بسم الله الرحمن الرحيم

Palestine Polytechnic University

College of Information Technology and Computer Engineering

Computer Systems Engineering

Smart Glasses to Minimize Phone Distractions while Driving

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Abstract

Mobile phone usage while driving remains a common issue, despite ongoing awareness efforts and legal measures. This behavior poses significant safety risks on the road, prompting extensive research into effective strategies for addressing this concern.

This project aims to find an innovative solution to the problem of vehicle accidents resulting from drivers using their phones while driving. The proposed solution aims to create an electronic system that is connected to any eyewear, transforming it into smart glasses. The goal is to reduce accidents by enhancing situational awareness and providing real-time information to users. The smart glasses will be connected to the phone via Bluetooth, receiving notifications displaying time, date, caller ID, and SMS messages. It also enables the driver to respond to messages by converting their voice into written text and sending it.

Keywords: Smart glasses, Distracted driving, Mobile application, Caller ID, SMS messages.

الملخص

استخدام الهواتف المحمولة أثناء القيادة يظل مشكلة شائعة، على الرغم من الجهود المستمرة للتوعية والتدابير القانونية. هذا السلوك يشكل مخاطر كبيرة على الطريق، مما دفع إلى إجراء بحوث واسعة لاستكشاف استراتيجيات فعالة لمعالجة هذا القلق.

يهدف هذا المشروع إلى إيجاد حل للتخفيف من حوادث السير الناجمة عن استخدام السائقين لهواتفهم أثناء القيادة. تهدف الحلول المقترحة إلى إنشاء نظام إلكتروني يتصل بأي نظارة لتحويلها إلى نظارة ذكية. الهدف هو تقليل الحوادث عن طريق تعزيز الوعي بالبيئة المحيطة وتوفير معلومات فورية للمستخدمين. ستكون النظارة الذكية متصلة بالهاتف عبر تقنية البلوتوث، حيث يتم استقبال الإشعارات التي تعرض الوقت والتاريخ وهوية المتصل ورسائل SMS . كما تتيح للسائق الرد على الرسائل من خلال تحويل صوته إلى نص مكتوب وإرساله.

الكلمات المفتاحية: نظارة ذكية، التشتت في السياق، تطبيق الهاتف المحمول، هوية المتصل، الرسائل القصيرة.

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List of Acronyms

AI	Artificial Intelligence
AR	Augmented Reality
BLE	Bluetooth Low Energy
CATIA	Computer Aided Three-Dimensional Interactive Application
CNN	Convolutional Neural Network
GHz	Gigahertz
GND	Ground
GPIO	General Purpose Input/Output
HC	Host Controller
ID	Identification
INMP441	InvenSense Microphone Part 441
IOS	IPhone Operating System
LCD	Liquid Crystal Display
Mah	Milliampere-hour
MFCCs	Mel-Frequency Cepstral Coefficients
MIT	Massachusetts Institute of Technology.
ML	Machine Learning
OLED	Organic Light-Emitting Diode
PANs	Personal Area Networks
SCK	Serial Clock
SCL	Serial Clock

SD	Secure Digital
SDA	Serial Data
SDK	Software Development Kit
SMS	Short Message Service
UI	User Interface
UUID	Universally Unique Identifier
WS	Wall Socket
3D	Three-Dimensional

Chapter One

Introduction

Chapter One: Introduction

1.1 Preface

This chapter provides a comprehensive overview of the project, including its aims, objectives, problem statement, significance, requirements, system components, limitations, expected output, project schedule, and report outline. The chapter emphasizes the critical need for addressing the issue of mobile phone usage while driving to enhance road safety. It introduces the proposed solution of utilizing smart glasses to display essential information without the need for drivers to handle their phones, thereby reducing distractions and minimizing the risk of accidents. Additionally, the chapter outlines the functional and non-functional requirements of the smart glasses system, details its hardware components, and highlights the project's schedule and report structure.

