5. EVALUATION

In this section, we delve into the crucial aspect of testing for AlertSense. As a product designed to provide effective emergency alerts for individuals with hearing impairments and heavy sleepers, testing plays a pivotal role in ensuring the reliability and performance of its key features. AlertSense combines vibrational, visual, and auditory cues to comprehensively address emergency alerts. The following details highlight the testing procedures conducted to validate the functionality and responsiveness of AlertSense, emphasizing its purpose, features, and intended market.

5.1. Testing Certification – Subsystems

The AlertSense prototype comprises several major subsystems that synergistically work to address the specific needs of individuals with hearing impairments during emergencies.

The Safety System, equipped with door sensors, carbon monoxide sensors, air quality sensors, and fire sensors, plays a pivotal role in threat detection, triggering appropriate alerts. The Vibrational System, featuring strategically placed motors beneath the bed, introduces a non-intrusive method of waking up the user through gentle vibrations. Complementing this, the Lighting System utilizes a low-wattage LED bulb, specifically the Philips LED Bulb, for visual alerts that prioritize user comfort and cost-effectiveness. The Application Interface, representing the software component, offers a user-friendly platform for interacting with the system. Users can effortlessly set alarms, configure sensor settings, and manage various aspects of AlertSense through this interface. At the heart of the prototype is the Control Module, centered around the Arduino Uno Rev 2 microprocessor. Serving as the central hub, it connects and orchestrates the functionality of all subsystems. This integrated approach ensures a comprehensive and synchronized response to diverse emergency scenarios, making AlertSense a robust and versatile solution.

5.1.1. Control Module/Bluetooth (Subsystem 1)

- The control box serves as the secure enclosure for housing sensitive and potentially hazardous equipment within the system. It is designed with dimensions of 6 in L x 9 in W x 9 in H, providing ample space to house critical components, including backup batteries and processors for various subsystems to fit in tight remote spaces. Additionally, air vents have been thoughtfully included to ensure proper ventilation and prevent overheating, guaranteeing the reliability and safety of the system even in challenging conditions.

- To ensure uninterrupted operation during power outages, an emergency battery plays a vital role in supplying continuous power to the sensors and motors. The control box is designed to accommodate the battery pack while also featuring an automatic charging mechanism. The sensors must maintain activity for at least 24 hours, crucial for reliability during emergencies such as fires or intrusions. While in standby mode, the sensors consume a minimal amount of power in the micro amps. Consequently, the battery possesses sufficient capacity to sustain both the standby mode of the sensors and power the motors [4]. The control module can transform and output the required voltage of 0 to 5 volts from another source's input. It is essential that the dimensions of the battery align with the constraints of the control box and do not exceed the specified weight limit to ensure seamless integration and optimal performance.

Test Writer: Thach Nguyen			
Test Case Name:	Back Up Power	**Test ID #:**	BU-P-01

Description		Ensures backup power in the case of a power outage.				**Type:**	☐ white box ☑ black box
Tester Information							
Name of Tester:		Thach Nguyen				**Date:**	04/30/2024
Hardware Ver:		Genwah Pack 1.0				**Time:**	2:00
Setup:		The vibrational system will be connected to the back-up power source not connected to the wall outlet.					
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**	
1	A signal will be sent to activate the motors.	When the arduino receives the signal the motors will run for the required duration time.	☑	☐	☐	The motors activate using the battery power.	
Overall Test Results			**1**	**0**	**0**		

Test Writer: Thach Nguyen							
Test Case Name:		Overheat Prevention				**Test ID #:**	OH-P-01
Description		Maintains normal temperatures during operation.				**Type:**	☐ white box ☑ black box
Tester Information							
Name of Tester:		Thach Nguyen				**Date:**	03/14/2024
Hardware Ver:						**Time:**	2:00
Setup:		Ventilation methods will be in place to adequately keep the control module from overheating while the motors are at full voltage.					
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**	
1	5 volts will be supplied to the motors for multiple operation cycles.	The system should remain cool due to air vents and short activation periods.	☑	☐	☐	The control box remained cool after multipl activation.	
Overall Test Results			**1**	**0**	**0**		

