SAN DIEGO STATE UNIVERSITY

System Description, Requirements, and Validation Document

EE/COMPE 496A Senior Design

Team 14, Project 25: Rapid Deployment Runway Closure System

The Blockage Brigade

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Table of Contents

Executive Summary

The Rapid Deployment Runway Closure System (RDRCS) will allow aviation workers to deploy multiple rapid deployment systems across the runway to prevent any unauthorized aircraft from landing based on the situation. The user of the RDRC system will use a series of buttons and switches to activate the blower to release the inflatable across the runway. If an aircraft needs to land on the runway, the inflatable will be able to deflate so that the aircraft could land safely. Once the inflatable has done its job, it will retract back into the system within 3-5 minutes.

The core of the Rapid Deployment Runway Closure System is using an Arduino Due Microcontroller which is a dominant component to the system. The RDRCS will include writing firmware, containing C code, to allow for the buttons and switches to work properly. For more information and descriptions on the different components can be found in the “Development and Procurement” section of this report.

A stretch goal for the Rapid Deployment Runway Closure System is to create a remote control where a user within a certain distance could activate the system. Utilizing radio signals is one of the ideas in order for the controller to respond to the deployment system and within a certain time frame.

Functionality

The Rapid Deployment Runway Closure System (RDRCS) will allow aviation workers to deploy multiple rapid deployment systems across a personal aircraft runway in order to prevent any unauthorized aircrafts from landing. These remote runways are used by owners/operators rather than a full team of people like normal airport runways. Therefore, the user of the RDRC system will have to first toggle the ON switch in order to turn the system on, and then press a button to activate the blower fan. This will then create an inflatable bouncy house type of object that will be laid out across the runway. These runways contain no type of lighting therefore, the RDRCS would be a way for pilots to see the runway easier. If an aircraft is going to land on the runway, the inflatable will deflate from the system and the aircraft will be able to safely land on it. Once there is no need for the inflatable, it will retract back into the system.

Inputs/Outputs

The Rapid Deployment Runway Closure System will be using an Arduino Due Microcontroller that has a maximum 3.3V that the input and output pins could tolerate. Developing C code for the inputs and outputs is required for the system and then it would have to be downloaded to the microcontroller. One of the inputs that would be used would be a pin switch, which has a maximum AC voltage rating of 125 to 250 volts and maximum current rating of 8 to 16 amps. Another input would be a push button and it has a power rating of mac 50mA 24V DC. Figure 4 under the physical description shows the PCB layout. On one side of the PCB, it shows the inputs such as the ON/OFF switch, pin switch, and push button switch; while, there is also an output which is the RGB LED at the bottom. On the other side of the PCB, there is the Arduino Due Microcontroller and the dimension of it is shown as 4 x 2.2’’. Adding the step down DC voltage to the PCB allows the 12V from the solar panel to “step down” to a maximum of 3.3V needed for the Arduino Due Microcontroller. This project also requires a 200W ruggedized solar panel. On average, a 200W solar panel can be able to produce 10 to 12 amps of power per hour. This is roughly 60 to 70 amps of power per day. This information is not exact because there can be days of no sunlight which could affect the amount of power that can be provided.

Use Case

The purpose of the Rapid Deployment Runway Closure system is to deploy an obstacle on the aircraft runway in order to prevent any unwanted individuals from landing their aircraft without any authorizations or permissions. This system shall be able to operate with a single person and inflate and deflate through a powered system. In Figure 1 and Figure 2, both show the basic system while also showing how an individual may use the system.