1.2 Project Aims and Objectives

This project aims to reduce traffic accidents resulted from using mobile phone while driving by the development of a device designed to be mounted on the driver's eyewear you can see this in the Figure 1.1. This device is connected to the phone via Bluetooth, displaying time, date, SMS messages, and call information on the screen. The information is then reflected onto a reflector in front of the eyewear lens, enabling the driver to receive notifications without resorting to phone usage during driving. Furthermore, drivers can respond to calls by converting their spoken words into written text.

Figure 1.1: Smart Glasses

1.3 Problem Statement

This section provides an in-depth exploration of the problem at hand, encompassing its definition, significance, and the driving motivation behind its resolution.

1.3.1 Problem Definition

In order to increase safety for drivers and vehicle passengers, drivers should not use mobile phones while driving their vehicles.
Drivers use mobile phones several times while driving their vehicles for several reasons, and it may lead to accidents.

According to the study published in the 'New England Journal of Medicine' on Thursday, drivers' attention is diverted from the road for up to 10% of the time they spend behind the wheel. The majority of this distraction is attributed to mobile phone usage, leading to a significant increase in accident rates. [1]

According to a security source who spoke to Al-Ghad newspaper in Amman, more than 60% of traffic accidents are caused by distraction due to using mobile phones while driving. Some of these accidents are devastating and result in deaths or serious injuries.[2]

It can be noted that in many countries, strict penalties for using mobile phones while driving are implemented. While these measures have reduced accidents, they have not completely solved the problem.

To address this issue, we suggest drivers use smart glasses. These glasses will show them the time, caller ID, and text messages, so they won't need to hold their phones while driving. This way, we aim to make driving safer and reduce accidents resulted from using mobile phone while driving on the road.

1.3.2 Problem Significance and Motivation

The project aims to address the profound impact of mobile phone use on road safety. It is essential to recognize that the risks posed by using a mobile phone while driving can be compared to driving under the influence of alcohol or drugs.

The alarming fact is that this behavior significantly increases the likelihood of accidents resulted from using mobile phone while driving, endangering the lives of drivers, pedestrians, and other road users.

This project aims to design a practical and easy-to-use solution to reduce the alarming rate of road accidents resulted from using mobile phone while driving. As shown in Figure 1.2 below. By utilizing advanced smart technology, we seek to empower drivers to make safer choices while driving and mitigate the risks associated with mobile phone distractions. Through this project, we aspire to promote a safer and more responsible driving culture, ultimately saving lives and protecting communities from the severe impacts of road accidents resulted from using mobile phone while driving.

Figure 1.2: A Driver Uses Mobile Phone While Driving [3]

1.4 Project Requirements

The system requirements are summarized as:

1.4.1 Functional Requirements

Smart glasses play a crucial role in ensuring that they can effectively reduce accidents resulted from using mobile phone while driving.
The following is a list of functional requirements:

1. It can be paired to any android smart phone via Bluetooth connection.
2. It is able to receive notification messages from smart phones.
3. Displays messages from mobile phone using small display unit attached to the glasses.
4. Shows incoming calls information.
5. Shows Date and Time with display.
6. It can answer calls without using the mobile phone, reply to incoming calls by voice, and convert the voice into a written SMS message

1.4.2 Non-Functional Requirements:

In addition to the critical functional requirements that empower smart glasses to enhance safety on the road, there are equally important non-functional requirements that contribute to their overall effectiveness:

- **Usability:** The glasses are small in size and lightweight.
- **Portability:** The electronic part can be taken off or added to both regular eyeglasses and sunglasses.
- **Maintainability**: Due to its few components and simple assembly, it is easy to maintain.
- **Security:** The glasses maintain privacy and the data transferred from the phone to the glasses via Bluetooth is not breached.

1.5 System Components

This section shows the hardware used in creating the smart glasses.

1.5.1 Hardware Components:

1. OLED Display.
2. Controller.
3. Microphone.
4. Mirror Glass.
5. Focal Lens.
6. Reflector.
7. Battery.

1.6 Project Limitations/Constraints

One of the necessary requirements is the availability of a suitable operating system to connect the glasses to.

