**System Requirements Specifications for Roadie**

Sponsor

**Electrical, Computer, Software & Systems Engineering at Embry-Riddle Aeronautical University**

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**Are We There Yet?**

# **Revision History**

|  |  |  |
| --- | --- | --- |
| Date | Reason for Change | Version |
| 18 Nov 2014 | Initial Draft | 0.1.0 |

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# **Introduction**

## **Purpose**

The purpose of this document is to define the system requirements of Roadie, the robot put forth by team Are We There Yet (AWTY) to compete in the 2015 Institute of Electrical and Electronics Engineers (IEEE) SoutheastCon student hardware competition. These requirements include both functional requirements and non-functional requirements. This document is intended for the customer of AWTY, the requirements engineering team for AWTY, the design, testing and quality assurance teams, as well as all other teams involved in the development and construction.

## **Problem Statement**

To create an autonomous robot to compete in the 2015 IEEE SoutheastCon student hardware competition.

## **Scope**

Roadie is intended to compete in the 2015 IEEE Southeast Con student hardware competition. The system is envisioned to complete four unique challenges:

* Correctly play Simon for 15 seconds
* Draw “IEEE” on an Etch-A-Sketch
* Twist one row of a Rubik’s cube 180 degrees
* Pick up and carry one playing card across the finish line

Roadie system is intended to successfully complete the challenges outlined above within a time limit of five minutes.

Roadie is not intended to serve any other functions or fulfill any other purposes other than competing in the 2015 IEEE SoutheastCon competition.

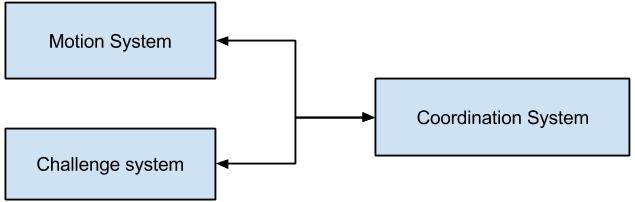
## **Team Information**

|  |  |
| --- | --- |
| Name | Role |
| Brian Powell | Team Leader |
| Michael Philotoff | Software Configuration Manager |
| Alex Senopoulos | Testing Leader |
| Brian Sterling | Development Leader |

## **Overview**

# **Functional Decomposition of System**

Roadie is broken down three main subsystems: (1) the communications and coordination subsystem, (2) the arm subsystem and (3) the movement subsystem. The division of these subsystems is illustrated in **Fig. 1**.

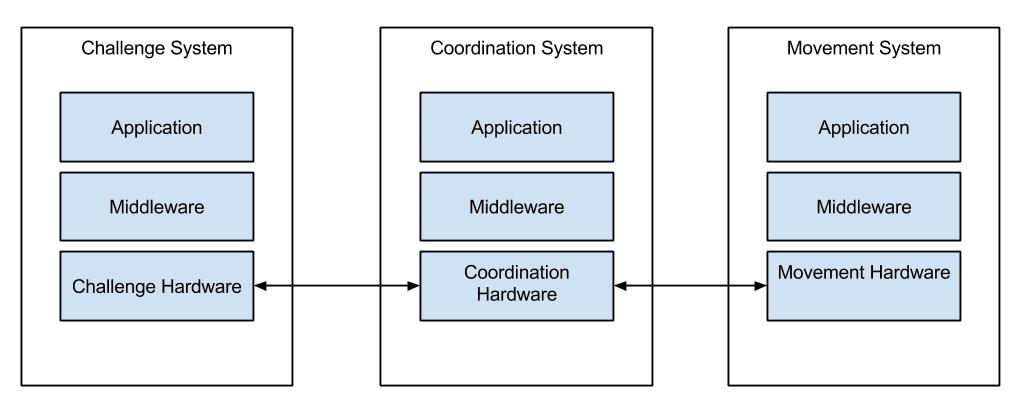


**Fig. 1**: Division of Roadie into three subsystems.

The communication and coordination subsystem relays information to both the arm subsystem and the movement subsystem. These subsystems are further divided by functionality to create the high-level architecture as described in Sections 2.1, 2.2 and 2.3.

## **High-Level Architecture of System**

The system architecture of Roadie is designed in a layered approach, depicted in **Fig*.* 2** below, in order to better divide the work being done and to aid in the conceptualization of the system design.