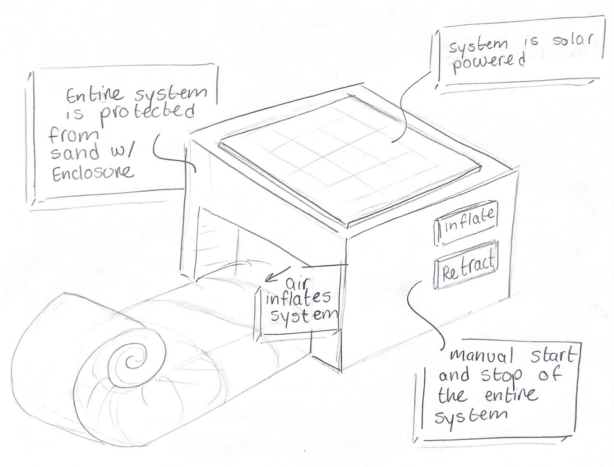

Figure 1: Basic System with Expectations

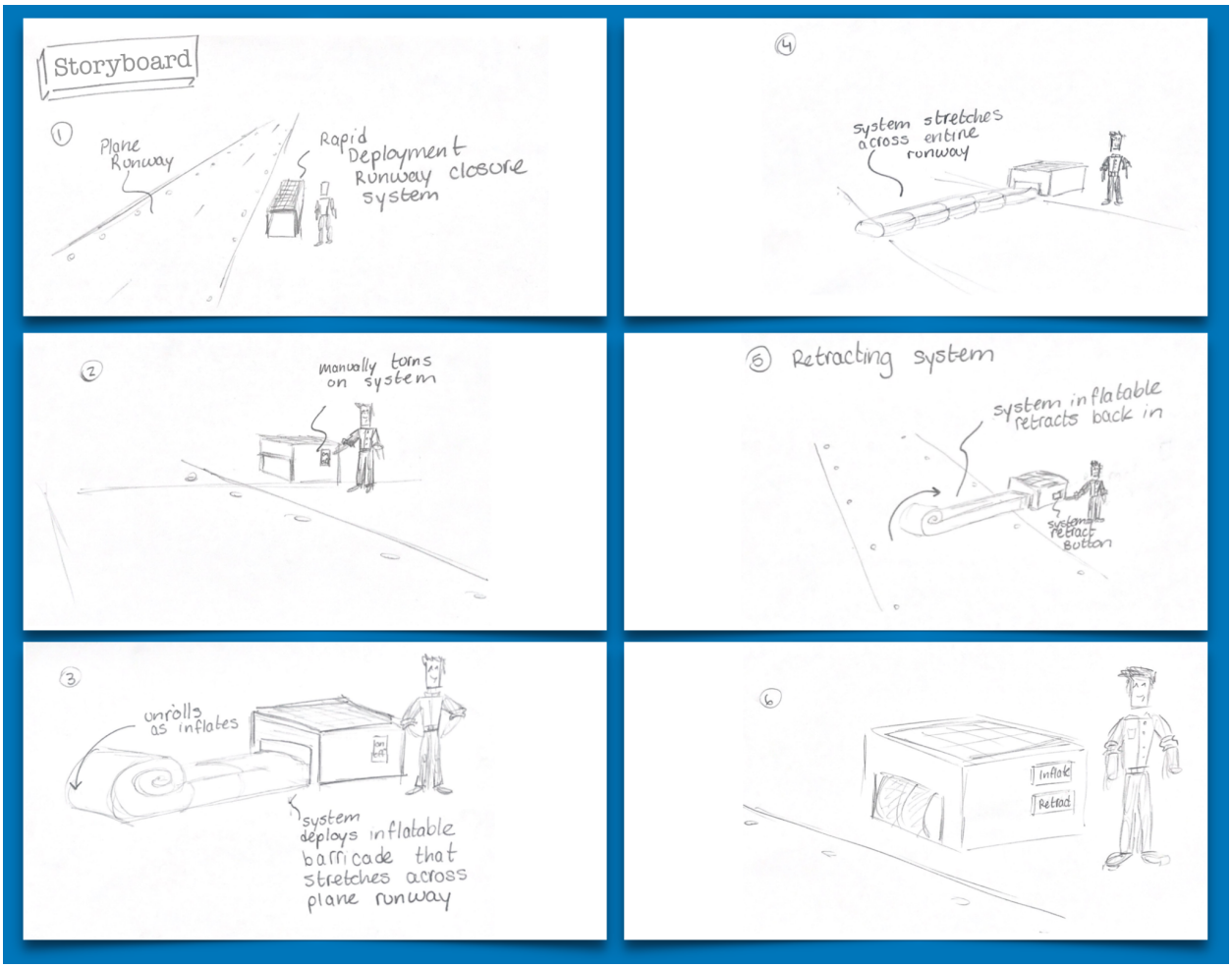

Figure 2: Storyboard of Use Case

Physical Description and User Interface

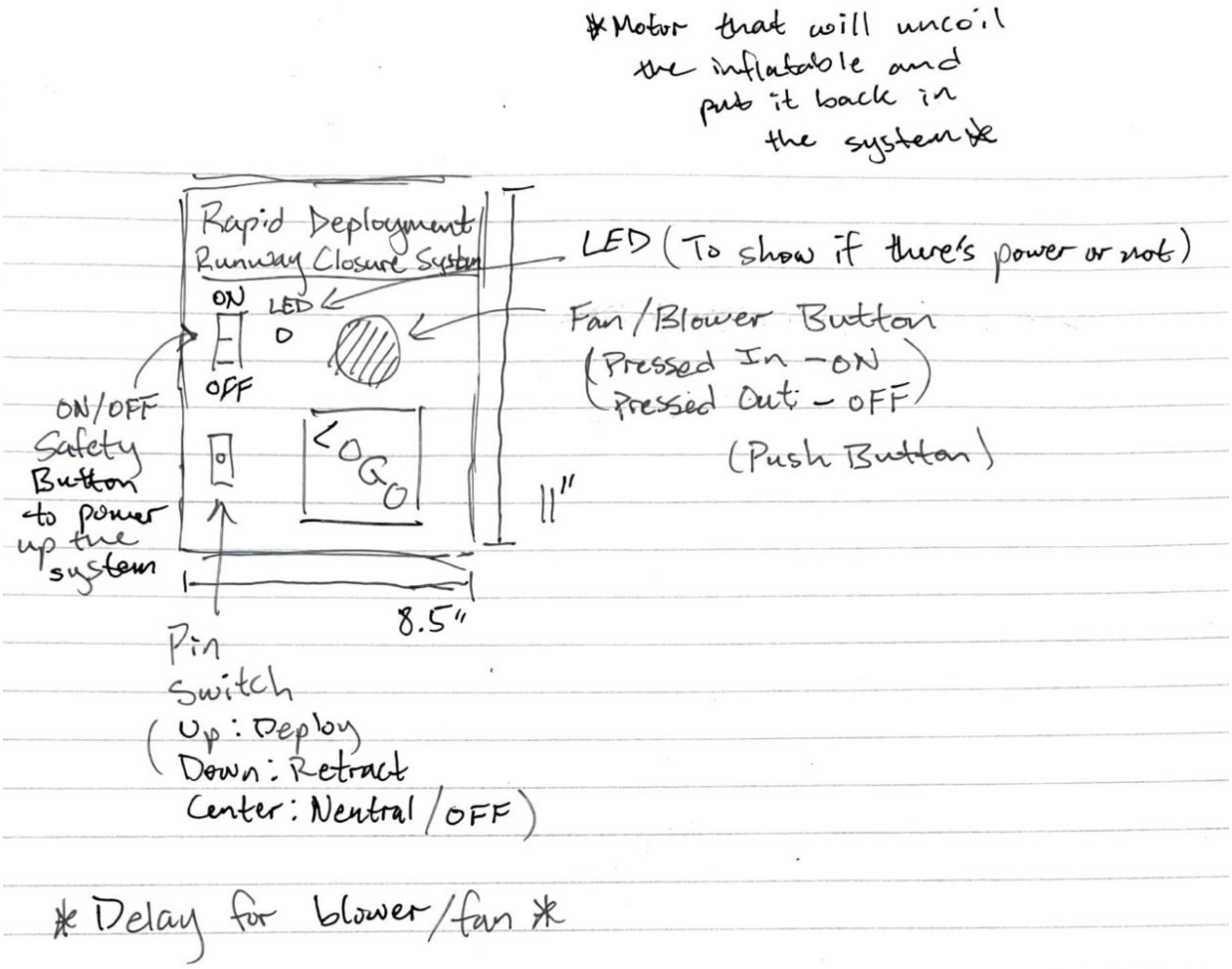

Figure 3: Sketch of the Rapid Deployment Runway Closure System

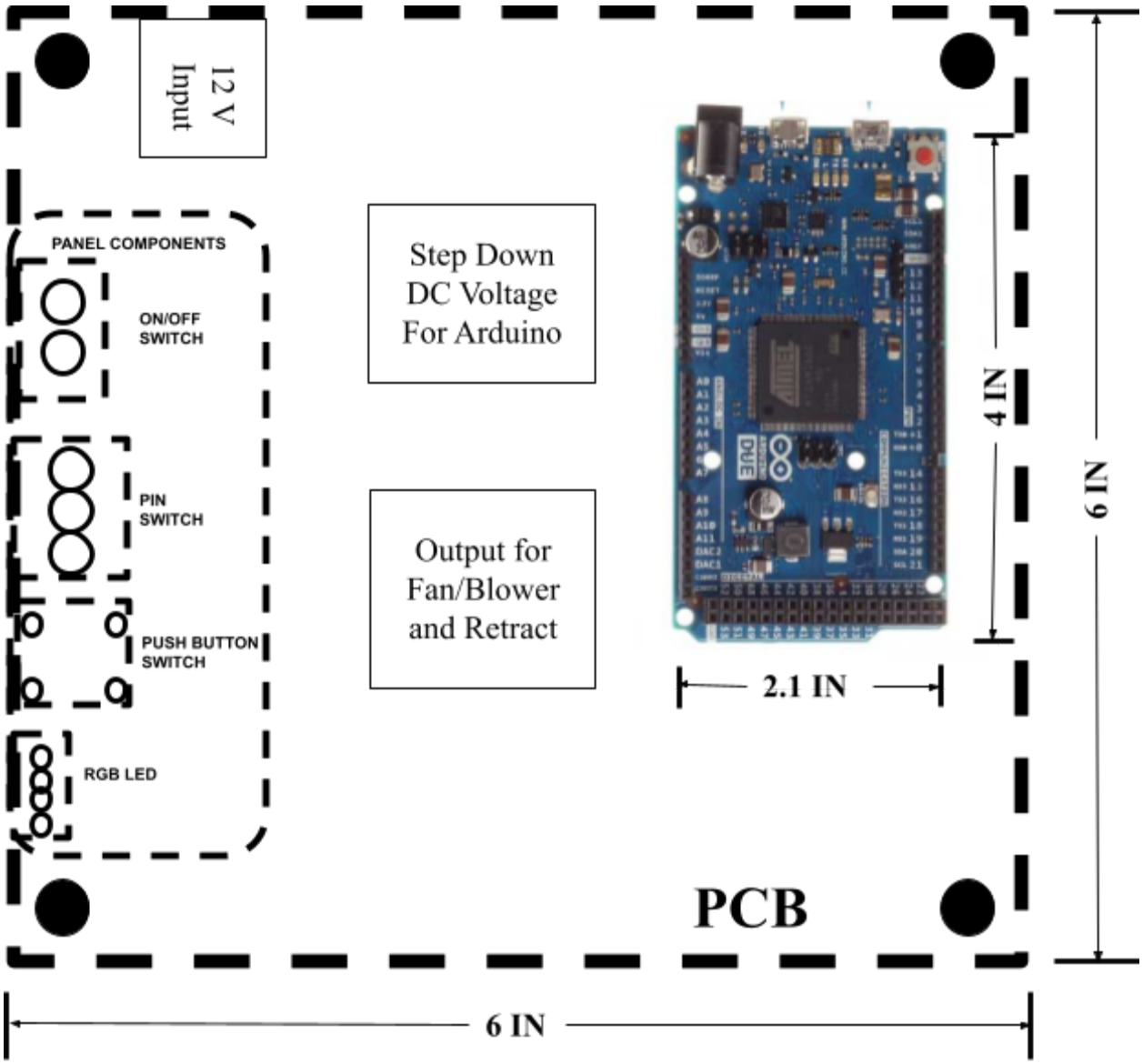

Figure 4: Sketch of the PCB going into the system

Development and Procurement

Arduino Due Microcontroller:

The Arduino Due Microcontroller will be used as the base for the Rapid Deployment Runway Closure System where this is all the firmware and hardware aspects of the system. This microcontroller allows for the system to use buttons/switches to operate the system when needed. The Arduino Due Mircrocontroller runs on 3.3V and the maximum voltage that the I/O pins can tolerate is 3.3V. Applying voltages higher than 3.3V to any I/O pin could possibly damage the board.

Embedded Systems:

The Rapid Deployment Runway Closure System will induce an embedded system that deals with interrupts and delays. In order to be able to use interrupts and delays within the Arduino Due Microcontroller, C code will have to be used. After this, the downloaded code that was created into the microcontroller, will be attached to the PCB.

Electromechanical Hardware:

The Rapid Deployment Runway Closure System will use an ON/OFF switch, pin switch, RGB LED, and a push button. These components will allow for the system to work correctly with the physical system and power supply. These components and the layout could be seen in the physical description section of the report.

Specifications

1) The system shall operate during the daytime hours (R1-003) and withstand any environmental issues (R1-002) (desert-like temperatures, sand, dust, etc).
2) The system shall be operable at 50 knots of wind and survivable at 80 knots (R1-005).
3) The system must be able to operate by a single person (R1-004).
4) The system shall deflate when an aircraft must make an emergency landing.
5) The inflatable system shall retract (S1-001) within 3-5 minutes.
6) The system must use a 200W ruggedized solar panel as per sponsor's request.