One of the constraints is that you must use the glasses while driving because the device is attached to the glasses.

1.7 Project Expected Output

In this project, we aim to develop smart glasses capable of receiving and displaying essential information such as the time, date, incoming SMS messages, and calls from the paired smartphone. These smart glasses will project this information onto a reflector positioned in front of the wearer's eyes, enabling drivers to access it without the need to physically handle their phones. Moreover, users will have the ability to respond to incoming calls using voice commands. The smart glasses will convert the spoken response into a SMS message and send it back to the sender, facilitating seamless communication while maintaining focus on the road.

1.8 Project Schedule

A project timeline is a representation of the tasks accomplished over weeks. It involves the identification and organization of various tasks and activities over time, highlighting the tasks completed during each specific week or designated time period. table 1.1 show the project schedule.

Time (each cell represents 2 weeks)														
Tasks	**First Semester**							**Second Semester**						
Planning														
Project requirement														
Analysing and design														
Project development														
Project test and maintenance														
Documentation														

Table 1.1: Project Schedule

1.9 Report Outline

The rest of the report is organized as follows: chapter 2 presents a theoretical background of the project. chapter 3 introduces the system design, chapter 4 explains implementation of the system, In chapter 5 testing and result and chapter 6 for conclusion and future work.

Chapter Two

Background

Chapter Two: Background

2.1 Preface

This chapter provides a theoretical background and literature review for the project and provides information on the methodology and machine learning models that will be used to help in reducing the accident. Overall, it aims to provide the necessary background information to understand the system and its functioning.

2.2 Theoretical Background

This section explores the fundamental technologies and concepts of Bluetooth technology and voice recognition, used in the design and implementation of smart glasses include various elements.

2.2.1 Bluetooth Technology

Bluetooth technology is a wireless communication standard used for exchanging data between devices over short distances using short-range radio frequencies, ranging from 2.4 to 2.485 GHz. Bluetooth was developed to provide a low-power, cost-effective means of creating secure wireless connections between devices such as smartphones, tablets, computers, printers, headphones, and more. The technology relies on creating Personal Area Networks (PANs) known as "piconets," allowing multiple devices to connect to each other simultaneously. Bluetooth includes various versions, such as Bluetooth Classic and Bluetooth Low Energy (BLE), each designed for specific purposes, making Bluetooth a versatile technology adaptable to a wide range of everyday and industrial applications. [4]

2.2.2 Machine learning

Machine Learning is a branch of Artificial Intelligence (AI) that focuses on developing algorithms and models enabling computers to learn from data and improve their performance over time without the need for explicit programming for each task. Machine Learning relies on techniques such as neural networks, random forests, and deep learning, and it is applied in a wide range of fields such as speech and image recognition, text prediction, big data analysis, and recommendation systems. Machine Learning is considered one of the key tools driving the current digital revolution, as it helps automate processes, improve decision accuracy, and deliver personalized user experiences in various applications. [5]

2.2.3 Voice Recognition

The technology of converting speech to text in smart glasses is an exciting field with numerous promising applications. It allows users to speak and transform their words into written text, enabling them to send messages without using their hands. The technology employs a variety of techniques, including:

1. Speech Recognition: This type of technology recognizes spoken words and translates them into written text.
2. Audio Analysis: This technology divides the audio into smaller parts and searches for patterns that correspond to words.
3. Machine Learning: This type of technology uses artificial intelligence to learn patterns in the sound and enhance the accuracy of the conversion. [6]

2.2.4 Mel Frequency Cepstral Coefficient (MFCC).

The first step in any automatic speech recognition system is to extract features i.e. identify the components of the audio signal that are good for identifying the linguistic content and discarding all the other stuff which carries information like background noise, emotion etc.

