Homework #7 – Social Distancing Device Test Plan

ECE 411 - Industry Design Processes

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V1.01

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1.0 – Introduction

1.1 – This Document/Types of Testing

This Test Plan Documentation will illustrate and explain the guidelines to appropriately test the social distancing device prototype. The series of test will involve unit/module, functionality, integration, stress, and acceptance testing.

Unit Tests – A unit test consists of a set of test cases each of which establish that a given module performs the basic form of functionality to some specification (e.g. sensors perform the function they were designed for).

Functionality Tests – A complete test of a module's functionality based on the system behavioral model listed in the required documents.

Integration Tests – Checks that the major modules within the system operates correctly together. The test cases for integration testing must be traceable to the high and low-level system designs illustrated in the detailed design and behavioral modeling documentation, and all test cases are designed based on the characteristics of the design architecture.

Stress Tests – Checks whether degradation of system performance occurs when the system is tested beyond the boundary conditions for which the system was intended for.

Acceptance Tests – Consists of test cases that exercise the conditions under which the customer will accept the system. These test cases must adhere to the functional and performance specifications

1.2 – Conduct of Systems Tests

The Social Distancing Device requires thorough testing for all test cases listed above. All tests must be conducted as stated by the specific test case generated for that respective test. All steps must be followed to completion and in the appropriate ordered that is illustrated in the test case. If there are potential errors within a specific test case preventing a thorough test, then the errors must be specifically listed on the appropriate test case with reasons why the test could not be completed. All errors will then be reviewed,

1.3 – Recording of Results, Witnessing, and Authorities

All results from the multiple methods of testing illustrated above must be abstract, unambiguous, traceable, and verifiable. Within the test case, all results must be listed and verified from the respective tester. Any failures or potential errors within each test case will reviewed by the proper authorities and either the system design will be revised, or the test case will be updated.

2.0 - Reference Documents

2.1 - Project Requirements

- Product Design Specification V1.03

2.2 - Design Documentation

- Detailed Design V1.02
  - Social Distancing Device Level 0 Block Diagram V1.02
  - Social Distancing Device Level 1 Block Diagram V1.02
  - Power Supply Module V1.01
  - MLX90614 Contactless IR Temperature Sensor Block Diagram V1.03
  - VL53L1X Time of Flight (ToF) Sensor Block Diagram V1.02
  - Low Power Audio Amplifier Block Diagram V1.02

- Behavior Modeling V1.02
  - ocial Distancing Device Behavioral Model V1.03
  - MLX90614 Contactless IR Temperature Sensor Behavioral Model V1.02
  - VL53L1X Time of Flight (ToF) Sensor Behavioral Model V1.02
  - LED Display and Audio Amplifier Behavioral Model V1.03

2.3 - System Schematic and Board Layout

- Final System Schematic V1.06
- Finalized Board Layout V1.06

3.0 – Objectives

3.1 – Unit Testing

3.1.1 – Power Supply (Voltage Regulator)

The Power Supply test will verify that the battery voltage (9V) gets regulated to the system operating of 5V.

3.1.2 – MLX90614 Contactless IR Temperature Sensor

The Contactless IR Temperature Sensor unit test will determine that the sensor reads the appropriate temperature (in Fahrenheit and Celsius) of the current room temperature and how the sensor readings are affected by different objects from varying distances.

3.1.3 – VL53L1X Time of Flight (ToF) Sensor

The Time of Flight (ToF) Sensor unit will determine that the sensor reads the appropriate distance (in feet). The test will verify that the distance measured is +/- 0.1 feet from the control distance.

3.1.4 – LED Display

The LED Display unit test will determine that the LED's turn on/off appropriately, and that the LED's will be able to flash (blink on/off) appropriately.

3.1.5 – Low Power Audio Amplifier

The Low Power Audio Amplifier unit test verifies that tones will play through the 8Ω speaker of the audio amplifier. Additionally, this test will determine if the user can appropriately control the volume of the tones through a 10kΩ potentiometer.

3.2 – Functionality Testing

3.2.1 – Average Temperature out of 1,000 Samples

The Average Temperature functionality test will verify that the MLX90614 Contactless IR sensor will measure and store 1,000 concurrent samples into a total temperature summation. Then it will determine the average by taking the quotient of the total summation of temperatures by the total number of samples taken.

3.2.2 – Average Distance out of 1,000 Samples

The Average Distance functionality test will verify that the VL53L1X Time of Flight sensor will measure and store 1,000 concurrent samples into a total distance summation. Then it will determine the average distance by taking the quotient of the total summation of distances by the total number of samples taken.

