TEST PLAN

For the Direct Interference System for Coordination Limitation by Amplified and Stimulated Emission of Radiation (DISCo LASER)

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1 – Unit Testing

1.1 - Processor Unit Testing

In order to ensure that the processing unit in the system is functional, individual unit testing to the processor, a Raspberry Pi, will be employed as shown in Table 1. This testing will function to ensure that the processor unit is able to turn on and interface with the sensor, motor, and lighting units. In addition, this unit testing will ensure that the basic facial recognition image processing is working as expected.

Table 1: Processor Unit Testing

Test Case	Procedure	Expected Result
Processor Unit Activation	1. Boot up the Raspberry Pi	1. The Raspberry Pi boots up successfully
Sensor Unit Interfacing	1. Capture an image in jpeg format using "raspistill -o image.jpg" at the prompt	1. Image is successfully captured
Target Identification	1. Obtain an image through the sensor unit	1. The software is able to selectively identify the heads of targets from data obtained from the sensor unit 2. The software is able to selectively identify whether the individual is facing the sensor module 3. The software is able to selectively identify the eyes of the individual
Motor Unit Interfacing	1. Provide coordinates to the motor unit via the Raspberry Pi	1. The motor unit moves to the specified coordinates
Lighting Unit Interfacing	1. Fire the lighting unit via the Raspberry Pi 2. Fire the lighting unit 10 times	1. The lighting unit fires without significant delay (half a second) 2. The software shall be able to selectively fire the lighting unit at a repetition rate of at least 6 Hz

1.2 – Sensor Unit Testing

In order to ensure that the camera module in the sensor unit is working as expected, individual unit testing will be employed as shown in Table 2. This testing will function to ensure that the camera module is able to turn on, take images, and record video. In addition, this testing ensures that the facial features of an individual in average conditions (room temperature and average room lighting) from the maximum defined range (10 meters) can be identified.

Table 2: Sensor Unit Testing

Test Case	Procedure	Expected Result
Camera is Enabled	1. Boot up the Raspberry Pi 2. Run "sudo raspi-config"	1. Raspberry Pi successfully boots 2. Camera option is listed in configuration menu
Test Image	1. Capture an image in jpeg format using "raspistill -o image.jpg" at the prompt	1. Image is successfully captured 2. Image shows the entire 53.5-degree horizontal field-of-view

Test Video	1. Capture a 10-second video using "raspivid -o video.h264 -t 10000" at the prompt	1. 10-second video is successfully captured
Test Image Range	1. Capture an image of a target 10 meters from the sensor unit 2. Move the position of the individual within a 50-degree viewing angle to the lighting unit	1. Can identify individual's facial features from the image 2. Can identify individual's facial features at all angles within the 50-degree viewing angle, as long as they are facing the sensor

1.3 – Lighting Unit Testing

In order to ensure that the core incapacitation implementation in the system is functional, individual unit testing will be employed as shown in Table 3. This testing will function to ensure that the lighting unit is able to turn on, vary its output, and be visible throughout the specified range.

Table 3: Lighting Unit Testing

Test Case	Procedure	Expected Result
Lighting Unit Activation	1. Provide a voltage of 20V to the lighting unit 2. Provide a voltage of 17V to the lighting unit	1. LED Array turns on to maximum allowable brightness with a delay of no more than 50 milliseconds after power is supplied 2. The LED Array appears to be dimmer at 17V than 20V
Lighting Unit Output	1. Provide a voltage of 20V to the lighting unit for 30 seconds	1. The LED Array outputs a uniform intensity light for the duration (the output does not appear pulsed)
Lighting Unit Range	1. Position an individual 10 meters from the lighting unit 2. Move the position of the individual within a 50-degree viewing angle to the lighting unit 3. Move the individual incrementally 1 meter from the system to 10 meters (1 meter every 3 seconds)	1. Lighting unit output is clearly visible 10 meters from the system 2. Lighting unit output is clearly visible 10 meters from the system at all angles within the specified range 3. Lighting unit output does not significantly vary with distance
Ambient Light Detection	1. While light is activated, suddenly black out the ambient light sensor	1. Light should quickly dim to a lower brightness without turning off

1.4 – Motor Unit Testing

In order to ensure that the motor unit in the system is functional, individual unit testing will be employed as shown in Table 4. This testing will function to ensure that the motor unit is able to turn on and move per the coordinates provided by the Raspberry Pi. In addition, this testing will ensure that the motor unit is successfully moving using a combination of both of its stepper motors at the same time, and that it is able to successfully provide the correct torque in order to move the lighting unit.