The main point to understand about speech is that the sounds generated by a human are filtered by the shape of the vocal tract including tongue, teeth etc. This shape determines what sound comes out. If we can determine the shape accurately, this should give us an accurate representation of the phoneme being produced. The shape of the vocal tract manifests itself in the envelope of the short time power spectrum, and the job of MFCCs is to accurately represent this envelope. [7]

2.3 Literature Review

Smart glasses are designed to seamlessly integrate technology into daily life. They provide a unique experience for displaying information such as messages and calls without the need for a smartphone. In this section, we will discuss some projects similar to the idea of our project.

2.3.1 Focals by North Smart Glasses 2020

Involves smart glasses that provide a fun and convenient way to access your digital life. They offer a direct display of notifications and access to calendar, tasks, and presentation controls directly from your smartphone. Notifications are displayed discreetly, visible only to the user. However, despite their multiple functionalities, these glasses have some drawbacks. They can be heavy and uncomfortable to wear for long periods, and their high prices may raise concerns among potential buyers.[8]

2.3.2 Razer Anzu Smart Glasses

Involves smart glasses It offers an attractive design that combines exciting audio and theoretical functions, making it an important choice for those who want to experiment. The device features a good microphone that provides excellent performance for recording voice and calls clearly. However, it suffers from poor sound quality, especially on low voices, which may negatively affect the listening experience. The lack of sound isolation means that noise may get in the way of fully concentrating on the music content.[9]

2.3.3 Meta Smart Glasses

Smart Glasses offers a sophisticated user experience that combines elegance with the technology. They provide advanced features such as improved photo and video quality and excellent performance in voice calls, enhancing communication and overall viewing experience. However, there are still some shortcomings, such as the lack of advanced AI functions and issues with the speed of certain features like the voice assistant.[10]

	Focals by North Smart Glasses 2020	Razer Anzu Smart Glasses	Meta Smart Glasses	Our project.
Design	Electronic parts inside the glasses frame.	Electronic parts inside the glasses frame.	Electronic parts inside the glasses frame.	An electronic component is installed on the glasses frame.
Methodology	Used as regular smart glasses only.	Used as regular smart glasses and sunglasses only.	Used as regular smart glasses and sunglasses only.	Use with any type of glasses.
Connection to phone	Via Bluetooth	Via Bluetooth	not connect to the phone	Via Bluetooth

Table 2.1: Literature Review.

2.4 Summary

This chapter discussed the theoretical background that underpins the development of smart glasses additionally; the chapter explores various theories and literature relevant to the development of the smart glasses, such as Bluetooth technology, Machine learning, voice recognition and Mel Frequency Cepstral Coefficient. By providing a comprehensive overview of the theoretical background, this chapter lays the foundation for the practical implementation of smart glasses in the subsequent chapters.

Chapter Three

System Design

Chapter Three: System Design

3.1 Preface

This chapter will cover the overall design of the glasses and the integration of its components, showing the block diagram and schematic diagram, as well as details about the algorithms used.

The chart shows the feedback from a survey we gave different groups and drivers. Most people think the suggested idea would help decrease accidents resulted from using mobile phone while driving and reduce distractions.

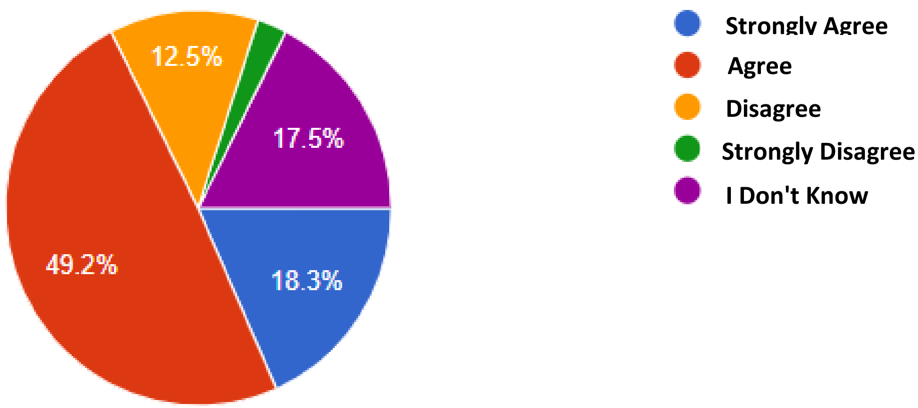


Figure 3.1: Survey Feedback Chart

Indicates through this study [11], it works towards reducing road distractions by utilizing features such as Augmented Reality, hands-free operation, and voice commands provided by smart glasses.

