Hazard Analysis
SE 4G06, TRON 4TB6

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Table 1: Revision History

Date	**Developer(s)**	**Change**
10/14/22	Azriel G.	Added sections 1, 2, and 3
Date2	Name(s)	Description of changes
...	...	...

Contents

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 bracelet with a purpose of improving quality of life by providing users with an alternate channel for sound recognition within their surroundings. Furthermore, this bracelet will have a corresponding application that will be made to be user-friendly so that users can easily access and configure their bracelets 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 Bracelet which also consists of:
   (a) Vibration Motor
   (b) Sound Sensor
   (c) Microcontroller
2. The Application to be installed on the users' devices which consists of:
   (a) User Interface
   (b) Bracelet 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. Failure of one electrical components will allow user to continue use of product

5 Failure Mode and Effect Analysis

Table 2: 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	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		SR1,SR2, FR9	H1-1
		Battery supplies incorrect power	Devices may lose some functionality or may work incorrectly. The internal components may get damaged.	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 low battery.			H1-2
		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.			H1-3
Microphone	Sound detection	Sound is not detected	Device is not able to perform the primary function	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			H2-1
		Sound is falsely detected	Device functions incorrectly	1.Loose connections 2.Microphone is damaged	Refer to H2-1 b.			H2-2
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.			H3-1
		Invalid message	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 foreign/ undefined messages			H3-2
Vibration Motor	Provide haptic notification to user	Vibrations not noticeable by user	User does not get alerted	not enough power supplied	User can calibrate the intensity of the motor.			H4-1
		Motor does not vibrate	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.			H4-2
		Incorrect vibration	User incorrectly identifies the sound	defective vibration motor	User can calibrate the vibration intensity and check the output			H4-3
		Vibration too intense	Painful or annoying to the user	Motor drawing excess current	1.Refer to H4-3. 2.Hardware connection is current limited.			H4-4

Table 3: 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			S1-1
		Sound is not classified	No notification for detected sound	Error/bug with signal processing code	Refer to S1-1 a			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 connections	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 releases of the OS.			S2-1
		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.			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.			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
SIR2. Auto shut-off when water penetration detected

6.2 Access Requirements

ACR1. Authorized users can access preferred vibration/sensitivity settings through application site.
ACR2. Authorized users can retrain the watch through watch interface.

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
IR4. No pairs of modes allowed identical settings
IR5. Stored data overridden only at synchronization request

6.4 Privacy Requirements

PPR1. Personalized access code will be created for user application accessibility
PRR2. Data is not transferable between accounts
PRR3. Watch interface locked if user application connection not established

7 Roadmap

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