Requirements For RockSat-X Payload - Hephaestus

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Abstract

The Oregon State University RockSat-X team shall be name Hephaestus. The requirements for the hardware, software, and programmatic development of Hephaestus shall be outlined in the following document. The mission requires that the payload, an autonomous robotic arm, perform a series of motions to locate predetermined targets. The hardware shall be capable of performing the motions to reach the targets. The software shall determine the targets and send the commands to the hardware to execute the motion. The combination of the hardware controlled by the software shall demonstrate Hephaestus's ability to construct small parts on orbit.

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1 Introduction

1.1 Purpose of Document

This document shall describe in detail the Hephaestus RockSat-X payload. It specifies the software behavior of the payload. This document will not discuss the specific implementations of the hardware or the software. It will specify the behavior by describing the Functional and Non Functional requirements of the software. This document will be updated throughout the project.

1.2 Overview of Document

This document will first cover the functional requirements of the project, then the non functional requirements. The Functional Requirements will include descriptions of the main behavior, target generation, movement, operation modes, and telemetry. Each of these topics will include descriptions of the behavioral requirements for each. The Non Functional requirements will cover the performance, security, and telemetry. Each of the non functional topics covered will include the requirements for the quality of each of the topics.

1.3 Overview of Payload

The Hephaestus RockSat-X payload shall perform the following operations:

- Remain retracted with power off for duration of launch
- Power on at apogee
- Deploy arm assembly body
- Deploy arm
- Perform 360 degree sweep with video camera
- Generate targets for arm motions
- Perform arm motions
- Record each arm motion with video camera
- Retract arm
- Retract arm assembly body
- Power off

1.4   Mission Success Criteria

The following criteria determine if the Hephaestus mission will be considered successful post-flight. The minimum mission success criteria represent the lowest criteria to be met in order for the mission to be considered successful. If the minimum mission success criteria are not met, then the mission may not be considered successful. The maximum success criteria define the highest goals for the mission. Fulfilling any or all of these criteria, in addition to the minimum success criteria, would constitute a highly successful mission. The success of the mission shall be evaluated by means of video recordings recovered post-flight and telemetry data received during the flight.

1.4.1   Minimum Mission Success Criteria

- The arm assembly body shall deploy and a video sweep is successfully recorded.

- The arm assembly body shall be fully retracted after data collection.

1.4.2   Maximum Mission Success Criteria

- The arm assembly body shall deploy and a video sweep is successfully recorded.

- The arm shall make contact with predetermined targets around the payload.

- The camera shall record all instances of contact between the arm and the targets.

- The arm assembly body shall be fully retracted after data collection.

1.5   Requirements Apportioning

1.5.1   Priority 1

This is the highest priority level. In order for the software system to be considered complete and ready for launch, all requirements of this level must be met. The completion of only Priority 1 requirements marks the completion of Minimum Mission Success criteria, as defined in section 1.4.

1.5.2   Priority 2

Requirements of Priority 2 are not required for the release of the software system. Not completing these requirements must not present a risk to mission success. The completion of these requirements and successful performance on orbit marks completion of part of the Maximum Success Criteria, as defined in section 1.4.

1.5.3   Priority 3

Requirements of Priority 3 are not required for the release of the software system. Not completing these requirements must not present a risk to mission success. Completion of all priority 3 requirements and those of higher priority, with successful performance on orbit, marks the completion of the Maximum Mission Success Criteria, as defined in section 1.4.

2   Functional Requirements

2.1   Main Behavior

Priority 1: The software shall control the movement of the arm assembly body to make contact with the outside of the rocket at locations generated by the Software (section 2.2).

2.2   Target Generation

Priority 1: The software shall generate points with a radius, angle, and height. The angle shall be in the range of 0 and 359 degrees. The angle shall be measured from normal. The normal angle shall be defined as the direction of payload deployment. These points shall be used as targets for the arm body.

2.3   Movement

The software shall control the movement of the arm body assembly.

Priority 1: The software shall rotate the arm body assembly in a full 360 degrees.

Priority 2: The software shall additionally control the movement the height of the arm body assembly. The arm should descend and touch the baseplate of the payload at any rotation.

2.4   Modes

During the course of the flight, the software will progress though several different modes of operation.

2.4.1   Launch

Priority 1: The software shall remain idle during launch.

2.4.2   Deployment

Priority 1: The software shall power on the arm assembly body and video camera. The software shall begin saving the video feed from the camera to a persistent storage location. The software shall generate target points, as defined in section 2.2.

2.4.3   Science

Priority 1: The software shall collect data to serve as a proof-of-concept for construction of structures in flight.

2.4.4 Safety

Priority 1: The software shall ensure that the arm assembly body can be fully retracted after completing the mission. The software shall, in case of a failure, eject the arm to prevent damage to the arm assembly body and the rocket during descent.
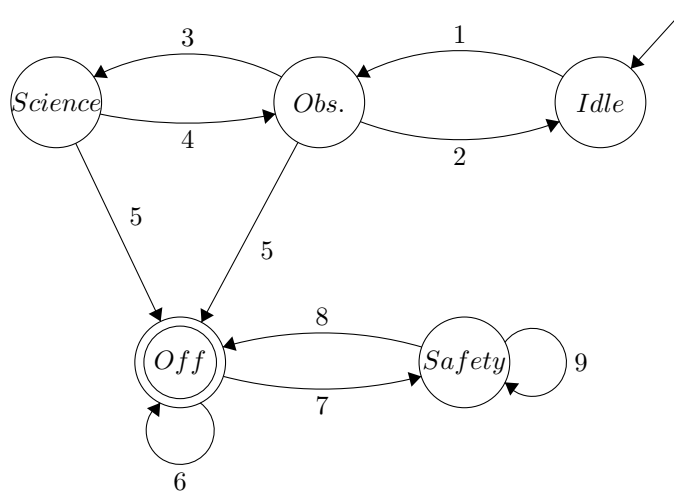
2.4.5 Observation

Priority 1: The software shall report all telemetry data (as defined in 2.5) to the ground station.

Priority 2: The software shall be responsible for turning the camera on and off.

2.4.6 Power Off

Priority 1: The software shall power down all subsystems of the payload in preparation for descent.

2.4.7 State Diagram

State diagram for transition between operational modes.

2.5 Telemetry

Let the telemetry interface be defined as 5 of the ten analog pins provided by Wallops Flight Facility. Let telemetry be defined as the data transmitted from the payload to the ground station via the telemetry interface. The software shall report all telemetry data to the ground station.

Priority 1: The software shall report via telemetry all the target points it generates, as defined in section 2.2. The software shall also report which code branch it takes to facilitate debugging and post-mortem analysis, if necessary.

3 Non Functional Requirements

3.1 Performance

Priority 1: The system shall perform efficiently. The maximum response service time should be long enough for the robotic arm to move from one target to another. The system should have a maximum throughput that allows for processing of input arguments about the arm's actions and processing for the telemetry data output. Resource usage should be limited to account for the storing of telemetry data. Power consumption must be limited to 28V.

3.2 Security

Priority 1: The system shall be secure. Since it is a closed system, the device will be programmed such that it cannot be accessed remotely and will only output sanitized data.

3.3 Telemetry

Priority 1: The system will perform telemetry. The data will be transmitted with a delay of up to 10 seconds.