3.2 Design Options

In this section, we will discuss some alternatives to smart glasses for monitoring time, date, and notifications, and we will provide a general overview of the system by including it within the three levels of input, output, and control unit. As for alternatives to smart glasses, we have two options:

First: Earphones

Many drivers use earphones, such as AirPods, to listen to music or respond to important calls, unaware that wearing them while driving is extremely dangerous. This increases the risk of road accidents because earphones block external noises, making it difficult for the driver to hear surrounding sounds, such as warnings from other cars, pedestrians, or cyclists. Earphones can also distract the driver due to the high-volume level, leading to a loss of focus on the road.

Second: In-car Display Screen

This screen displays the time, date, incoming call notifications, and messages, but it also increases the risk of road accidents because the driver is forced to look at it and divert their sight away from the road while driving. As shown in Figure 3.2 below.

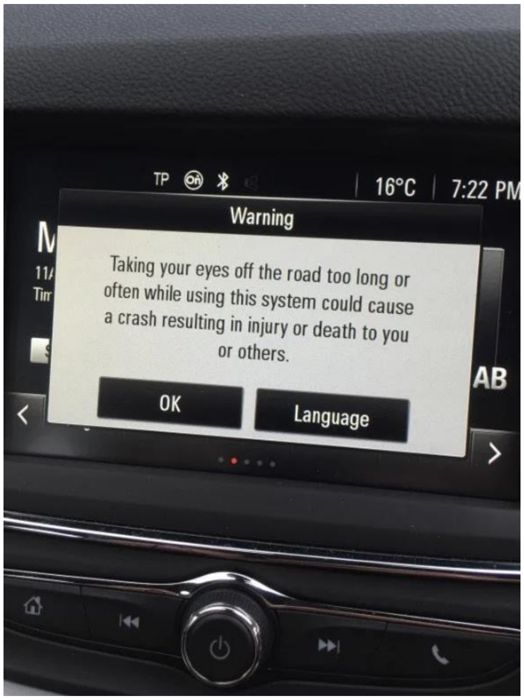


Figure 3.2: Warning Message of In Car Display Screen [12]

We found that smart glasses are the best option. Although not widely adopted yet, they are easy to use, readily available, eliminate the need to carry a smartphone by hand, prevent distraction, and reduce the risk of accidents resulted from using mobile phone while driving for drivers.

As for the system: For inputs, we have a microphone to capture the driver's voice and convert it into written text to be sent to the caller.

As for outputs, we have a display screen to show the time, date, and notifications.

Finally, the controller is a 32 ESP, which is the brain of the system. It processes the input to produce one or more outputs to manage the system. It receives the time, date, and incoming call notifications and messages from the application via Bluetooth. It processes the information and sends it to the OLED display for display. It also receives the driver's voice, processes it, converts it into written text, and sends it out.

Summary Thus, in conclusion of this section, we explained the design scheme in terms of inputs, outputs, and the control unit. The project aims to eliminate the need to carry a distracting phone while driving and to know the time, date, incoming call notifications, and messages, thereby reducing the occurrence of accidents resulted from using mobile phone while driving.

3.3 Hardware Components:

In this section, we provide clarity on the hardware components used in the project and give our reasoning for selecting them. We also present a detailed comparison with other components.

3.3.1 Display Device

The differences between OLED and LCD displays are highlighted in table 3.1.

