Design Validation plan

Battery Pack/BMS

Components

- Designed battery pack
- Buck Converter
- Voltage Divider

Test 1

Test Name: Battery Tests
Interdependencies: This test is dependent on the proper installation and connection of the battery pack.
Description: Verify the voltage and amperage of the total battery pack and ensure that BMS maintains battery voltage safely.
Quantitative Measurement: The voltage and amperage readings.
Acceptable Range of Values: The range is 14-15V 4-6A.
How to obtain the range of values: The range of values is obtained from the requirements for the batteries and relevant industry standards.
Relevant standard: IEC 62133-2:2017, which specifies the requirements and tests for the safe operation of lithium-ion cells and batteries used in portable applications. This standard includes tests for electrical, mechanical, and environmental safety, as well as performance and abuse testing.

Test 2

Test Name: Buck Converter & Voltage Divider Tests
Interdependencies: This test is dependent on the proper installation and connection of the battery pack.
Description: This test will verify that the buck converters and voltage divider appropriately step down the voltage.
Quantitative Measurement: The voltage and amperage readings.
Acceptable Range of Values: The range is 5V, 2.5A for the Raspberry pi and 9V 2A for the HoloLens. With 0-5V for the voltage divider.
How to obtain the range of values: The range of values is obtained from the manufacturer's requirements for Raspberry pi and HoloLens and relevant industry standards.

Sensor node

Sensors

- PULSE SENSOR
- BODY TEMPERATURE
- WATER LEVEL
- OXYGEN LEVELS
- ACCELERATION
- BATTERY LEVELS

Test 1

Test Name: Sensor Integration Test
Interdependencies: This test is dependent on the proper installation and connection of all sensors in the system.
Description: Verify the integration of all sensors into the system and ensure that they are functioning correctly and accurately.
Quantitative Measurement: The output readings from each sensor will be compared to the expected values.
Acceptable Range of Values: The range will be determined based on the sensor calibration, specifications, or relevant industry standards.
How to obtain the range of values: The range of values is obtained from the sensor datasheets, calibration certificates, and relevant industry standards.

Sensor node PCB

Sensors

- PULSE SENSOR
- BODY TEMPERATURE
- WATER LEVEL
- OXYGEN LEVELS
- ACCELERATION
- BATTERY LEVELS

Test 1

Test Name: PCB Sensor Integration Test
Interdependencies: This test is dependent on the proper installation and connection of all sensors on the PCB.
Description: Verify the integration of all sensors into the system and ensure that they are functioning correctly and accurately.
Quantitative Measurement: The output readings from each sensor will be compared to the expected values from previous testing on a protoboard.
Acceptable Range of Values: The range will be determined based on the sensor calibration, specifications, or relevant industry standards.
How to obtain the range of values: The range of values is obtained from the sensor datasheets, calibration certificates, and relevant industry standards.

Machine Learning

Components

- Sensors baseline data
- Data transmission to Pi
- Data saved and organized
- Sensors real-time data

Test 1

Test Name: Machine Learning Accuracy Test
Interdependencies: This test is dependent on the sensor node, having baseline data and the components above.
Description: Verify ML model for activity detection and abnormality detection using sensor data.
Quantitative Measurement: The percentage of correctly classified data.
Acceptable Range of Values: The range will be determined based on the sensor calibration, specifications, or relevant industry standards.
How to obtain the range of values: The range of values is obtained from the sensor datasheets, calibration certificates, and relevant industry standards.

Hub-To-Hub

Components

- Sensor node data
- Machine Learning
- XBee modules calibration

Test 1

Test Name: XBee Module Communication Range Test
Interdependencies: This test is dependent on the sensor node and the components above.
Description: Verify the communication accuracy/reliability between the hubs (XBee modules) by sending and receiving messages indoors and outdoors at different distances.
Quantitative Measurement: The number of successfully sent and received messages will be counted, as well as the time taken for the message to be transmitted and received. The latency, packet loss rate and signal strength (RSSI) will also be measured.
Acceptable Range of Values: The range will be 100%-80% accuracy at 0-400ft.
How to obtain the range of values: The range of values is obtained from the XBee modules datasheets. Indoors (0-200ft) and outdoors (0-4000ft).

