SYSTEM REQUIREMENTS SPECIFICATION

ENGR: D. Kaputa	Revisions			
	Rev.	Description	Date	Approved
ENGR:	1.0	Initial Specification	3-7-2016	
ENGR:				
ENGR:				
MGR: D. Kaputa				

Table of Contents

1   INTRODUCTION

This document is meant to capture the performance requirements and desirable physical characteristics that Dr. Doom is to attain in its final design and operational state.

1.1   OVERVIEW

Dr. Doom is a rover based upon the Rover 5 platform which is being designed to compete in the Embedded Systems Design II class competition in the College of Applied Science and Technology at the Rochester Institute of Technology. There are three phases to the competition however this single system requirements document shall envelope all of those phases. If there are any phase specific requirements they shall be clearly denoted as applying only to that specific phase. For the competition the main body of the rover must be used for all phases however different attachments can be added or removed as desired.

1.2   SCOPE

This specification defines the overall functionality and establishes the performance, design, development, and test requirements which Dr. Doom must satisfy.

1.3   REQUIREMEN MARKING

All requirements are marked with a unique identification designated by [R.ROV_XXXX] (where R stands for requirement, and XXXX equals a numerical sequence). V is used in place of R for section 4 which is the requirement verification section.

2   APPLICABLE DOCUMENTS

This section contains documents referenced in this specification. The revision listed is the revision effective for this design effort. When no revision is listed, the latest issue in effect is applicable. Documents that do not have a specific revision specified may be industry/government standards, etc. that when revised normally, do not directly impact the design, development, or testing parameters of the item in question.

2.1   STANDARDS

2.2   REFERENCE DOCUMENTS

The documents listed herein are provided as background information for users of this specification defining the source of the requirements in sections 3 and 4 of this specification. The listing in this section does not levy new or relieve specific requirements which are imposed by this specification or other contractual documents associated with procurement of this specification.

Document Number	Document Title	Revision

3 REQUIREMENTS

3.1 ROVER DESCRIPTION

[insert high level description of the entire system]

3.1.1 DRAWINGS

[insert high level block diagram of the entire system]

3.2 CHARACTERISTICS

3.2.1 PERFORMANCE AND FUNCTIONAL CHARACTERISTICS

3.2.1.1 Controller Functional Requirements

[A functional requirement is a specific business need or behavior as seen by an external user of the system.]

3.2.1.1.1 Inputs/Outputs

[R.ROV.30] **Motor Encoders**

Each motor shall interface with a rotary encoder that will provide relative position feedback.

[R.ROV.40] **Camera Module**

The controller shall interface with a camera module by providing a digital command and receiving a digital image.

[R.ROV.50] **Motor Driver**

The controller shall interface with four motor drivers (one channel for each motor) by providing a digital PWM signal as defined in section TBD.

[R.ROV.60] **Motor Driver Logic Power**

The motor driver logic circuit shall interface with a +3.3 VDC electrical power supply.

[R.ROV.70] **Motor Driver Output Power**

The motor driver output circuit shall interface with a +12 VDC electrical power supply.

[R.ROV.80] **Controller Power**

The controller shall interface with a +12 VDC electrical power supply.

[R.ROV.90] **Remote Desktop Interface**

The controller shall interface with a remote PC via an attached WiFi dongle.

3.2.1.1.2   Functions

[R.ROV.100] **Motor Driver**

The motor controller shall reside in the FPGA and receive and process commands from the processor per the communications protocol defined in Appendix B.

3.2.1.1.3   Thermal

[R.ROV.120] **Active Heating or Cooling**

The rover shall not require active heating or cooling when operating within the environment specified in TBD.

3.2.1.1.4   Electrical Power

[R.ROV.60] **Electrical Power Input**

The rover shall have two battery packs that supply power to the digital and drive output subsystems respectively.

[R.ROV.60] **Power-up Sequence**

The digital subsystems shall power up TBD ms before the drive output subsystem.

[R.ROV.60] **Fault/Low Power Detection**

The controller shall be able to detect and annunciate a low battery as well as a loss of output drive power.

3.2.1.2   Controller Performance Requirements

[A performance requirement specifies the speed or operational effectiveness of a capability that must be delivered by the system architecture as seen by the technical layers within that system architecture.]

[R.ROV.60] **Camera Update Rate**

Camera shall update at a rate of 5 frames per second.

[R.ROV.60] **Motor Command Update Rate**

Motor command shall update at a rate of 1 kHz.

