Hazard Analysis: SE 4G06, TRON 4TB6

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Revision History

Date	Version	Notes
10/14/2022	1.0	Added sections 1, 2, and 3
10/19/2022	1.1	Worked on Sections 5 / General Editing
04/04/2023	1.2	Updated according to Feedback and Formated Table

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Symbols, Abbreviations and Acronyms

symbol	description
Age groups	(15-30, 31-50, 51-75, 75+)

1 Introduction

This document is the hazard analysis for the entirety of Synesthesia Wear. For context, Synesthesia Wear is an inexpensive and non-intrusive ~~hearing aid~~ wearable device with a purpose of improving ~~quality of life by providing users~~ the users' auditory awareness with an alternate channel for sound recognition within their surroundings. Furthermore, this wearable device will have a corresponding application that will be made to be user-friendly so that users can easily access and configure their wearable devices to whatever settings they so desire. Lastly, for the purposes of this document, the Synesthesia Wear developers believe that the definition of a hazard is one that is derived from Nancy Leveson's work. With that in mind, a hazard is any property or condition within the Synesthesia Wear system where after pairing up with any conditions in the environment, a potential for loss to the system now exists.

2 Scope and Purpose of Hazard Analysis

The scope of this document is to identify any and all possible hazards within the system, clarify the mitigation steps of each identified hazard, determine the causes and effects of all failures, and define all safety and security requirements that have resulted from the overall analysis.

3 System Boundaries and Components

The hazard analysis will be conducted on the Synesthesia Wear system which will be comprised of the following components:

1. The wearable device consists of:
   (a) Vibration Motor
   (b) Microphone
   (c) Microcontroller
   (d) Bluetooth module
   (e) Battery
2. The Application to be installed on the users' devices consists of:
   (a) User Interface
   (b) Wearable device Settings Configuration
3. The Device that runs the application
   (a) Operating System

With the above in mind, the system boundary is limited to the above 3 components with each having their own respective subcomponents. Furthermore, it is important to note that not all components in the above list can be controlled (i.e. Device's Operating System) by the Synesthesia Wear developers. However, these components still needed to be listed down in the system boundary as the potential for a hazard can still be correlated to them.

4 Critical Assumptions

CA1. The battery will not need to be replaced during product lifespan.
CA2. Signal input devices will be consistent with the results they produce.
CA3. Software application failure will not diminish usage of product.
CA4. The microphone is not blocked and has full access to the environment.
CA5. The device will be used in indoor conditions.

5 Failure Mode and Effect Analysis

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Table 1: Wearable Device Failure Modes and Effects Analysis

System: Wearable Device Phase/Mode: System Requirements								
Sub-System	**Design Function**	**Failure Mode**	**Effects of Failure**	**Causes of Failure**	**Recommended Actions**	**Risk Priority Number (RPN)**	**Safety Requirement**	**Ref**
Battery	Power the various components of the device	Battery stops delivering power to the device	1.Device loses all functionalities	1.Battery was not charged 2.Battery fails and stops holding charge 3.Battery gets disconnected from the controller	1.Inform users of best charging practices to avoid battery failure i.e (only charge to 80%, don't leave it plugged in when battery is full etc.) 2.Microcontroller should throw error code if it detects battery disconnection 3.Have CMOS battery in the Micocontroller incase of power loss	Severity: 10 Occurrence Likelihood: 3 Detection Likelihood: 1 Total: 30	SIR4, SIR2	H1-1
		Battery supplies incorrect power	1.Devices may lose some functionality or may work incorrectly. The internal components may get	1.Battery Failure 2.Low charge in the battery 3.Issue in the battery management system (BMS)	1.Hardware should be able to cut off the battery in case of excess current draw 2.Microcontroller can signal the user in case of	Total: 32	SIR2	H1-2

System: Wearable Device Phase/Mode: System Requirements								
Sub-System	**Design Function**	**Failure Mode**	**Effects of Failure**	**Causes of Failure**	**Recommended Actions**	**Risk Priority Number (RPN)**	**Safety Requirement**	**Ref**
Battery	Power the various components of the device	Battery overheats	1.Device container can melt 2.Battery can melt other components of wearable device 3.Burn the user 4.Damage future battery performance	1.Device operates in temperatures outside the operating conditions of the battery 2.Battery failure 3.Excessive current draw 4.Loose connections	1.Insure proper cooling or heat dissipation of the microcontroller 2.Refer to H1-2 a 3.Install a battery that can operate in the working conditions of the device 4.refer to H1-1 b.	Total: 40	SIR3	H1-3
Microphone	Sound detection	Sound is not detected	1.~~Device is not able to perform the primary function~~Device is unable to recognize sounds	1.Loose connections 2.Microphone is damaged	1.Microcontroller can throw an error code in case of microphone disconnect 2.User can check the microphone output on the app to see if it is functioning correctly	Total: 30	IR6	H2-1
		Sound is falsely detected	1.Device functions incorrectly	1.Loose connections 2.Microphone is damaged	1.Refer to H2-1.b	Total: 80	IR6	H2-2