3.2.3 – LED Display and Auditory Alert

The LED Display and Auditory Alert functionality test will verify the sequence of two LED flashes of different colors serially before the auditory alarm and is then followed by another sequence of LED flashes. The test will verify that each LED's flash for a predetermined set of time, and that both LED's turn on separately. The Auditory Alarm functionality test will verify that the alarm begins at 700Hz, and that it progressively increments to 1,000Hz then progressively decrements to the starting frequency of 700Hz.

3.3 – Integration Testing

3.3.1 – The Sensors functionality Without the LED Display or the Auditory Alarm

This integration test will verify that both sensors operate serially, while confirming that both sensors take 1,000 concurrent samples and properly computes the average from those

samples. Lastly this test will verify that the averages are stored in the appropriate variable locations that will be used later in the conditional statements for the appropriate actuator.

3.3.2 – The Sensors functionality with Solely the LED Display

This integration test will further integrate more functions from the Social Distancing Device. This test includes all the testing procedures from integration test 3.3.1 but establishes If-Then-Else conditions to operate the LED sequence if certain conditions are met. This test will verify that the LED's will flash for when another person is within 6' of space from the user and when they are 3' of space away from the user.

3.3.3 – The Sensors functionality with Both the LED Display and the Auditory Alarm

The final integration test includes all the integration test requirements from 3.3.2. This test will include the auditory alarm for the conditional statement when someone is within 3' from the user. This test will verify that the LED sequence begins first, and then is followed by the auditory alarm. The tester must verify that these conditions are met only when another person is within the set parameters and rejects inanimate objects.

3.4 – Stress Testing

3.4.1 – Reliability of Temperature Averages with Varying Ambient Temperatures

This stress test will test the reliability of the system architecture with varying ambient temperature differences. This test will verify if we can adequately detect another person from 6' and within in varying ambient temperatures. Need to verify as conditions change through the user daily schedule will not alter performance of the system.

3.5 – Acceptance Testing

3.5.1 – Requirements from User

This acceptance test will verify that the Social Distancing Device will only require a 9V battery source to be fully operational out of the box. In more detail this test will verify that all firmware has been properly uploaded to the microcontroller and functions exactly from the system specifications and requirements. The user will only be required to supply the power supply and understand the behavioral function of the design to operate the system.

4.0 - Resources

4.1 – Personnel Roles

The following roles of human resources for testing:

Human Resources		
Role	**Minimum Resources Recommended**	**Responsibilities/Comments**
System Tester	1 Person	This person will wear the device. Typically, this person is an adult.
Human Obstacle	1 Person	Recommended that this person has a similar height to the system tester.

4.2 – Unit Testing Resources

All unit testing will require the minimum personnel and equipment:

Personnel: A Technician with the understanding of electrical circuit analysis and Arduino IDE experience

Equipment:

- PC/Laptop with Windows 10 and Arduino 1.8.12 IDE installed
- The respective module required for testing
- The Reference material listed in section 2.0 (Primarily Block Diagrams).

Additional Equipment for the Respective Test

3.1.1 – Power Supply (Voltage Regulator)

- 9V Battery
- Multimeter to accurately measure voltage and current

3.1.2 - MLX90614 Contactless IR Temperature Sensor

- Access to Arduino IDE Serial Monitor for displayed object and ambient temperatures
- Temperature Probe to verify the MLX90614 results.

3.1.3 - VL53L1X Time of Flight (ToF) Sensor

- Access to Arduino IDE Serial Monitor for the measured distance
- Tape Measure that expands beyond 6’ to verify VL53L1X results

4.3 – Functionality Testing Resources

All functionality testing will require the minimum personnel and equipment:

Personnel: A Technician with the understanding of electrical circuit analysis and Arduino IDE experience

Equipment:

- PC/Laptop with Windows 10 and Arduino 1.8.12 IDE installed.
- Access to Arduino IDE Serial Monitor for the average temperature and distance.
- The respective module required for testing.
- Tape Measure beyond 6’ and a temperature probe
- The Reference material listed in section 2.0 (Primarily Behavioral Models).

4.4 – Integration Testing Resources

All unit testing will require the minimum personnel and equipment:

Personnel: A Technician with the understanding of electrical circuit analysis and Arduino IDE experience. A human obstacle with little/no technical experience is efficient. Preferable condition is for this person to be among a normal height.

Equipment:

- PC/Laptop with Windows 10 and Arduino 1.8.12 IDE installed
- The respective module required for testing
- The Reference material listed in section 2.0 (System Requirements, Circuit Schematics, Block Diagrams, and Behavioral Models).