[R.ROV.60] **Motor Command Resolution**

Motor command shall have a resolution of TBD inches.

[R.ROV.60] **Position Command Frequency Response**

3.2.2   USER INTERFACE REQUIREMENTS

3.2.3   NOMINAL OPERATING FUNCTIONALITY

[R.ROV.60] **Built-In-Test**

[R.ROV.60] **Operating States**

[R.ROV.60] **Position Command Latency**

3.2.4   OFF-NOMINAL OPERATING FUNCTIONALITY

[R.ROV.60] **Position Command Clamps**

[R.ROV.60] **Communication Loss**

[R.ROV.60] **Loss of Sensors**

[R.ROV.60] **Sensor Inputs out of Range**

3.2.5   OPERATING MARGINS

[R.ROV.60] **Memory Margins**

[R.ROV.60] **FPGA Timing Margins**

[R.ROV.60] **Processing Margins**

3.2.6   PHYSICAL CHARACTERISTICS

[R.ROV.60] **Weight**

[R.ROV.60] **Envelope**

3.2.7   RELIABILITY

3.2.8   ENVIRONMENTAL CONDITIONS

3.3   DESIGN AND CONSTRUCTION

3.3.1   IDENTIFICATION AND PRODUCT MARKING

3.4   INTERFACE DEFINITION

3.4.1   STRUCTURAL/MECHANICAL INTERFACE

[R.ROV.60] **DE1 Mounting Interface**

The DE1 board shall attach to the rover chassis per the diagram below. TBD.

 [R.ROV.60] **Camera Mounting Interface**

The camera shall attach to the rover chassis per the diagram below. TBD.

3.4.2 POWER INTERFACE

[R.ROV.60] **DE1 Power Interface**

The DE1 board shall accept a cable connected to a battery pack that mates with the +12 VDC power input jack on the board.

[R.ROV.60] **Motor Drive Logic Power Interface**

The motor driver logic power shall accept a two wire power input where ground is black and +3.3 VDC is red.

[R.ROV.60] **Motor Drive Output Power Interface**

The motor driver output power shall accept a two wire power input where ground is black and +TBD VDC is red.

[R.ROV.60] **Steady-state Input Voltage**

[R.ROV.60] **Inrush/Surge Transient Operation**

[R.ROV.60] **Peak Ripple Voltage**

[R.ROV.60] **Peak Ripple Spectrum**

[R.ROV.60] **Overvoltage/Undervoltage Surge Operation**

[R.ROV.60] **Average Power**

[R.ROV.60] **Single Point Ground**

3.4.3 PROCESSOR TO FPGA POSITION COMMAND INTERFACE

[R.ROV.60] **Position Polarity**

A positive position command shall move the rover forward.

[R.ROV.60] **Position Scaling**

All position commands shall be in units of encoder ticks.

[R.ROV.60] **Position Update Rate**

All position commands shall be sent to the FPGA at a rate of 100 Hz.

3.4.4   ENCODER INTERFACE

[R.ROV.600] **Encoder Scaling**

Each motor encoder shall supply 1000 ± 5, +3.3 VDC pulses to the controller for every single rotation of the motor. 1000 counts equates to TBD inches.

3.4.5   CAMERA INTERFACE

3.4.6   MOTOR DRIVE INTERFACE

3.4.7   CONNECTOR INTERFACE

[R.ROV.60] **Electrical Connectors**

The rover shall have electrical connectors as defined in the table below.

Reference Designation	Connector Type	Function
J1	40 pin dual row	Camera Interface
J2	Barrel connector	DE1 +12 VDC

[R.ROV.60] **Communications Connectors**

The rover shall have the below connector for remote desktop communications

Part Number	Distributor	Description
		WiFi dongle

4   VERIFICATION

Section 4 presents details of the verification approach, including verification requirements, the definition of applicable terminology, and identified constraints imposed on verification requirements.

The Verification Cross Reference Matrix (VCRM) is generated to show the requirement trace and primary verification closure methods. The VCRM is located in Appendix A of this document.

4.1   VERIFICATION CONFORMANCE

The verification methods are inspection, demonstration, test, and analysis or a combination thereof. The allocation of these methods is based upon design analyses, design maturity, complexity of the item, criticality category and associated cost. Analysis and testing are considered to be the primary methods used to verify performance requirements.