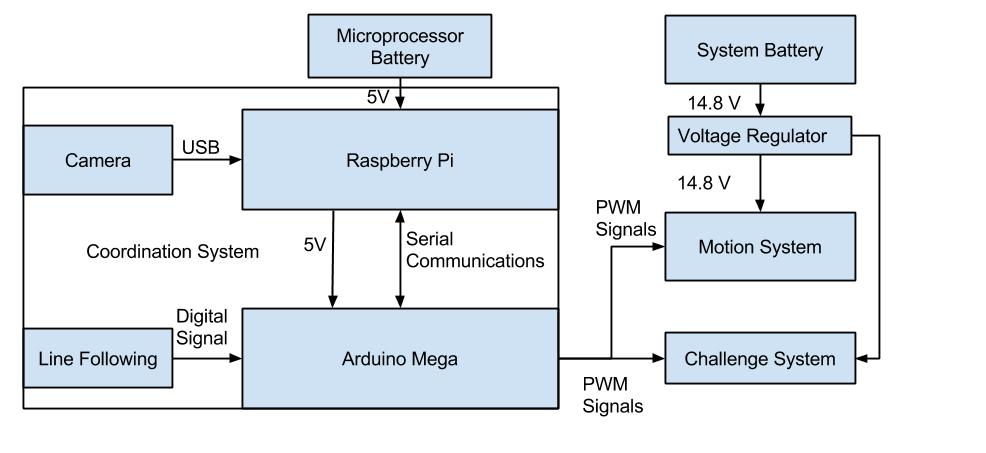


**Fig. 2**: High level description of the systems in Roadie.

The applications on the communications and coordination system in the form of feedback from the sensors (reflectance and camera) is translated by the middleware (software) to the physical communications means. From here, the arm subsystem and the movement subsystem are directed by the communications and coordination system in order to complete the challenges. From there, middleware in the form of software is used to talk to the applications. In this instance, the application on the arm side represents the challenges (Simon Carabiner, pocket Etch-A-Sketch, Rubik’s cube, picking up a playing card), with the movement application being line following. As Roadie progresses along, it continues to send feedback from the movement system and the arm system to the communications and coordination system so that Roadie may understand what exactly is happening.

## **Decomposition of Coordination System**

**Fig. 3** below, better illustrates the communications that occur amongst the systems in Roadie.



**Fig. 3**: Decomposition of coordination system for Roadie.

As depicted in **Fig. 3**, the Coordination System is composed of two microcontrollers, both communicating with each other over a serial interface. The Arduino Mega is the primary micro controller, interpreting inputs from the reflectance array (line following) and issuing commands based on values received. For instance, once the Arduino has detected a challenge location based on a pre-defined threshold, it will issue a command to the Raspberry Pi to object detect with the camera. Once an object has been found, the Raspberry Pi will send a signal back to the Arduino identifying what object has been found. The Arduino will then issues commands to the Challenge System based upon what challenge has been found, and to the Motion System to move the system to the corresponding location on the challenge array.

All of the communications originating from the Coordination System are a hard wire connection. That is to say that all of the communications occur over a physical medium. The Arduino issues commands to the Motion System and the Challenge System via pulse width modulation (PWM) signals through wires connected to the Arduino’s PWM ports. Similarly, communications within the Coordination System occur over a physical medium. The Raspberry Pi and the Arduino communicate via a serial communications over a USB cable. The camera is activated by the Raspberry Pi via serial signals over a USB cable as well. The line following array communicates via digital high and low signals over wires connected to the digital pins on the Arduino.

## Requirements

## Use Cases

## Traceability Matrix

## **Decomposition of Challenge System**

**Fig. 4** shows the decomposition of the Challenge System into its major components.



**Fig. 4**: Decomposition of Challenge System for Roadie.

Signals into this subsystem originate from the Coordination System via PWM signals from the Arduino’s PWM ports. The signals designate what interactor is to activate and what challenge sequence is to be completed. Power for each interactor is sourced from a 14.8V battery.

