Mitigating Autistic Meltdowns

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INTERFACE CONTROL DOCUMENT

REVISION 1
23 February 2022

Interface Control Document
FOR
Mitigating Autistic Meltdowns

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Change Record

Rev.	Date	Originator	Approvals	Description
-1	[2/23/2022]	[Team 12]		Draft Release

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1. Overview

The Interface Control Document or ICD for The 12th Man will go into detail regarding how the subsystems in the Concept of Operations and requests from the Functional System Requirements will be fulfilled. The ICD will provide characteristics of the various stages of our project and how they will interact between each other including communications, component location, and electrical characteristics.

2. References and Definitions

2.1. References

MIL-STD-810F
Environmental Engineering Considerations and Laboratories Tests
1 Jan 2000
Change Notice 2
30 Aug 2002

American National Standard for VME64 (ANSI/VITA 1-1994 (R2002))
4 Apr 1995

American National Standard for VME64 Extensions (ANSI/VITA 1.1-1997)
7 Oct 1998

2.2. Definitions

AI	Artificial Intelligence
ASD	Autism Spectrum Disorder
CONOPS	Concept of Operation
GPS	Global Positioning System
IC	Integrated circuit
I/O	Input/Output
mA	Milliampere
mAH	Microamp hours
mm	Millimeters
mW	Milliwatt
Li	Lithium
PCB	Printed Circuit Board
SQL	Structured Query Language
TBD	To Be Determined
V	Volts
W	Watts
4G	Mobile Communication Standard

3. Physical Interface

3.1 Weight

3.1.1 Weight of the Sensors and microcontroller

The sensors and microcontroller have a combined weight of less than half a kilogram This allows for the wearable device to sit comfortably on the user's waist.

Component	**Weight(grams)**
Raspberry Pi 4 (microcontroller)	46 grams
MPU6050(accelerometer)	6.208546
GPS Module GPS NEO-6M	9.8089
Polar H9 Heartrate Monitor	100
USB 2.0 Mini Microphone	22.9631
DS18B20 Temperature Sensor	22.96

3.1.2 Weight of Power System Components

Component	**Weight(grams)**
Li-ion Battery	158.757
Battery Charger and Power-Path Management IC	0.05
Boost Converter	TBD
AC/DC adapter	TBD

3.2 Dimensions

3.2.1 Dimensions of Sensors and Microcontroller

The biometric sensors will fit on a PCB board inside a 3D printed enclosure. The enclosure will be less than or equal to 170 mm in length, 112 mm in width, and 50 mm in height.

Component	Length(mm)	Width(mm)	Height(mm)
Raspberry Pi 4	88	58	19.5
MPU6050	20.066	16.51	9.906
GPS Module GPS NEO-6M	27.686	100.076 mm	22.606
Polar H9 Heartrate Monitor	34.036	65.024	9.906
USB 2.0 Mini Microphone	22.29	18.45	7.12
DS18B20 Temperature Sensor	60.96	15.24 mm	2.54

3.2.2 Weight of Power System Components

Component	Length(mm)	Width(mm)	Height(mm)
Li-ion Battery	109.982	59.944	9.906
Battery Charger and Power-Path Management IC	3.0	3.0	0.9
Boost Converter	TBD	TBD	TBD
AC/DC adapter	TBD	TBD	TBD

3.3. Mounting Locations

3.3.1. Mounting of Sensors

All sensors will be placed on the PCB board such that there is no interference with their data collection. The microphone and temperature sensors will be partially external to allow for accurate noise and temperature collection without interference. The other sensors are not location dependent.

3.3.2. Mounting of Microcontroller

The microcontroller will be inside a 3D printed enclosure below the PCB board. The wiring from the microcontroller to the sensors will also be tucked inside said enclosure and spaced apart to avoid any potential for short circuits.

3.3.3. Mounting of Heartbeat Sensor

The heartbeat sensor should be around the user's chest to ensure the best heartbeat possible.

3.3.4. Mounting of the device

The 12th man device should be attached to the user's pants or belt around their waist without anything covering the microphone. This to ensure the best audio quality of the surrounding noise is collected.

