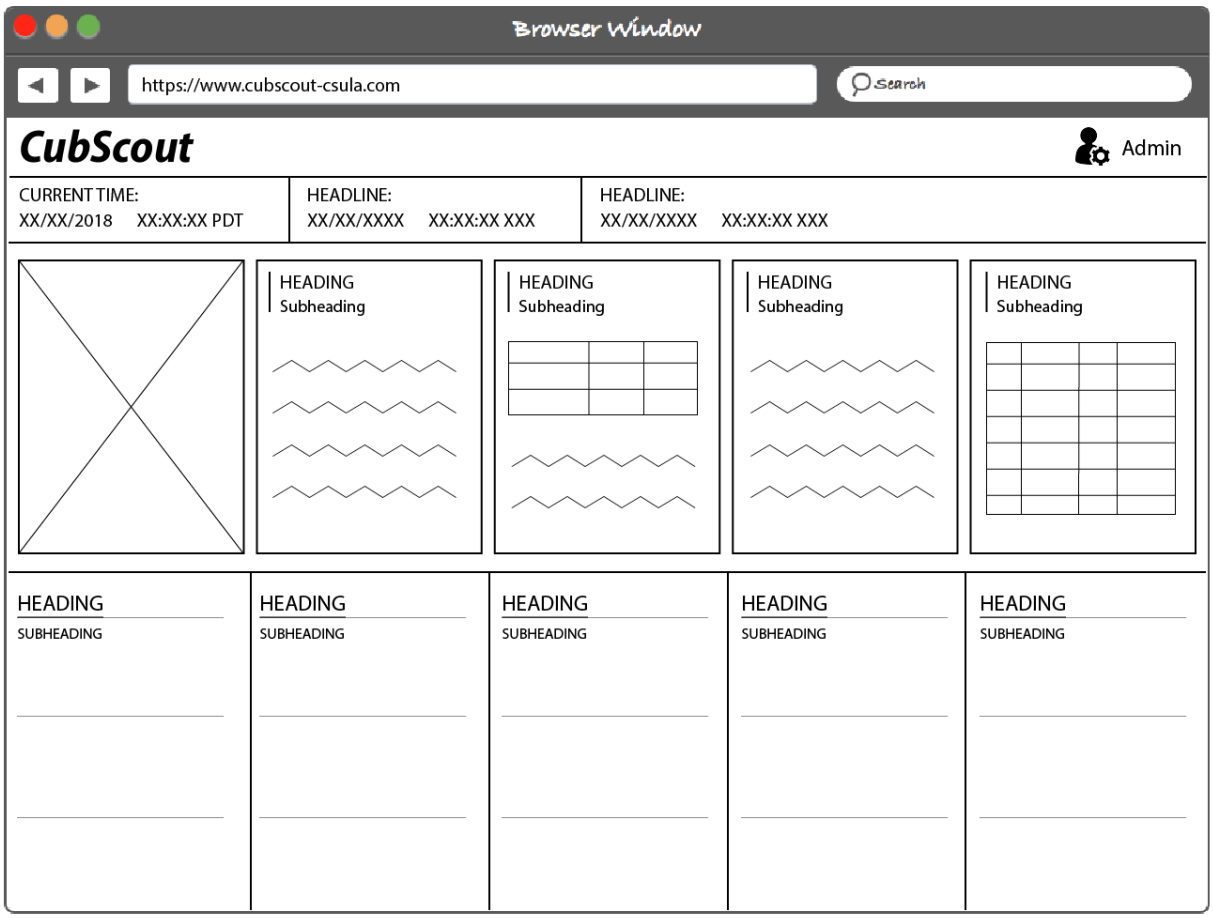
**Not a working link*

2.7 **Assumptions and Dependencies**

Assumptions/Dependencies	Examples
Internet Connectivity	WiFi, Ethernet, Tethering, etc.
Modern Internet Browser	Google Chrome, Firefox, Edge
Computer & Computer Peripherals	Computer, Mouse, Keyboard, Monitor

3. External Interface Requirements

3.1 User Interface



This software only requires an up-to-date web application on a device connected to the internet.
The user interface will consist of clickable/tappable buttons used to navigate. It is intended to be usable on any device with web connectivity and internet browser, so everything should be navigable through a tap or click.
There will be four different screen to show different data receiving from CubeSat and camera.
There will be a message display location anytime when trying to move CubeSat.

3.2 **Hardware Interfaces**

Component:	Software Interaction:
Raspberry Pi 3 Model 3B+ (1)	Runs the motion software for the SimPlat.
Raspberry Pi 3 Model 3B+ (2)	Runs the Machine Learning Algorithm for the CubeSat.
Camera	Attaches to (2) and records video for ML Algorithm.
WiFi Module	Built into (2) and sends image data to the GS.
Sensors (Proximity, Motion)	Attaches to (2) and provide data for the Machine Learning Algorithm.
LoraWAN/Zigbee	Attaches to (2) and sends sensor data to the GS.