## Rubik’s & Card Interactor

## Requirements

## Use Cases

## Traceability Matrix

## Etch-A-Sketch Interactor

## Requirements

## Use Cases

## Traceability Matrix

## Simon Interactor

## Requirements

## Use Cases

## Traceability Matrix

## **Decomposition of Movement System**

**Fig. 5** shows the decomposition of Roadie’s movement System into major components.



**Fig. 5**: Decomposition of Movement System Roadie.

Signals into this subsystem originate from the Coordination System via PWM signals from the Arduino’s PWM ports. The signals are sent to a motor shield, which interprets the signals and activates the correct motor. When the motor receives a signal to activate, it turns a wheel which is connected via bolts. Power to the Movement System is sourced from a 14.8V battery.

## Requirements

## Use Cases

## Traceability Matrix

# **Appendix A**

Appendix A includes all of the requirements presented in the System Requirements Specifications for Roadie, version 1.0.0, dated 2014-09-18. The requirement text is shown, followed by changes, signified by a red strike-through. The resulting revised requirement in shown in the final column. This information is displayed in **Table** 1below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Requirement Number | Previous Text | Changes | Resulting Requirement Text | New Requirement Number |
| 3.1.1 | The system shall move in the competition area shown in **Fig. 7**. |  |  |  |
| 3.1.2 | The system shall move from the starting area to the Simon Carabiner along the Scotch Blue Painter’s tape (guidance tape). |  |  |  |
| 3.1.3 | The system shall move from the Simon Carabiner to the pocket Etch-a-Sketch along the guidance tape. |  |  |  |
| 3.1.4 | The system shall move from the pocket Etch-a-Sketch to the Rubik’s Cube along the guidance tape. |  |  |  |
| 3.1.5 | The system shall move from the Rubik’s Cube to the deck of playing cards along the guidance tape. |  |  |  |
| 3.1.6 | The system shall move from the deck of playing cards to the finish line along the guidance tape. |  |  |  |
| 3.1.7 | The system shall wait for red [RGB value TBD] LED in starting area to turn off before exiting the starting area. |  |  |  |
| 3.2.1 | The system shall start in the starting area. |  |  |  |
| 3.2.2 | The system shall progress forward along the blue guidance tape until reaching a challenge area or reaching the finish line. |  |  |  |
| 3.2.3 | The system shall identify the challenge zone and stop movement upon arrival. |  |  |  |
| 3.3.1 | The system shall correctly identify the challenge upon arrival. |  |  |  |
| 3.3.1.1 | The system shall correctly identify the Simon Carabiner depicted in **Fig. 8** |  |  |  |
| 3.3.1.2 | The system shall correctly identify the Rubik’s Cube depicted in **Fig. 9.** |  |  |  |
| 3.3.1.3 | The system shall correctly identify the pocket Etch-A-Sketch depicted in **Fig. 10**. |  |  |  |
| 3.3.1.4 | The system shall correctly identify the playing cards depicted in **Fig.** [TBD]. |  |  |  |
| 3.3.2 | The system shall align with the challenge before attempting to complete the challenge. |  |  |  |
| 3.3.3 | The system shall play the Simon Carabiner. |  |  |  |
| 3.3.3.1 | The system shall play the Simon Carabiner for 15 seconds. |  |  |  |
| 3.3.3.2 | The system shall initiate the Simon Carabiner by pressing the start button. |  |  |  |
| 3.3.3.3 | The system shall correctly sense color blue [exact RGB values TBD] when illuminated on the Simon Carabiner. |  |  |  |
| 3.3.3.4 | The system shall correctly sense color red [exact RGB values TBD] when illuminated on the Simon Carabiner. |  |  |  |
| 3.3.3.5 | The system shall correctly sense color yellow [exact RGB values TBD] when illuminated on the Simon Carabiner. |  |  |  |
| 3.3.3.6 | The system shall correctly sense color green [exact RGB values TBD] when illuminated on the Simon Carabiner. |  |  |  |
| 3.3.3.7 | The system shall not obstruct the Simon Carabiner during play. |  |  |  |
| 3.3.3.8 | The system shall respond to the last color in the Simon sequence within [TBD] amount of time. |  |  |  |
| 3.3.4 | The system shall twist one row of a Rubik’s Cube 180 degrees. |  |  |  |
| 3.3.4.1 | The system shall not obstruct the Rubik’s Cube during play. |  |  |  |
| 3.3.5 | The system shall draw “IEEE” on the pocket Etch-A-Sketch. |  |  |  |
| 3.3.5.1 | The system shall use [Font and Size TBD] for drawing “IEEE”. |  |  |  |
| 3.3.5.2 | The system shall not obstruct the pocket Etch-A-Sketch during play. |  |  |  |
| 3.3.6 | The system shall collect a single playing card [Exact deck TBD]. |  |  |  |
| 3.3.6.1 | The system shall carry playing card across finish line. |  |  |  |
| 3.3.6.2 | The system shall keep the card in a usable condition. |  |  |  |
| 4.1.1 | The system size shall be no greater than 1ft. x 1ft. x 1ft. within the starting area and the finishing area. |  |  |  |
| 4.2.1 | The system shall operate for a minimum of [TBD] minutes when the power source starts with a full charge. |  |  |  |
| 4.3.1 | The system shall have an easily accessible power switch. |  |  |  |
| 4.3.2 | The system shall be completely autonomous after being powered on. |  |  |  |
| 4.3.3 | The system shall maintain contact with the competition area’s surface at all times. |  |  |  |

