

# System Design for SE 4G06, TRON 4TB6

Team 26, STRONE

Jordan Bierbrier

Azriel Gingoyon

Taranjit Lotey

Udeep Shah

Abraham Taha

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## Revision History

Date	Version	Notes
Date 1	1.0	Notes
Date 2	1.1	Notes

# Reference Material

This section records information for easy reference.

## Abbreviations and Acronyms

symbol	description
SE 4G06, TRON 4TB6 <a href="#">[... —SS]</a>	Explanation of program name <a href="#">[... —SS]</a>

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# 1 Introduction

Synesthesia Wear is a wearable product that assists users with certain vocal tasks that need attention. These tasks can be generic or custom to the user as needed. Furthermore, the product will use signal processing to gather and analyze information to determine the best and most appropriate feedback (via vibrations) to send to the user. As a result, this gives the users peace of mind knowing that if their attention is needed (doorbell, ring, name call, etc.), Synesthesia Wear will be able to alert them.

## 2 Purpose

The purpose of this document is to be able to identify and elaborate on all aspects of design involved in the creation of the Synesthesia Wear system. This involves decomposing the system into different categories and components that all have an impact on the system's overall design and functionality.

To add on, this document is intended to be viewed in conjunction with the [MG.pdf](#) (Software Architecture Design) and the [MIS.pdf](#) (Detailed Design) documents so that readers may have a full comprehension on the many aspects of Synesthesia Wear's design in its entirety.

## 3 Scope

### 3.1 Document Scope

As stated before, this document will split up the system design into different categories and components such that the readers may be able to better understand each components impact on the system's functionality/completeness.

With the above in mind, the scope of this document will involve:

- **Project Overview:** This section goes over the system's behaviour, undesired event handling, system components, and requirement-design connections.
- **System Variables:** As its name suggests, this section goes over variables/aspects to the system that has the potential to change.
- **User Interfaces:** This section involves elaborating on the interfaces that users interact with when using the Synesthesia Wear system.
- **Design of Mechanical Hardware:** In this section, details on what will be built, fabrication, materials, and drawings/sketches for mechanical components will be discussed in further detail.

- **Design of Electrical Components:** Similar to design of hardware, this section will instead involve details regarding electrical components.
- **Design of Communication Protocols:** For this section, details on the communication protocols used in the Synesthesia Wear system will be discussed.
- **Timeline:** This section will go over the schedules of all remaining tasks for Rev 0 and which team member will be responsible for each task's completion.

## 3.2 Assumptions

The system is designed with the following assumptions:

A1	Each user has a device and WIFI capable of installing the Synesthesia Wear application.
Rationale	Without a device and/or internet connection, the user will be unable to benefit from using Synesthesia Wear.

A2	The users set their sound configurations to realistic daily-life sounds.
Rationale	The system would be inaccurate when trying to process imaginary or rare sounds with a lack of audio samples (like a meteor crash).

The following are in reference to the critical assumptions in Synesthesia Wear's [\*HazardAnalysis.pdf\*](#) document:

A3	The battery will not need to be replaced during product lifespan.
Rationale	It is undesirable and annoying for users if they had to replace the battery frequently during use.

A4	The microphone is not blocked and has realistic access to the environment.
Rationale	If the microphone is intentionally blocked or put into an environment that hinders its detection (anechoic chamber), it is unreasonable to expect accurate results.

### 3.3 System Context



Figure 1: System Context Diagram

## 4 Project Overview

### 4.1 Normal Behaviour

When starting off, the users should strap the Synesthesia Wear bracelet onto either of their wrists as it was intended. Afterwards, users would have to install the Synesthesia Wear app onto a device of their choice and possibly look through the app to get more familiar with its features and user interface. When ready, the user would then input their desired sound configuration settings into the app and then save them so that the app can send these settings over to the bracelet for configurations. Once received, the bracelet can then start to detect for sounds where its built-in microcontroller will process these sounds and try to match it with the sounds configured in the settings. Lastly, once a detected sound has “accurately” (according to Machine Learning Algorithm) matched a configured sound, a vibration alert signal will be sent to the built-in vibration motor which will notify the user that their attention is needed.