3.3 **Software Interfaces**

Software shall store information to database such as location data and video data.
Software shall communicate with CubeSat to control it.
Software shall communicate with camera for receiving video data.
Software shall make connection between itself and CubeSat with wifi.
Software shall allow user to control CubeSat in any secured environment.
Software shall provide detail about CubeSat when CubeSat is working.

3.4 **Communications Interfaces**

The GS system shall use wifi for communication over the internet/raspberry pi and for the internet communication will be through the connection signal.

4. System Features

4.1 CubeSat

4.1.1 Shall receive commands from GS.
4.1.2 Shall send telemetry data to GS.
4.1.3 Shall send commands to SimPlat.
4.1.4 Shall autonomously navigate to target specified by GS.
4.1.4.1 Shall avoid obstacles.
4.1.4.2 Shall identify specified target.
4.1.5 Shall attach to the specified target.
4.1.6 Should service specified target.
4.1.7 Should deorbit specified target.

4.2 Ground System - GS

4.2.1 Shall send commands to the CubeSat.
4.2.1.1 Shall specify a target.
4.2.1.2 Shall send retrieval commands.
4.2.2 Shall send SimPlat emergency STOP command.
4.2.3 Shall receive telemetry data from the CubeSat.
4.2.4 Shall store telemetry data in a database.
4.2.5 Shall have an intuitive User Interface.
4.2.5.1 Shall display sensor data.
4.2.5.2 Shall display image data.
4.2.5.3 Shall display telemetry data.
4.2.5.4 Shall display CubeSat Diagnostics.

4.3 Space Dynamics Simulation Platform (SimPlat)

4.3.1 Shall simulate motion in space.
4.3.2 Shall receive commands from CubeSat.
4.3.3 Shall receive emergency STOP command from GS.

5. Other Nonfunctional Requirements

5.1 Performance Requirements

- The transferring of data between the CubeSat and GS must be no less than 8 MBps.
- This allows the the CubeSat and GS to communicate and transfer video from the camera in the CubeSat to the GS.
- This will also allow both to exchange information and communicate with lower delay.

5.2 Safety Requirements

Malfunctioning of this kind of software, could not possibly cause direct or indirect, human or environmental damage. Therefore, there are no safety requirements for this project. (ADF)

5.3 Security Requirements

- The server must authenticate every request accessing the restricted Web pages.
- After authenticating the browser, the server must determine whether that browser is authorized to access the requested restricted Web pages.
- The system must have security controls to protect against attacks.
- The behavior of the software must be correct and predictable.
- The software must ensure the integrity of the user information. (ADF)

5.4 Software Quality Attributes

- Correctness:
    - Agreement of program code with specifications
    - Independence of the actual application of the software system
- Reliability: The probability that this system fulfills a function for a number of input trials under specified input conditions in a time interval (assuming that hardware and input are free of errors).
- Learnability: The user interface should present information as close to reality as possible and permit efficient utilization of the software's failures.

- Efficiency: Ability of a software system to fulfill its purpose with the best possible utilization of all necessary resources (time, storage, transmission, channels, and peripherals). (ADF)

5.5 Business Rules

The system shall have roles assigned for every individual.
Such roles shall be: administrators, moderators, and users.
Each role shall have different access level to the system.

1. Administrators shall have the ability to:
    a. view the GS,
    b. send commands to the CubeSat from GS,
    c. access system data,
    d. modify system data,
    e. view system log,
    f. change the roles of other users,
    g. add new users
2. Moderators shall have the ability to:
    a. view the GS,
    b. access system data,
    c. view system log,
    d. add new users
3. Users shall have the ability to:
    a. view the GS

6. Other Requirements

Appendix A: Glossary

Abbreviation/Acronym	Phrase	Definition
CubeSat	CubeSat	A type of miniaturized satellite for space research that is made up of multiples of 10×10×10 cm cubic units.
GS	Ground System	A centralized venue for managing some operation.
LEO	Lower Earth Orbit	An orbit around Earth with an altitude above Earth's surface of 2,000 kilometers (1,200 mi), and an orbital period between about 84 and 127 minutes.
SimPlat	Space Dynamics Simulation Platform	A vehicle with platform and CubeSat mount that simulates motion in space.
SRS	Software Requirements Specification	A description of a software system to be developed.
Target	Decommissioned/ Wounded Satellite	Satellites that are no longer functional or operable.
UI	User Interface	The means by which the user and the cubesat interact, in particular the use of input device and software.