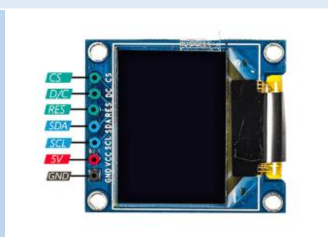
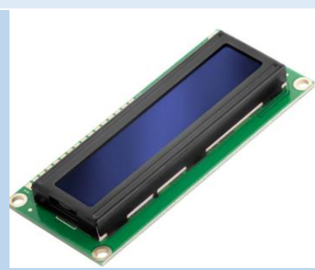
Feature	OLED Displays	LCD Displays
Colours	More vibrant colors	Colors may be less vibrant
Blacks	Deeper blacks	Blacks may appear less deep
Thickness & Weight	Thinner and lighter	Slightly thicker and heavier
Cost	~12$	~22$
Image	 Figure 3.3: 0.95 Inch OLED Display [13]	 Figure 3.4: LCD Display [14]

Table 3.1: OLED Display vs LCD Display [15]

We chose OLED screen because they offer excellent image quality with high brightness, good contrast, and wide viewing angles. OLED is the optimal choice to ensure an exceptional visual experience.

3.3.2 Battery

The battery supplies the smart glasses with energy to operate the controller and OLED display.

This table illustrates the differences between Lipo and Li ion Battery

Feature	Lipo Battery	Li ion Battery
Impedance	<50m Ω	<100m Ω
Temp range, usage	-20to60 °C	-20to60 °C
weight	10 g	12g
Image	 Figure 3.5: Lipo Battery 300mah, 3.7V[16]	 Figure 3.6: Li ion Battery 300mah, 3.7V[117]

Table 3.2: Lipo Battery vs Li ion Battery

We went with the LiPo battery because it has lower impedance (<50mΩ) and is lighter (10g) compared to the Li-ion battery. This makes it more efficient for our needs.

3.3.3 Focal Lens

A Focal lens is added to this system because it has the capability to transmit and reverse what is displayed on the screen. As shown in Figure 3.6 below.

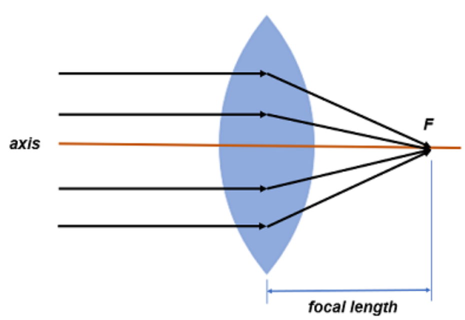


Figure 3.7: Focal Lens [18]

3.3.4 Mirror Glass

Adding a mirror to this system provides a reflection of what appears on the screen as is.

3.3.5 Controller

This table illustrates the differences between ESP32 and Arduino Nano.

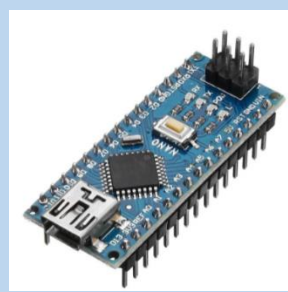
Feature	ESP32	Arduino Nano
Microcontroller	Tensilica Xtensa LX6	Dual-Core Atmega328P
Clock Speed	Up to 240 MHz	16 MHz
Flash Memory	4 MB to 16 MB	32 KB
SRAM	520 KB to 800 KB	2.5 KB
Wi-Fi	Built-in	Requires external module
Bluetooth	Built-in	Requires external module
Analog Pins	12-16	6
Digital Pins	34-42	14
PWM Pins	16	6
Operating Voltage	3.3V	5V
Price Lower	~13$	~15$
Applications	IoT projects, wearables, robotics	Simple Arduino projects, prototyping
Image	 Figure 3.8: ESP32 [19]	 Figure 3.9: Arduino Nano [20]

Table 3.3: ESP32 vs Arduino Nano [21]

ESP32 was chosen for our project as it supports audio, Bluetooth, and Wi-Fi. With ESP32, there is no need for external modules.