4.1.1   METHODS OF VERIFICATION

4.1.1.1   Analysis

Verification by analysis is the verification of a product or system using models, calculations and testing equipment. Analysis allows someone to make predictive statements about the typical performance of a product or system based on the confirmed test results of a sample set or by combining the outcome of individual tests to conclude something new about the product or system. It is often used to predict the breaking point or failure of a product or system by using nondestructive tests to extrapolate the failure point.

- Car: complete a series of tests which rev the engine at a specific rpm for a set length of time, while monitoring engine vibration and temperature, to verify that the expected results are achieve. Use this information to model the failure point of the engine, i.e. max rpm sustained over a specific period of time.
- Software Application: complete a series of tests in which a specified number of users input the characteristics of the car they are attempting to price and initiate the pricing functionality at the same time. Measure the response of the system to ensure that the pricing function returns its results within the time specified. Analyze the relationship between increasing number of system users and the time it takes for pricing to be returned. Record the results to capture system degradation. Use this information to predict at what point the system no longer meets the maximum allowable time to return pricing as defined by the requirements.

4.1.1.2 Inspection

Verification by inspection is the nondestructive examination of a product or system using one or more of the five senses (visual, auditory, olfactory, tactile, taste). It may include simple physical manipulation and measurements.

- Car: visually examine the car to ensure that it has power windows, power adjustable seats, air conditioning, a navigation system, a tow package, etc.
- Software Application: visually examine the software for screens that were requested, check for the fields needed for data entry, verify that the necessary buttons exist for initiating required functionality, etc.

4.1.1.3 Demonstration

Verification by demonstration is the manipulation of the product or system as it is intended to be used to verify that the results are as planned or expected.

- Car: use the automatic switches to verify that the windows and seats work as intended, start the vehicle and ensure that the air conditioning produces cold air, take the car for a test drive to sense the acceleration and cornering as it was described based on the requirements.
- Software Application: enter all required fields on a screen and select the button to return a specific report. Ensure that the report is returned with the type of data needed.

4.1.1.4 Test

Verification by test is the verification of a product or system using a controlled and predefined series of inputs, data, or stimuli to ensure that the product or system will produce a very specific and predefined output as specified by the requirements.

- Car: accelerate the car from a complete stop to 60 mph, and verify that it can be done in 5.2 seconds. Accelerate through a turn under controlled conditions, producing .8G of force, without the car loosing traction.
- Software Application: enter the type and model of car, automatic windows, power steering, and all other options as stated in the predefined test plan, select the price now button and receive back a price quote of precisely $43,690.

4.1.2 PHASES OF VERIFICATION

4.1.2.1 Qualification

The qualification phase is the period during which the product design is verified to be in compliance with all specification requirements and that at least minimum design margin exists to ensure that the requirements can continue to be met under worst-case conditions. Qualification will be based on the full range of design requirements that are documented in this product specification. The verification methods used to perform qualification activities include analysis, demonstration, inspection, and test, or any combination of the four, and are defined in Appendix A (VCRM).

4.1.2.2   Acceptance

No acceptance testing is to be performed.

4.2   CHARACTERISTICS

4.2.1   PERFORMANCE AND FUNCTIONAL CHARACTERISTICS

4.2.1.1   Controller Functional Requirements

[A functional requirement is a specific business need or behavior as seen by an external user of the system.]

4.2.1.1.1   Inputs/Outputs

[V.ROV.30] **Motor Encoders**

Motor encoder feedback shall be verified via Inspection during qualification. Verification shall be considered successful when the test data from [R.ROV.600] is inspected and found to be successful.

[R.ROV.40] **Camera Module**

The controller shall interface with a camera module by providing a digital command and receiving a digital image.

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4.4.5   CAMERA INTERFACE

4.4.6   MOTOR DRIVE INTERFACE

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The rover shall have the below connector for remote desktop communications

Part Number	Distributor	Description
		WiFi dongle

5   DEFINITIONS

5.1   ACRONYM LIST

Acronym	Definition
DC	Direct current
TBD	To be determined

6   APPENDIX A – VERIFICATION CROSS REFERENCE MATRIX (VCRM)

The following table acknowledges the two phases of verification namely Qualification and Acceptance, and their associated verification methods. The recognized verification methods are defined as: A = Analysis, I = Inspection, D = Demonstration, T = Test.

Section No.	Requirement ID	Requirement Title	Method	Verification ID	Comment	Comply
3.2.1.1.1	R.ROV.30	Motor Encoders	I	V.ROV.30		

7 APPENDIX B – MOTOR COMMAND AND STATUS FORMAT