Test Writer: Thach Nguyen							
Test Case Name:		Power Regulation				**Test ID #:**	RL-P-01
Description		Ensures that a max of 5 volts is running through the system while fully activated.				**Type:**	☐ white box ☑ black box
Tester Information							
Name of Tester:		Thach Nguyen				**Date:**	03/14/2024
Hardware Ver:						**Time:**	2:00
Setup:		The control module will be connected to a 120 volts ac outlet and brought down to 5 volts using a voltage transformer and regulator.					
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**	

1	The inputs of the system will be meaured by a multimeter.	The voltage read by the meter should remain below 6 volts.	☑	☐	☐	The relays limit the volts to 5.
Overall Test Results			**1**	**0**	**0**	

Bluetooth Subsystem Test						
Name of Tester:		Jalen Noles			**Date:**	2/18/2024
Description:		This test will see if the microcontroller will be able to communicate with the other subsystems via Bluetooth within a certain radius.			**Time:**	5:00 PM
Test Case Name		Bluetooth connection Test				
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1	Have a BLE app send continuous data to Arduino and see when data is interrupted	The data should be constant until around 5 meters	☑	☐	☐	The Arduino was able to receive constant data past leaving the testing area which was about 15 meters

5.1.2. Lighting Subsystem (Subsystem 2)

The lighting subsystem works alongside the vibrational system to provide an additional way to alert the user in the event of an emergency. The lighting system consists of a dimmable LED light and a wall mount, which is used to position the light above the user. It also uses a dimmer and a 5-volt relay. The lighting system is directly connected to the control module, which will power on the light when one of the sensors detects any type of danger. We will test the lighting system by triggering each of the sensors and ensuring that the light powers on. We will also test the brightness of the light to ensure that it will not cause damage to the user's eyes.

Test Writer: Cody McDoniel						
Test Case Name:					**Test ID #:**	
Description					**Type:**	☐ white box ☑ black box
Tester Information						
Name of Tester:		Cody McDoniel			**Date:**	
Hardware Ver:					**Time:**	
Setup:						
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1			☑	☐	☐	
Overall Test Results			**1**	**0**	**0**	

5.1.3. Vibrational Subsystem (Subsystem 3)

The vibrational subsystem consists of two different types of motors that will be powered by the control module. These motors provide an alternative to waking up the user by using vibrations instead of sound. The motors would be distributed evenly beneath the bed with a protective covering to prevent damage to both the bed and the motors. We will do testing to decide how much power will be distributed to the motors to see just how much vibration we deem will be necessary.

Vibrational Subsystem Test						
Name of Tester:		Collin Beech			**Date:**	2/8/2024
Description:		This test will see if the motors will run for longer than 20 seconds.			**Time:**	5:35 PM
Test Case Name		Motor Duration Test				
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1	A timer is set after we turn the motors on to see if they will run for 20 seconds.	They exceeded the 20 second mark.	☑	☐	☐	