### 4.2 Undesired Event Handling

Currently, there are only a few undesired events that can be identified. However, as time progresses, more undesired events will be recognized and dealt with appropriately. So for now, any undesired events not yet discovered will be resolved by setting the Synesthesia Wear system into a dormant state and alerting the user. This makes it so that potential system issues are prevented while also keeping the user informed that the system is in a dormant state and needs a reset for continued use.

With the above in mind, an undesired event that has been identified is in regards to the bracelet trying to detect/process sounds before sound configuration settings have been set.



To deal with this, similar to unidentified events, the Synesthesia Wear system will be created such that it is in a dormant/inactive state until sound configuration settings have been inputted. However, one exception would be that there is no need to alert the user for a reset since they have just started using Synesthesia Wear in its refreshed/new state.

Another undesired event would be in regards to the components breaking or malfunctioning. In these cases, the system will be made such that it tests connections/signals between components (like microcontroller, application, etc.) and alerts the user when a connection test has consistently failed. Afterwards, the user would need to contact the Synesthesia Wear team and they would then try to fix the components or order new parts to replace the broken ones.

A third undesired event would be in regards to intentionally covering/hindering the bracelet to detect sounds via holding the bracelet or going into an anechoic (soundless) chamber. In this situation, the microphone in the bracelet will be unable to accurately detect sounds in the environment while its functionality is obstructed. With this in mind, it is believed that there is not really any resolution needed for this situation considering once the user reenters a “normal” or unhindered environment, so long as the components are undamaged, the system’s functionality should still work as intended.