4. Electrical Interface

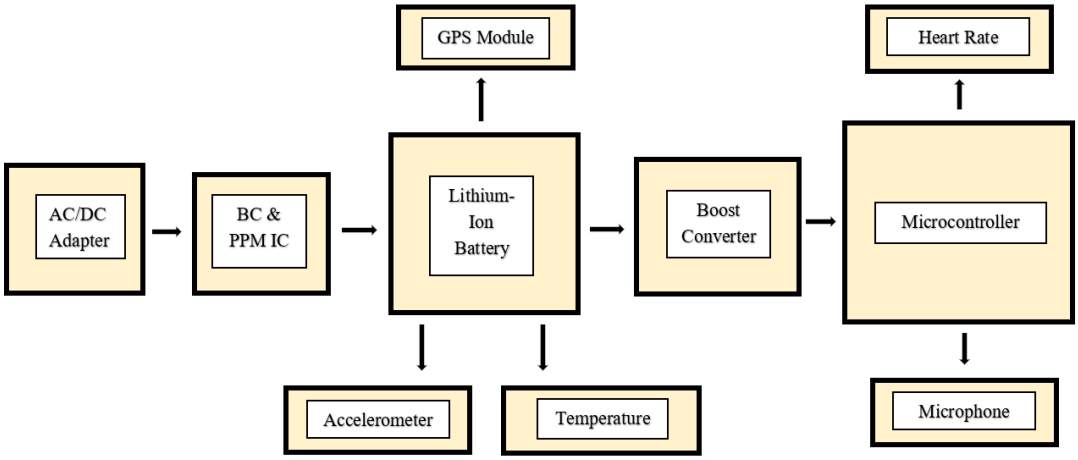

Figure 1. Electrical block diagram

4.1. Primary Input Power

The Lithium Ion battery shall be charged and recharged by an AC/DC adapter in which a battery charger and power path management integrated circuit shall be connected to the 3.7V 10,500 mAh battery. The battery shall supply power to the GPS module, temperature sensor, and accelerometer. The battery shall provide input voltage to a boost converter to boost the voltage output to 5V and supply power to the Raspberry Pi. The microphone shall be powered by the microcontroller via usb. The heart rate sensor is an internally powered sensor.

4.2. Voltage and Current Levels

4.2.1. Voltage, Current, and Power Consumption

Component	Voltage(V)	Current(mA)	Power(mW)
Raspberry Pi 4b	5	3000	15000
GPS Module	3.6-5V	Capture 45mA/5.0V	TBD
Temperature Sensor	3-5.25	TBD	TBD

Accelerometer	3.3V	TBD	TBD
Microphone + Speaker	TBD	TBD	TBD

The current drawn by the GPS module, temperature sensor, accelerometer is assumed to not draw significant current. The Raspberry Pi 4b will draw a significant amount of current. The battery shall have a capacity of 10500mAh to ensure sustainable battery life for the device.

4.3. Signal Interfaces

4.3.1. Input Sensors

The GPS module, ambient temperature sensor, heart rate sensor, accelerometer, and microphone shall communicate with the Raspberry Pi so that data can be collected.

4.3.2. Output Signals

For the purpose of mitigation, The 12th Man device should have an output speaker that can be used to play audio recordings. Said audio recordings are grounding exercises recorded by loved ones. The Raspberry Pi should be able to communicate with the speaker so that it can be utilized as an output device.

4.4. User Control Interface

4.4.1. Database Signals

The mobile application will provide the user with a control interface. This interface will provide the user the ability to tether their mobile application to the 12th Man device their dependent will be wearing. The parent/guardian shall then be able to view the data collected by the device and an indication of the meltdown status of their dependent.

The user will be able to check the status of each input signal. The user will see if all the database is receiving data from the GPS, accelerometer, ambient temperature sensor, heart rate sensor, and microphone.

4.4.2. Physical Device

The individual with Autism who is wearing the device is not provided a control interface whatsoever, and is simply responsible for wearing the device.

5. Communications / Device Interface Protocol

5.1. Wireless Communications (WiFi)

Wifi connection will be achieved using the Raspberry Pi 4 microcontroller. The Raspberry Pi 4 microcontroller utilizes a Wifi package that allows for wireless connectivity. The wifi connection will allow the device to take inputs from the GPS, accelerometer, heart rate sensor, temperature gauge, and microphone and send that information to the database. The database will use this data to identify if a meltdown will occur. If a meltdown is about to happen, a signal will be sent to the device to start the grounding exercises. The database will also send information from the database to the app using a HTTP connection, while the app is connected to the internet.

5.2. Microcontroller Input and Output

The raspberry pi includes an assortment of digital and analog inputs. Analog Input pins take in voltage at 5v and also take in signals from an accelerometer and GPS. The digital input pins receive microphone data via bluetooth and USB ports. All the following pins meet the requirements for the sensors used above.

5.3. Sensor Communication

The sensors will primarily communicate through pins with the Raspberry Pi using an I2C connection. The heartbeat sensor will use the bluetooth module attached to the Raspberry Pi and the microphone will use the USB module included with the Raspberry Pi.

5.4. Device Peripheral Interface

The database will be connected to the mobile app through a HTTP connection. This is a reliable way to send data from a SQL database to an application.