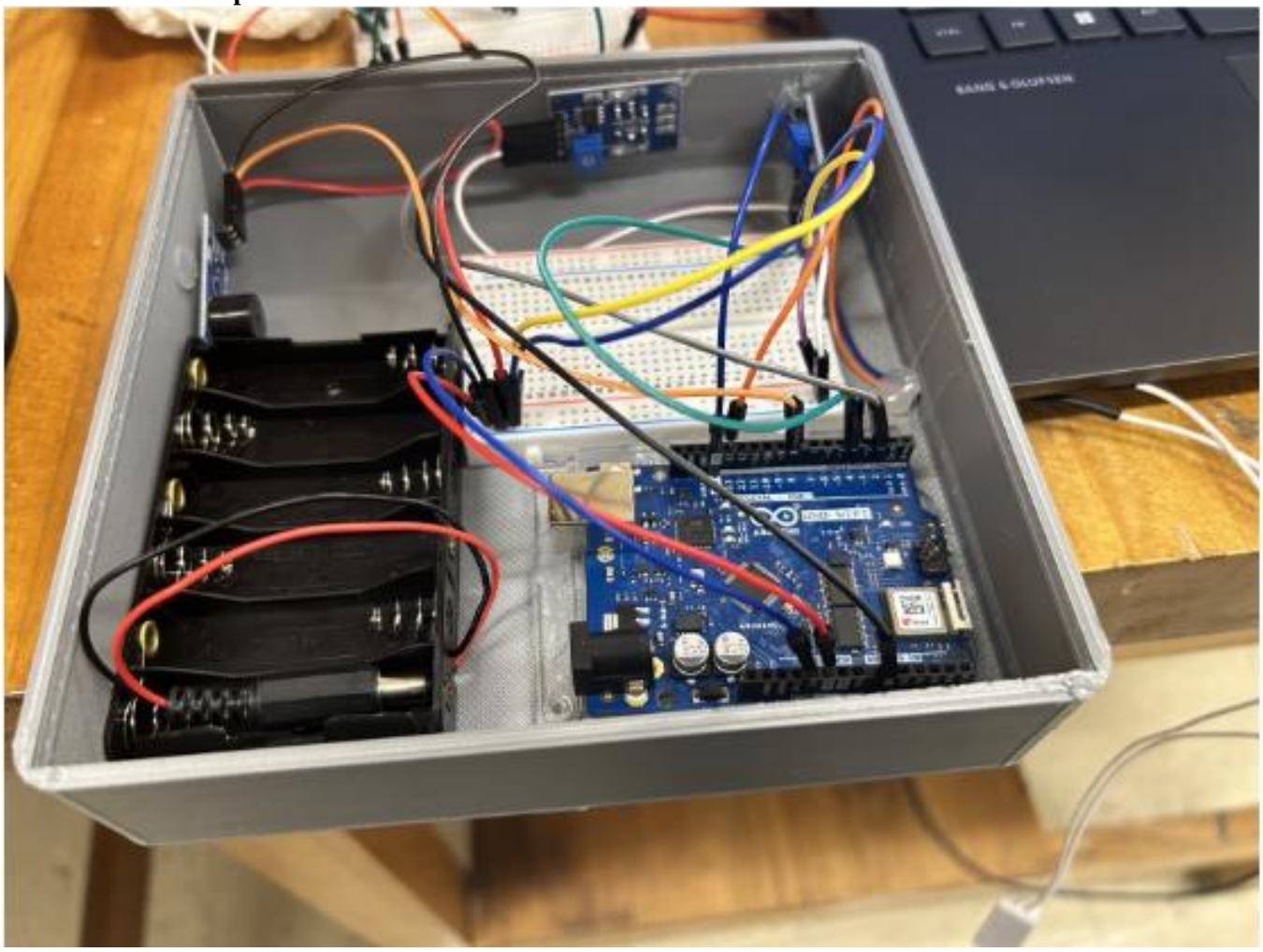
5.1.4 Safety Subsystem (Subsystem 4)

The safety subsystem protects the user from hazardous situations that could result in injury or death. The situations covered by the safety system are intrusion, fire, and gas. An additional feature provided is a battery pack utilized to provide constant power to the system in the event of a power outage. The safety system is separate from the main module and uses Bluetooth to send alerts. The enclosure for the system is mounted to the wall next to the door.

For the safety subsystem's standards, the system must detect fire, gas, and intruders and send an alert to the main system within a second of detection. To meet the following standards, it is required for the system to contain a fire sensor, gas sensor, and door sensor. For the fire sensor, we are using a fire detection module that focuses on detecting Infared radiation to determine if a fire is present. To detect the presence of a gas,

the gas sensor has a special coating which reacts with the electrochemical sensor to check for harmful gases. Finally, for our door sensor, a reed switch is used to detect if the door is ajar.

5.1.4.1 Sensors Setup



5.1.4.2 Test Data

Test Writer: Joshua Edoff						
Test Case Name:		Flame Sensor test #1			**Test ID #:**	Flame-Sen-01
Description		Check relative strength of IR photodiode on flame sensor.			**Type:**	☐ white box ☑ black box
Tester Information						
Name of Tester:		Joshua Edoff			**Date:**	2/4/2024
Hardware Ver:		Flame 1.0			**Time:**	3:59 PM
Setup:		The flame sensor is connected to an Arduino Uno Wi-Fi rev2 and a buzzer. The Arduino is programmed to send output to the buzzer when the flame sensor detects a fire. A light was used to produce the flame for this test.				
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1	A program is written to send	When a fire is placed in front of the flame	☑	☐	☐	The buzzer successfully rang when a fire was