### 4.3 Component Diagram

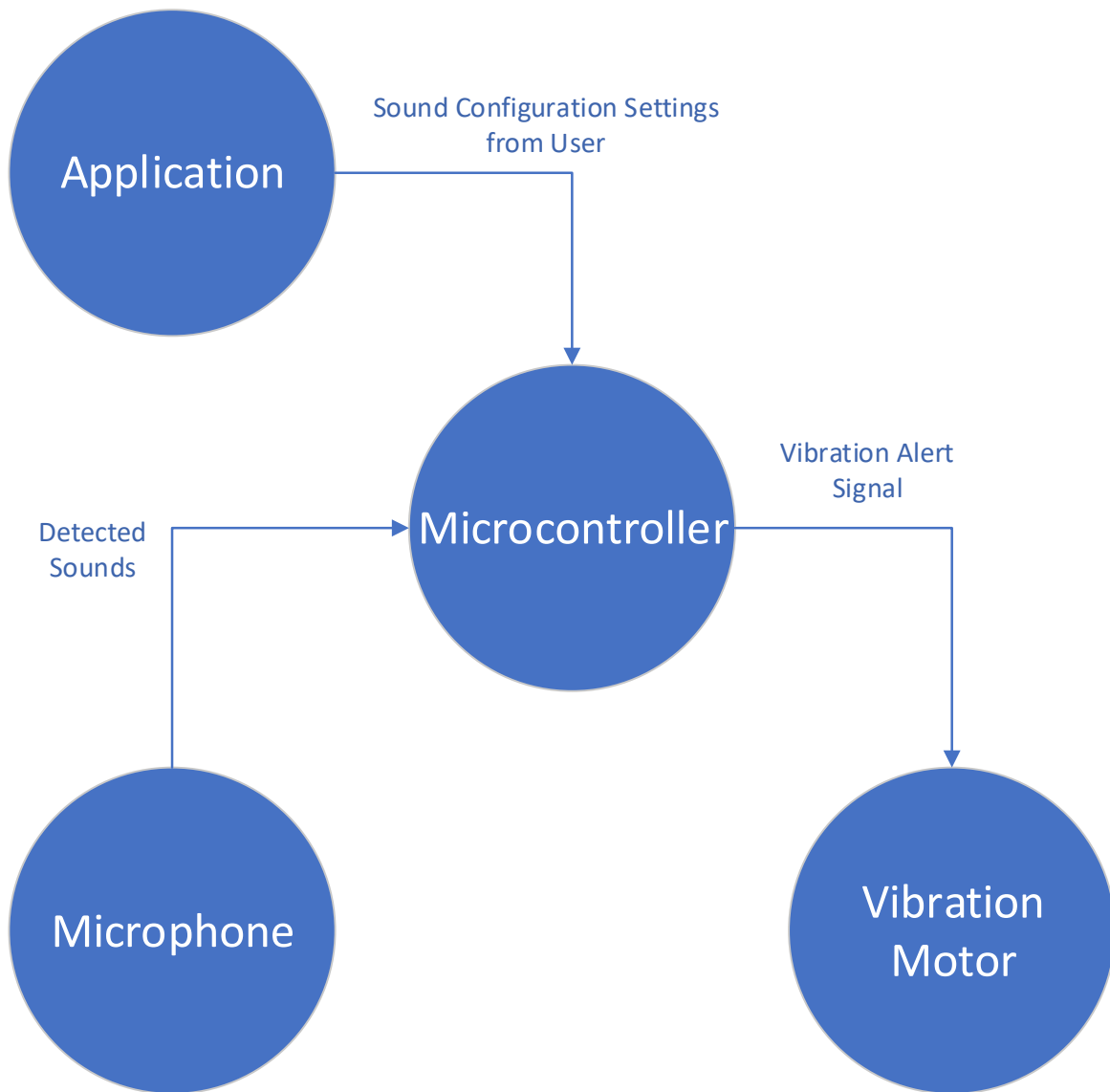


Figure 2: Component Diagram

### 4.4 Connection Between Requirements and Design

The following requirements were taken from Synesthesia Wear's [SRS.pdf](#) document:

Table 1: Requirements and Design Connections Table

Requirements	Design Decision
Capability to pick up sounds.	Need to purchase and integrate a microphone.
Capability to classify different sounds.	Need to purchase and integrate a programmable microcontroller that can run machine learning classification algorithms.
Ability to set/change sound classifications.	Need to create an application that allows users to change classification settings.
Ability to effectively give the user feedback on a sound classification match.	Need to purchase and integrate a vibration motor into the Synesthesia Wear bracelet.
Battery of the device should be shielded to prevent any direct contact with the user.	Need to design/build/purchase a case around the bracelet where the battery will be stored to prevent damage and any contact between user and battery.
The product dimensions should allow fitment on wrist of the user.	Need to purchase and integrate a microcontroller with built-in modules (bluetooth, microphone, etc.) to reduce product dimensions as much as possible.

## 5 System Variables

[Include this section for Mechatronics projects —SS]

### 5.1 Monitored Variables

### 5.2 Controlled Variables

### 5.3 Constants Variables

## 6 User Interfaces

[Design of user interface for software and hardware. Attach an appendix if needed. Drawings, Sketches, Figma —SS]

## 7 Design of Mechanical Hardware

[Most relevant for mechatronics projects —SS] [Show what will be acquired —SS] [Show what will be built, with detail on fabrication and materials —SS] [Include appendices as appropriate, possibly with sketches, drawings, CAD, etc —SS]