Test 2

Test Name: CSV Data Transfer Test
Interdependencies: This test is dependent on the sensor node and the components above.
Description: Test the ability of the XBee modules to send and receive CSV data files over a wireless connection.
Quantitative Measurement: The size of the CSV data file transferred, the time taken to transfer the file will be measured and the accuracy.
Acceptable Range of Values: The acceptable range of values will depend on the size of the data file and data lost.
How to obtain the range of values: The data transfer rate specifications and maximum file size limitations for the XBee modules can be obtained from the manufacturer's datasheet.

Server

Components

- Sensor node data
- Hub-to-Hub
- Server setup (Python client, and Unity client)

Test 1

Test Name: Socket Server Transmission Test
Interdependencies: This test is dependent on the sensor node, the components above and the server being setup.
Description: Test the ability of the Python socket server and client to transmit and receive messages between each other.
Quantitative Measurement: The successful transmission and reception of messages will be recorded.
Acceptable Range of Values: The test is considered successful if messages are transmitted and received without errors.
How to obtain the range of values: The acceptable range of values is based on the successful transmission and reception of messages without errors.

Test 2

Test Name: CSV Data Transmission Test
Interdependencies: This test is dependent on the sensor node, the components above and the server being setup.
Description: Test the ability of the Python socket server and client to transmit and receive CSV data files between each other, and save the received data to a folder.
Quantitative Measurement: The successful transmission and reception of CSV data files will be recorded, as well as the ability to save the received data to a folder.
Acceptable Range of Values: The test is considered successful if CSV data files are transmitted and received without errors, and the received data is saved to a folder.
How to obtain the range of values: The acceptable range of values is based on the successful transmission and reception of CSV data files without errors, and the successful saving of received data to a folder.

Unity User Interface (UI)

Components

- Sensor node data
- Hub-to-Hub
- Server

Test 1

Test Name: Unity UI Functionality Test
Interdependencies: This test is dependent on the proper transmission and reception of data from the sensors, as well as the correct functioning of the server and clients.
Description: Test the Unity UI display interface is set up correctly and that the allocated UI elements are functioning properly.
Quantitative Measurement: The success of test output messages being printed on the console using the Debug call.
Acceptable Range of Values: The data that was specified is the same one that is displayed.
How to obtain the range of values: The acceptable range of values is based on the successful display of messages without errors.

Test 2

Test Name: Unity UI CSV Data Display Test
Interdependencies: This test is dependent on the proper transmission and reception of data from the sensors, as well as the correct functioning of the server and clients.
Description: Verify that the Unity UI elements and scenes are displaying the received data correctly and in the expected locations.
Quantitative Measurement: The data displayed on the UI elements will be compared to the expected values.
Acceptable Range of Values: The range of values will depend on the specific vital being displayed and the expected values based on sensor readings.
How to obtain the range of values: The data obtained from the sensors is expected to remain constant, without any changes.

HoloLens Interface (UI)

Components

- Sensor node data
- Server
- Unity UI
- HoloLens Emulator

Test 1

Test Name: Unity UI Usability Test
Interdependencies: This test is dependent on the Unity UI being functional and all the components above.
Description: Evaluate the usability and functionality of the Unity UI design on the HoloLens emulator.
Quantitative Measurement: The success of UI elements working as expected. The user satisfaction ratings, time to complete a specific task and number of errors made by users.
Acceptable Range of Values: The UI elements display data and functioning as setup. The UI being easy for users to learn and use, a low error rate and a high satisfaction rating.
How to obtain the range of values: The acceptable range of values is based on the successful display of data without errors and the usability of the interface.
Relevant standard: The Cognitive Walkthrough defined by IEEE 1296-1998 as a "method for evaluating the usability of a product by systematically walking through a task from a user's perspective." To ensure the Unity UI design is user-friendly and efficient.

Test 2

Test Name: HoloLens UI Functionality Test
Interdependencies: This test is dependent on the Unity UI being functional and all the components above.
Description: Verify the Unity display interface is functioning correctly and that the allocated UI elements are working properly.
Quantitative Measurement: The data displayed on the UI elements will be compared to the expected values.
Acceptable Range of Values: The range of values will depend on the specific vital being displayed and the expected values based on sensor readings.
How to obtain the range of values: The data obtained from the sensors is expected to remain constant, without any changes.