	output to the buzzer.	sensor, the buzzer should begin to ring.				detected from the lighter using the flame sensor.
2	The lighter is placed a foot away from the flame sensor	The flame sensor should detect the presence of the fire and send an alert to the buzzer.	☑	☐	☐	The flame sensor successfully detected the lighter from a foot away and alerted the buzzer
3	The lighter is placed a meter away from the flame sensor	The flame sensor should detect the presence of the fire and send an alert to the buzzer.	☐	☑	☐	The flame sensor did not detect the flame from a meter away. This is due to the small flame not producing enough Infared radiation.
Overall Test Results			**2**	**1**	**0**	The test was a success. The only failure was due the small amount of Infared radiation produced by the lighter but should not be a problem from the system.

Test Writer: Joshua Edoff						
Test Case Name:		Gas Sensor test #1			**Test ID #:**	Gas-Sen-01
Description		Check the relative strength of the chemical sensor in the gas sensor.			**Type:**	☐ white box ☑ black box
Tester Information						
Name of Tester:		Joshua Edoff			**Date:**	2/4/2024
Hardware Ver:		Gas 1.0			**Time:**	4:15 PM
Setup:		The gas sensor is connected to an Arduino and a buzzer. When a gas is detected, the buzzer will ring, alerting its presence. An unlit lighter will be used to produce gas to test the gas sensor.				
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**
1	A program is written to send output to the buzzer.	The gas from the lighter should cause the buzzer to ring.	☑	☐	☐	The buzzer began to ring during the presence of gas.
2	The lighter is placed a foot away from the gas sensor.	The gas sensor should detect the presence of the gas.	☐	☑	☐	The Lighter does not produce enough gas to fill such a distance in a room.
Overall Test Results			**1**	**1**	**0**	The gas sensor is working but for a proper test, a different solution for a gas needs to be used. Safety is a large concern when testing this sensor.

Test Writer: Joshua Edoff			
Test Case Name:	Door Sensor	**Test ID #:**	Door-Sen-01

Description		Check the relative strength of the reed sensor.				**Type:**	☐ white box ☑ black box
Tester Information							
Name of Tester:		Joshua Edoff				**Date:**	2/4/2024
Hardware Ver:		Door 1.0				**Time:**	4:27 PM
Setup:		A reed sensor is connected to an Arduino and buzzer. When the magnet attachment of the reed sensor is taken away from the sensor portion, the buzzer will be set off.					
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**	
1	A program is produced to set off the buzzer when the magnet is no longer detected	When the magnet is taken away from the sensor, the buzzer should begin to ring.	☑	☐	☐	The buzzer began to ring when the two parts of the reed sensor were separated.	
Overall Test Results			**1**	**0**	**0**	The reed sensor successfully set off the buzzer when each portion was separated.	

5.1.5 Application and Website (Subsystem 5)

The Application Subsystem serves as the interface through which users interact with the AlertSense system, providing a user-friendly platform to configure settings, set alarms, and manage various functionalities. This subsystem is crucial for ensuring that users, particularly those with hearing impairments, can easily customize the system to meet their specific needs.

The primary components of the Application Subsystem include menus, buttons, and graphical user interfaces (GUIs) designed to facilitate seamless navigation. Users can access features such as setting wake-up alarms, configuring sensor parameters, and managing the overall functionality of AlertSense.

To accommodate user preferences and accessibility requirements, the Application Subsystem incorporates features like adjustable vibration levels and visual indicators with different intensities. The web-based application ensures flexibility, allowing users to control AlertSense remotely from various devices.

Moreover, the subsystem includes a settings menu where users can toggle specific sensors on or off based on their preferences. For instance, users may choose to disable the fire sensor during cooking activities to prevent false alarms. The Application Subsystem thus provides a personalized and adaptable experience, enhancing the overall usability and effectiveness of AlertSense for individuals with hearing impairments.