System: Wearable Device Phase/Mode: System Requirements								
Sub-System	**Design Function**	**Failure Mode**	**Effects of Failure**	**Causes of Failure**	**Recommended Actions**	**Risk Priority Number (RPN)**	**Safety Requirement**	**Ref**
Bluetooth Module	Provide a communication stream between mobile phone and wearable device	Mobile device loses connection with bluetooth module	1.Sound processing capabilities are lost 2.Vibration motor wont receive signal to provide/not provide haptic feedback	1.Signal between mobile phone and device is lost due to higher than rated distances 2.Signal is blocked due to external factors such as a faraday cage 3.Other signals such as wifi, microwave etc. cause interference with bluetooth signal 4.Connected phone loses power	1.Provide a notification to the user when the signal strength is diminished 2.Include auto-reconnection with the device and phone when signal is found 3.Ensure final design of the product has adequate clearing for the bluetooth antennas such that it maximizes signal strength	Total: 20	NFR-8	H3-1
		Invalid message	1.Unexpected or incorrect output from device	1.Message corrupted during transmission 2.Message corrupted during reception	1.Add a checksum into the bluetooth signal to check for message integrity 2.Only accept predefined messages, discard	Total: 15	IR7	H3-2

System: Wearable Device Phase/Mode: System Requirements								
Sub-System	**Design Function**	**Failure Mode**	**Effects of Failure**	**Causes of Failure**	**Recommended Actions**	**Risk Priority Number (RPN)**	**Safety Requirement**	**Ref**
Vibration Motor	Provide haptic notification to user	Vibrations not noticeable by user	1.User does not get alerted	1.Not enough power supplied	1.User can calibrate the intensity of the motor	Total: 7	ACR1	H4-1
		Motor does not vibrate	1.User does not get alerted	1.Loose connections 2.Defective vibration motor	1.Microcontroller can signal the user in case of motor disconnect 2.Refer to H4-2	Total: 20	SIR4	H4-2
		Incorrect vibration	1.User incorrectly identifies the sound	1.Defective vibration motor	1.User can calibrate the vibration intensity and check the output	Total: 18	SIR4	H4-3
		Vibration too intense	1.Painful or annoying to the user	1.Motor drawing excess current	1.Refer to H4-3 2.Hardware connection is current limited	Total: 8	ACR1	H4-4

Table 2: Application Failure Modes and Effects Analysis

System: Mobile Application Phase/Mode: System Requirements								
Sub-System	**Design Function**	**Failure Mode**	**Effects of Failure**	**Causes of Failure**	**Recommended Actions**	**Risk Priority Number (RPN)**	**Safety Requirement**	**Ref**
Signal Processing	Classify sound	Sound is incorrectly classified	1.Incorrectly notify user about sound 2.No notification for detected sound	1.Insufficient training data 2.Model parameters not fully optimized 3.Outlier sound received	1.user can help with calibration by adding more samples 2.Filter outlier noise	Total: 168	~~ACR2~~, IR6	S1-1
		Sound is not classified	1.No notification for detected sound	1.Error/bug with signal processing code	1.Refer to S1-1.a	Total: 105	IR6	S1-2
Graphical User Interface	Give visual representation of the application to the end user	Incompatibility between different mobile devices	1.Formatting errors when resizing 2.Unable to download application 3.Loss of functionality or crashing	1.Button hit box detection may be lost/compromised 2.Mobile OS may not support application 3.Processing power of phone may be too inadequate for required signal processing 4.Mobile phone may not support bluetooth	1.Provide end users with a list of certified compatible devices 2.Code/Style the application such that resizing is done automatically as the application detects screen size 3.Update the application on a regular basis to ensure compatibility with latest	Total: 20	NFR-7	S2-1

System: Mobile Application Phase/Mode: System Requirements								
Sub-System	**Design Function**	**Failure Mode**	**Effects of Failure**	**Causes of Failure**	**Recommended Actions**	**Risk Priority Number (RPN)**	**Safety Requirement**	**Ref**
Graphical User Interface	Give visual representation of the application to the end user	Combination of user inputs	1.Loss of saved data 2.Abrupt crashing of the application	1.User chooses incorrect bluetooth device to connect to 2.User force closes application before applying changes	1.System should recognize invalid inputs from users and provide helpful error messages 2.Application should provide warning when entries are not saved before allowing a force close. Warnings should require user confirmation before allowing the event	Total: 48	ACR3	S2-2
		Abnormal closing of application	1.Loss of saved data 2.Incorrect communication of data	1.User closes application while data is being transferred 2.System preemptively forces the application to close	1.Communication protocol between the device and the application should have error handling in case of errors in data transmission	Total: 40	IR3	S3-3

6 Safety and Security Requirements

~~Bold statements are an extension of the SRS document safety requirements which should have been included in revision 1.~~

6.1 System Isolation Requirements

SIR1. Product is isolated from electrical components at contact locations. Using wire isolation material
SIR2. Auto shut-off when electrical malfunction detected.
SIR3. Product has sufficient heat dissipation such that all the electrical components stay in their working temperatures.
SIR4. System can perform a hard reboot to reset all hardware components. The built in temperature control system within the Arduino

6.2 Access Requirements

ACR1. Authorized users can access preferred vibration/sensitivity settings through application site.
~~ACR2. Authorized users can retrain the device through application site.~~
ACR3. Users given error message if invalid inputs are entered in application.

6.3 Integrity Requirements

IR1. Only required variables will be given access to change.
IR2. Data will be accessible by authorized users.
IR3. After synchronization, a copy of ~~data is loaded to system application.~~ the Arduino signal data is loaded to system application.
IR4. No pairs of modes allowed identical settings.
IR5. Stored data overridden only at synchronization request.
IR6. Application can detect if there is an issue with the microphone.
IR7. Unknown messages from Bluetooth module prompt an error to the user and are rejected.

6.4 Privacy Requirements

PPR1. Personalized access code will be created for user application accessibility.
PRR2. Data is not transferable between accounts.

7 Roadmap

The requirements implemented according to the hardware research milestone created in the development plan are as listed, system isolation requirements and privacy requirements. With access requirements, integrity requirements and privacy requirements being researched in the future development plan.