Table 1: Rapid Deployment Runway Closure System ECE Test Fixture Specifications

Reference	Title	Specification	Notes
Material Cost			
TF-1	Material Cost	The Material Cost of the Rapid Deployment Runway Closure System shall be less than $2500.	What the sponsor provided
Construction			
TF-2	PCB Components	The Rapid Deployment Runway Closure System shall use through-hole PCB components.	
Physical			
TF-3	PCB Dimensions	The PCB shall have dimensions less than 6.0 x 6.0"	
TF-4	Enclosure	The enclosure that the system is stored in shall be 1 cubic yard.	May change depending on sponsor's preference
TF-5	Ruggedized Solar Panel	A 200W ruggedized solar panel that must be on top of the system.	Sponsor's Request

TF-6	Pin Switch	Pin switch that shall be used to deploy, retract, and turn off the inflatable	
TF-7	RGB LED	The LED shall be used to let the user know if the system has enough power or not	There will be a few color codes such as: RED: OFF GREEN: ON ORANGE: NOT ENOUGH POWER
TF-8	Push Button	The push button must be used when it is pressed in and when it is pressed out it's off.	
TF-9	ON/OFF Switch	The ON/OFF switch shall be used to power up the system.	
TF-10	Arduino Due Microcontroller	The Arduino Due Microcontroller must be used to allow for delays and connections of the power supply with the control system and placed on the PCB.	Will use C to code the interrupts/delays needed for the switches and buttons
TF-11	Fan	The fan must be used for the electrical box so that the system won't overheat inside.	
TF-12	Heat Sink	The heat sink must be attached to the PCB.	
Power Supply			
TF-13	Input Voltage	The Rapid Deployment Runway Closure System must pass all performance tests with an input voltage of 12V.	
TF-14	Operating Current	The Rapid Deployment Runway Closure System shall have 10-12 amps of power coming from the solar panel per hour.	

Table 2: Functional and Physical Requirements and Details

Requirement Number	Priority Level (1-highest 5- lowest)	User Requirement	Justification	User Requirement Information Sources
R1-001	1	System shall retract fast	An operator of the device needs to be able to open the runway quickly	Sponsor Request
R1-002	1	System shall be sand resistant	System will be operating in remote locations including the southern california desert	Sponsor Request, it will operate in remote locations
R1-003	1	Shall be daylight operable	Planes will only use the runway in the daytime, system needs to work during that time	Sponsor Request
R1-004	1	The system shall be operable by a single person	Remote runways are used by owner/operators, not a team of people	Sponsor Request
R1-005	1	System shall survive high winds	System will be operating in remote locations including the southern california desert	Sponsor request
R1-006	1	System shall span 60 feet	A remote runway is typically that wide	Airport Design and Operation Antonín Kazda and Robert E. Caves, page 96
R1-007	1	System shall operate using solar power	Typical runway will be in a remove environment without power to it	Sponsor request

Table 3: Functional and Physical Specifications and Details

Specification Number	User Requirement	Engineering Specification	Justification	Engineering Specification Information Sources
S1-001	System shall retract fast	System shall retract within 3-5 minutes	Sponsor requirement, need to verify with sponsor	Sponsor Request
S1-002	System shall be sand resistant	System shall operate to Mil-STD-810 sand and dust testing, or equivalent ASME specification	System will be operating in remote locations including the southern california desert	Sponsor request

S1-003	Shall be daylight operable	System shall last for 5 years without becoming inoperable due UV	System will be operating in remote locations including the southern california desert	Sponsor Request, need to do some research
S1-004	The system shall be operable by a single person	Each sub system shall weigh less than 51 lbs,	Remote runways are used by owner/operators, not a team of people	NIOSH 94-110
S1-005	System shall survive high winds	System shall survive 80 knots (92 mph)	System will be operating in remote locations including the southern california desert	Sponsor request
S1-006	System shall span 60 feet	System shall span 20 m (60 feet)	A remote runway is typically that wide	Airport Design and Operation Antonín Kazda and Robert E. Caves, page 96
S1-007	System shall operate using solar power	System shall use 200 watt ruggedized solar system	Sponsor request	Sponsor request

Validation and System Test

System Test: Rapid Deployment Runway System

Procedure:

1) Verify that the device is aligned with the runway and facing the runway

2) Flip open the shield panel

3) Verify that the power switch is in the OFF position

4) Verify that the power LED is dim (OFF)

5) Switch the power switch to the ON position

6) Verify that the power LED is lit green (ON) and is bright enough to see in bright desert daylight

7) Switch the PIN switch to the up (deploy) position

8) Press the red button until completely recessed

9) Verify that the device deploys the inflatable material onto the runway evenly and consistently

10) When the inflatable is completely deployed, press the red button until reset to original position to stop the fan/blower

11) Switch the PIN switch to the down (retract) position to begin retraction process

12) Verify that the inflatable is being retracted back into the device evenly and consistently and within 180 seconds (per sponsor request)

13) Once inflatable is completely retracted, switch the PIN switch to the middle (neutral) position

14) Switch the power switch to the OFF position

15) Verify that the power LED is dim (OFF)