5.4.1.1

Test Writer: Cooper Robertson			
Test Case Name:	Application Test #1	**Test ID #:**	Int-Nav-01
Description	Check to verify if users can navigate the application seamlessly.	**Type:**	☐ white box ☑ black box
Tester Information			
Name of Tester:	Cooper Robertson	**Date:**	2/7/2024

Hardware Ver:		Interface Navigation 1.0				**Time:**	4:16 PM
Setup:		The application is open on a web browser and all menu options are available.					
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**	
1	Test the responsiveness of each header button.	Responded swiftly.	☑	☐	☐		
2	Test the responsiveness of each button within the control panel.	All buttons were responsive with no issues.	☑	☐	☐		

Test Writer: Cooper Robertson							
Test Case Name:		Application Test #2				**Test ID #:**	Alarm-Set-01
Description		Test the functionality of setting alarms.				**Type:**	☐ white box ☑ black box
Tester Information							
Name of Tester:		Cooper Robertson				**Date:**	2/7/2024
Hardware Ver:		Alarm Setting 1.0				**Time:**	4:25 PM
Setup:		The application is open on a web browser and the alarm is ready to be set.					
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**	
1	Test to see if the alarm is set via JavaScript.	The alarm was set and the website provided feedback that the operation was a success.	☑	☐	☐		

Test Writer: Cooper Robertson							
Test Case Name:		Application Test #3				**Test ID #:**	Wi-Fi-Func-1
Description		Test to ensure the Wi-Fi connection is successful.				**Type:**	☐ white box ☑ black box
Tester Information							
Name of Tester:		Cooper Robertson				**Date:**	4/3/2024
Hardware Ver:		Wi-Fi 1.0				**Time:**	1:16 PM
Setup:		The application is open and ready to send a signal to the Arduino.					
Setup	**Action**	**Expected Result**	**Pass**	**Fail**	**N/A**	**Comments**	
1	Test to ensure the app can send signals via Wi-Fi.	The signal was sent to activate the system from the application and was successful.	☑	☐	☐		

In conclusion, the rigorous testing of the Application Subsystem has been integral to ensuring the optimal performance and user-friendliness of AlertSense. By systematically evaluating interface navigation, alarm

setting, and wireless signal emission, AlertSense has verified that the application meets the highest standards of functionality and reliability. The testing process has not only identified and addressed potential issues but has also provided valuable insights for enhancing the overall user experience. The comprehensive testing approach sets the stage for a user centric AlertSense system that effectively caters to the diverse needs of individuals with hearing impairments during emergencies.

5.2. Testing Certification – System Testing

This section marks the commencement of the comprehensive system testing phase, a crucial step in the validation of our full prototype. System testing, a high-level testing practice, is pivotal in ensuring that our integrated system meets the design specifications and requirements. Unlike subsystem testing, which focuses on individual components, system testing evaluates the entire system's functionality, reliability, and interaction with external systems.

Our approach to system testing will encompass a variety of testing methods, including functional testing to verify that each function of the software operates in conformance with the requirement specification; performance testing to ensure the system’s responsiveness and stability under a particular workload; and usability testing to check the user-friendliness and intuitiveness of the interface. Additionally, security testing will be conducted to identify any vulnerabilities and ensure data protection and compliance with relevant standards.

Throughout this phase, we will rigorously document all test cases, outcomes, and any anomalies encountered. This structured approach enables us to identify and address any issues proactively, ensuring the system’s readiness for real-world deployment.

As we conclude the system testing and thereby the Evaluation section of this Design Document, we take a moment to reflect on the journey thus far. This meticulous evaluation process has not only validated the functionality and performance of our design but has also highlighted areas for potential improvement. The insights gained here are invaluable in guiding us towards refining our prototype into a robust, market-ready product.

We now transition towards the final segments of our document, where we will encapsulate the lessons learned, challenges encountered, and the forward path for our project. This closing phase is not just an end, but a gateway to future possibilities and enhancements.

All references cited throughout the Evaluation section, including product specifications, academic papers, and graphical data, are listed below in the IEEE format. This meticulous documentation underscores our commitment to academic integrity and professional excellence.

We also extend our gratitude to all individuals, institutions, and sources of inspiration that have contributed to this project's development. Their invaluable input and guidance have been instrumental in shaping our design and evaluation process.