## 8 Design of Electrical Components

Table 2: Electrical Components List

Component	Amount	Cost (in CAD\$)	Dimensions	Link
Arduino Nano 33 BLE	2	80	48 * 18	<a href="https://www.amazon.ca/Arduino-Nano-33-BLE-Sense/dp/B07WV5GF17">https://www.amazon.ca/Arduino-Nano-33-BLE-Sense/dp/B07WV5GF17</a>
Lithium-Ion Polymer (LiPo) Battery (3.7V 1000mAh)	1	10	50*32*5	<a href="https://www.canadarobotix.com/products/588">https://www.canadarobotix.com/products/588</a>
0.1 microfarad capacitor	2	1.11	5*3	<a href="https://rb.gy/vyewya">https://rb.gy/vyewya</a>
resistor 1000 ohm	1	NA	5*3	At home
resistor 20 ohm	1	NA	5*3	At home
vibration motor	5	10	10*2	<a href="https://www.amazon.ca/dp/B089NTLLWB?ref_=cm_sw_r_apin_dp_YEQ7CS0SNQV7HKHZVFD">https://www.amazon.ca/dp/B089NTLLWB?ref_=cm_sw_r_apin_dp_YEQ7CS0SNQV7HKHZVFD</a>
Transistor NPN - PN2222	1	NA	5*3	At home
Diode - IN4007	1	NA	5*3	At home
Power Management module	2	17.5	35*22	<a href="https://www.digikey.com/en/products/detail/sparkfun-electronics/PRT-14411/1568-1723-ND/7725301">https://www.digikey.com/en/products/detail/sparkfun-electronics/PRT-14411/1568-1723-ND/7725301</a>

[Most relevant for mechatronics projects —SS] [Show what will be acquired —SS] [Show what will be built, with detail on fabrication and materials —SS] [Include appendices as appropriate, possibly with sketches, drawings, circuit diagrams, etc —SS]

## 9 Design of Communication Protocols

In regards to communication protocols, the only relevant aspect of Synesthesia Wear would revolve around the bluetooth functionality of the system. As stated in Table 1, the micro-controller used for Synesthesia Wear has a built-in bluetooth module that was purchased for the purposes of reducing product dimensions as much as possible. With this in mind, the system was set up so that this same bluetooth module would be able to connect to the Synesthesia Wear application on the user's device and thus be able to communicate between each other.

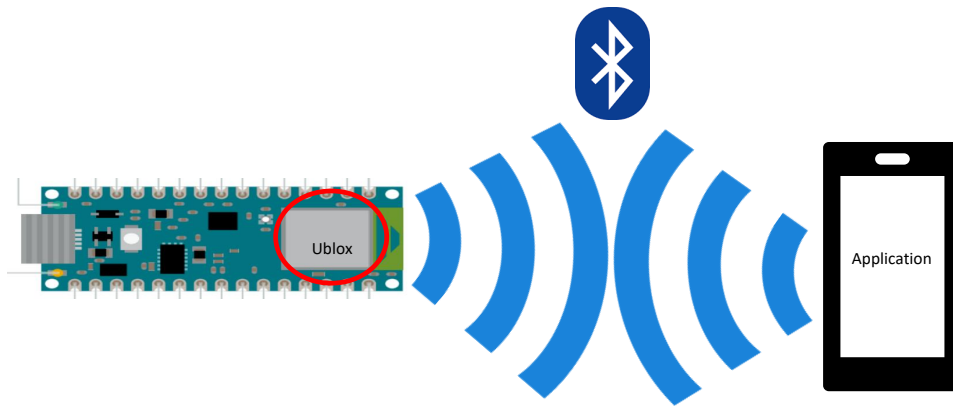


Figure 3: Bluetooth Connection between device and microcontroller

## 10 Timeline

[Schedule of tasks and who is responsible —SS]

# Appendices

## A Interface

[Include additional information related to the appearance of, and interaction with, the user interface —SS]

## B Mechanical Hardware

## C Electrical Components

## D Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Problem Analysis and Design. Please answer the following questions:

1. What are the limitations of your solution? Put another way, given unlimited resources, what could you do to make the project better? (LO\_ProbSolutions)
2. Give a brief overview of other design solutions you considered. What are the benefits and tradeoffs of those other designs compared with the chosen design? From all the potential options, why did you select documented design? (LO\_Explores)