Table :Requirements imposed upon Roadie in the level one requirements.

# **Glossary**

The glossary contains definitions of words and phrases used throughout this document.

|  |  |  |
| --- | --- | --- |
| Entry | Definition | Aliases |
| Align | The system will position itself so the appendages can properly reach the challenges. |  |
| Autonomous | Undertaken or carried on without outside control [2]. |  |
| Bad state | Any state that is not the line following state or the challenge state. |  |
| Challenge State | The state in which Roadie is completing one of the four challenges. |  |
| Challenge Zone | The 1ft. x 1ft. areas where each of the challenges will be played along the course. |  |
| Competition Area | The competition area is the plywood board where the competition is being held on. The system must maintain contact with the board at all times. |  |
| Course Round | A span of five minutes during which the system is expected to complete the 4 challenges [1]. |  |
| Pocket Etch-A-Sketch | The pocket Etch-A-Sketch is a popular children’s toy with two knobs to move the cursor up and down as well as left and right. For the competition, the specific version of the pocket Etch-A-Sketch being used is SKU:FD79DD3F from Toys R Us online [7], and can be seen in **Fig. 10.** |  |
| Finish Line | The finish line is the ending point of the competition. It is the point where the Scotch Blue Painter’s Tape comes to the final “T” shape on the course [1]. It is marked as FINISH in **Fig. 7**. |  |
| Good state | Either the line following state or the challenge state. |  |
| Institute of Electrical and Electronics Engineers | “IEEE is the world's largest professional association dedicated to advancing technological innovation and excellence for the benefit of humanity” [4]. That being said, IEEE is not only composed of electronic and electrical engineers as the name might suggest. Other types of members include computer scientists, software developers and even some doctors. | IEEE |
| Line Following State | The state in which Roadie is following the Scotch Blue Painter’s tape located on the competition area. |  |
| Obstruct | SoutheastCon rules state that the system cannot obstruct any obstacle [1]. |  |
| Playing Card | Information on the specific playing cards is still pending, thus, [TBD]. |  |
| Rubik’s Cube | The Rubik’s Cube is a puzzle game that achieved popularity in the 1980’s. For the competition, the specific version of the Rubik’s Cube being used is SKU:DAD09D9E from Toys R Us online [6], and can be seen in **Fig. 9.** |  |
| Scotch Blue Painter’s Tape | Scotch Blue is a brand of painter’s tape produced by the company 3M. For the competition, the specific model of painters tape being used is SKU: 958999 from Home Depot [8], and can be seen in **Fig. 11.** | Guidance Tape |
| Simon Carabiner | The Simon Carabiner is another version of the game, Simon, which is an electronic version of the children’s game “Simon Says”. For the competition, the specific version of Simon being used is SKU:226CE810 from Toys R Us online [5], and can be seen in **Fig. 8.** |  |
| SoutheastCon | SoutheastCon is the annual IEEE Region 3 Technical, Professional, and Student Conference. The conference includes technical sessions, tutorials, and exhibits. Additionally, various challenges and competitions are held for students to demonstrate their technical knowledge and understanding.“IEEE Region 3 encompasses the southeastern United States and includes the states of Alabama, Florida, Georgia, areas of Indiana, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia and the country of Jamaica” [3]. |  |
| Starting Area | A one foot by one foot area on the competition area marked by Scotch Blue Painter’s tape [1]. |  |
| Usable Condition | SoutheastCon rules state that the playing card must be left in a usable condition [1]. |  |