Table 4: Motor Unit Testing

Test Case	Procedure	Expected Result
Motor Unit Activation	1. Provide coordinates to the motor unit through the Raspberry Pi	1. The motor unit begins moving to the specified coordinates nearly immediately 2. The motor unit reaches its specified destination with 1/6th of a second 3. The motor unit is able to move both horizontally and vertically at the same time 4. The motor unit provides sufficient torque to accelerate and stop the motion of the lighting unit

2 – Full System Testing

In order to ensure that the overall system is functional in all specified conditions, an overall system test will be employed as shown in Table 5. This testing will ensure that the entire system is able to power on, that one or more targets are able to be identified in all specified conditions, that the lighting unit is able to vary intensity based on the environmental conditions, and that the overall mechanical design of the system is sturdy enough to be able to withstand the movements of the motor unit.

Table 5: Full System Testing

Test Case	Procedure	Expected Result
System Activation	1. Provide power to the system	1. The system boots up and is operational
Lighting Unit - Firing	1. Move an individual slowly within the system's range, staying at each position for at least 3 seconds	1. The system does not move until the previous pulse was completed, and does not fire the lighting unit until the motor unit has positioned it to the correct coordinates
Target Identification – Accuracy	2. Place an individual within 10 meters of the sensor module	2. The system targets the individual's eyes and fires the lighting unit with enough accuracy to be within 0.5 degrees of the target
Target Identification – Range	1. Place an individual within 10 meters of the sensor module 2. Move an individual within the 50-degree sensor range incrementally (3 seconds per 10-degree interval) 3. Have an individual slowly walk from 10 meters away to 1 meter away from the system incrementally (move 1 meter every 3 seconds)	1. The system is able to identify human targets within 10 meters of the sensor module 2. The system is able to identify human targets within a 50-degree scan range 3. The system is able to identify the target and position the lighting unit within a vertical field-of-view of approximately 40-degrees

Target Identification – Multiple Targets	1. Place 6 individuals within 10 meters of the sensor module and within the 50-degree horizontal field-of-view 2. Place 10 individuals within 10 meters of the sensor module and within the 50-degree	1. The system is able to identify and lock-on up to 6 targets per second 2. The system is able to identify and lock-on to up to 6 targets per second. The system is able to identify and lock-onto all 10 targets within 2 seconds
Target Identification - Selectivity	1. Place an individual within the device's range, but facing away from the camera 2. Place 3 individuals facing forwards towards the sensor module and 3 facing away from the sensor module within the device's range 3. Have an individual stand within range for 10 seconds	1. The system does not lock-on and fire at the individual 2. The system only locks-on and fires at the individuals facing the sensor module 3. The system only fires at the individual once
Target Identification - Speed	1. Move an individual slowly within the system's range, staying at each position for at least 3 seconds	1. The system is able to move the motor unit to the final targeting position no more than $1/6^{th}$ of a second after the coordinates have been received from the sensor module
Target Identification – Environmental Conditions	1. Operate the system in dim lighting conditions (half the room's lights) 2. Operate the system in bright lighting conditions 3. Operate the system in an environment that is < 10 degrees Celsius 4. Operate the system in an environment that is > 30 degrees Celsius	1. The system is able to target individuals in dim lighting conditions 2. The system is able to target individuals in bright lighting conditions 3. The system is able to operate in a cold environment 4. The system is able to operate in a hot environment
Lighting Unit Intensity – Environmental Conditions	1. Operate the system in dim lighting conditions (half the room's lights) 2. Operate the system in bright lighting conditions (turn on all of the room's lights)	1. The system adjusts the lighting unit's output to less than 20V (less bright) 2. The system adjusts the lighting unit's output to the maximum 20V (brightest)
Lighting Unit Intensity – Multiple Targets	1. Place 6 individuals within 10 meters of the sensor module and within the 50-degree horizontal field-of-view	1. The system employs a uniform lighting unit output to all individuals it targets
Mechanical - Device Base	1. Move an individual slowly within the system's range, staying at each position for at least 3 seconds	1. The base provides sufficient friction with the external surface such that it remains stationary as the lighting unit rotates