4.5 –Stress Testing Resources

All stress testing will require the minimum personnel and equipment:

Personnel: A Technician with the understanding of electrical circuit analysis and Arduino IDE experience. Also, a human obstacle with little/no technical experience is efficient. Preferable condition is for this person to be among a normal height.

Equipment:

- PC/Laptop with Windows 10 and Arduino 1.8.12 IDE installed
- The respective module required for testing
- The Reference material listed in section 2.0 (System Requirements, Circuit Schematics, Block Diagrams, and Behavioral Models).

Additional Equipment for the Respective Test

3.4.1 - Reliability of Temperature Averages with Varying Ambient Temperatures

- Temperature Controlled Rooms (45°F, 55°F, 65°F, and 75°F) - Common Winter season temperature
- Temperature Probe to measure whether ambient temperature conditions are met.
- Tape Measure to maintain 6’ distance

4.6 – Acceptance Testing Resources

All stress testing will require the minimum personnel and equipment:

Personnel: A system tester with little/no technical experience is efficient.

Equipment:

- Completed System Architecture Prototype
- 9V battery (Power Supply)
- In-box Instructions for System Behavior

Test Case #1

Integration Test 3.3.3 – The Sensors functionality with Both the LED Display and the Auditory Alarm

Test Writer: Kai Boldt						
Test Case Name:	The Sensors functionality w/ the LED Display and the Auditory Alarm			**Test ID #:**	INT-3.3.3	
Description:	Simulate the integration and functionality of the system architecture by repeating tests of a human obstacle moving between the > 6’ region, 3 < distance < 6’, and <3’ region.			**Type:**	☑ White Box ☐ Black Box	
Tester Information						
Name of Tester:	Elijah Penn			**Date:**		
Hardware Ver:	Final Circuit Schematic V1.06			**Time:**		
Setup:	Place the system in a control location with marked up distance regions. These regions should be noted as such: >6’, 3’ < distance < 6’, and <3’. Also include an inanimate object (e.g. chair) to test for human verification tests.					
Step	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1	> 6’ Human Obstacle	Either set of system actuators should remain in an off state	✓			Test Repeated 30 Times
2	> 6’ Object Obstacle	Either set of system actuators should remain in an off state	✓			Test Repeated 30 Times
3	3’ < x <6’ Human Obstacle	LED Display must remain in a ON state if condition is met	✓			Test Repeated 30 Times
4	3’ < x <6’ Object Obstacle	Either set of system actuators should remain in an off state	✓			Test Repeated 30 Times
5	< 3’ Human Obstacle	LED Display and Auditory Alarm must remain in a ON state if condition is met	✓			Test Repeated 30 Times
6	< 3’ Object Obstacle	Either set of system actuators should remain in an off state	✓			Test Repeated 30 Times
Overall Test Results: All steps have met expectations from testing the functionality of the full system integration			✓			

Test Case #2

Stress Test 3.4.1 – Reliability of Temperature Averages with Varying Ambient Temperatures

Test Writer: Kai Boldt						
Test Case Name:		Reliability of Temperature Averages with Varying Ambient Temperatures		**Test ID #:**		STS-3.4.1
Description:		In temperature control rooms, determine the reliability that a person can be detected at 6' of distance. If there's no noticeable difference between object temperature and ambient temperature, then a person can't be detected.		**Type:**		☑ White Box ☐ Black Box
Tester Information						
Name of Tester:		Kai Boldt		**Date:**		12/2/20
Hardware Ver:		Final Circuit Schematic V1.06		**Time:**		5:45pm
Setup:		Within a temperature-controlled environment. A outside temperature probe will be utilized to maintain specific condition.				
Step	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1	45°F Ambient Temperature Room	Accurately Detect Someone who is 6' away from the user	✓			Conditions of > 59.5°F for a person at 6'
2	55°F Ambient Temperature Room	Accurately Detect Someone who is 6' away from the user	✓			Conditions of > 65.5°F for a person at 6'
3	65°F Ambient Temperature Room	Accurately Detect Someone who is 6' away from the user	✓			Conditions of > 70.5°F for a person at 6'
4	75°F Ambient Temperature Room	Accurately Detect Someone who is 6' away from the user		✓		MLX90614 BCC cannot distinguish between people or an object due to limitations in the Field of Vision (FoV). When a person is 6' apart there's no noticeable change from a person to the ambient temperature
Overall Test Results: The stress test results are passable, but there's noticeable design flaws during warmer climates due to the accuracy of the Contactless IR Temperature Sensor from extended distances. System architecture should be revised for commercial use beyond Winter months. Passes for Practicum Demonstration			✓			System Architecture mostly functions as expected. MLX90614 BCC has limitations of Field of Vision (System Structure will need revisions)