3.3.6 Reflector

Using a reflector in smart glasses is beneficial for a few reasons. It helps display digital information directly in the wearer's line of sight, seamlessly integrating it with the real world. This compact design makes the glasses lightweight and comfortable. Reflectors also maintain transparency, allowing users to see both digital content and their surroundings. They can contribute to power efficiency and enhance privacy by making the displayed information less visible to others. Additionally, reflectors improve visibility, making smart glasses more effective in various lighting conditions, including bright outdoor environments.[22]

Figure 3.10: Reflector [22]

3.3.7 Microphone

The microphone captures the driver's voice, and the system processes this audio input, converting it into an SMS message. Subsequently, the converted text can be used to compose responses for calls through the smart glasses.

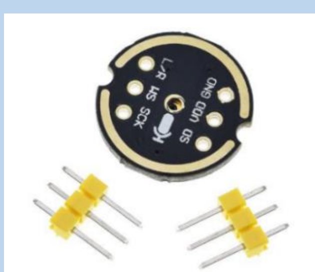
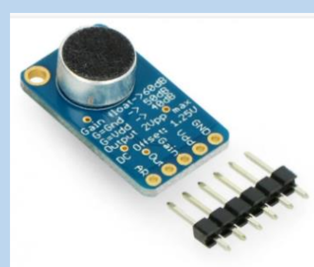
Feature	INMP441	Max9814
Function	Microphone amplifier	Digital microphone
Output format	Analog	Digital
ADC	Requires external ADC	Integrated ADC
Use case	Boosts microphone signal	Direct digital audio input
Image	 Figure 3.11: INMP441 Microphone [23]	 Figure 3.12: MAX9814 Microphone [24]

Table 3.4: INMP441 vs MAX9814

The INMP441 microphone was chosen due to its advanced features such as digital integration technology, which facilitates integration with digital processing systems, and its built-in signal amplification feature, making it the ideal choice for achieving high-quality performance and ease of use.

3.4 Software Options

In this section, we undertook the task of identifying various options for each designed component, encompassing both software and hardware aspects. These options were further elucidated by listing the key features of each option, facilitating a clear distinction between them. Subsequently, decisions were made for each component, and these choices were meticulously justified based on the specific needs and objectives of the project. This meticulous approach ensures that the selected options align seamlessly with the project requirements, thereby contributing to its overall success.

1. **Application For Smart Glasses.**

Choosing to develop a mobile application rather than a web application for our project can be influenced by several factors based on the project's needs and specific goals.

2. **Mobile Application Development Tool**

There are several options for creating a mobile application, including:

A. Java

Java application development has been on the rise for a long time as this versatile and powerful language allows developers to build secure, robust, and feature-rich mobile products. Java is an advanced and highly sought-after technology with significant benefits over other languages and environments. [25]

B. App Inventor

App Inventor is a user-friendly development platform designed for those with minimal programming experience, making it an ideal choice for beginners or individuals new to app development. Developed by MIT, it simplifies the creation of Android applications through a visual, drag-and-drop interface, eliminating the need for extensive coding. App Inventor allows users to design and build functional apps by connecting visual blocks that represent different functionalities. While it may not offer the complexity or flexibility of more advanced frameworks, its simplicity and accessibility make it a great tool for quickly prototyping and developing straightforward mobile applications without a steep learning curve.[26]

Java is chosen for its versatility and efficiency in developing cross-platform mobile applications, for several reasons:

A. Android Application Development:

Java is the main language used in Android application development. Android applications are mainly developed using the Android SDK and Java library to develop user interfaces and application logic. [25]

B. Libraries and Frameworks:

Java has a wide range of libraries and frameworks that facilitate application development, such as the Android SDK and Spring Framework. [25]

C. Clean writing and structure:

Java provides a robust and systematic programming structure, which makes it easier to write clean and structured code in an organized manner, which means developing robust and maintainable applications. [25]

D. Security and Reliability:

Java provides strong security, memory control, and exception management features, making applications developed in it more stable and secure. [25]

E. Compatibility and Support:

Due to Java's popularity and widespread use, there are many resources and support available to developers, including forums, online communities, and official documentation. [25]

3.5 General Block Diagram

The general block diagram of the system is illustrated in figure 3.13 and it show the two subsystems; the smart phone and the smart glasses.

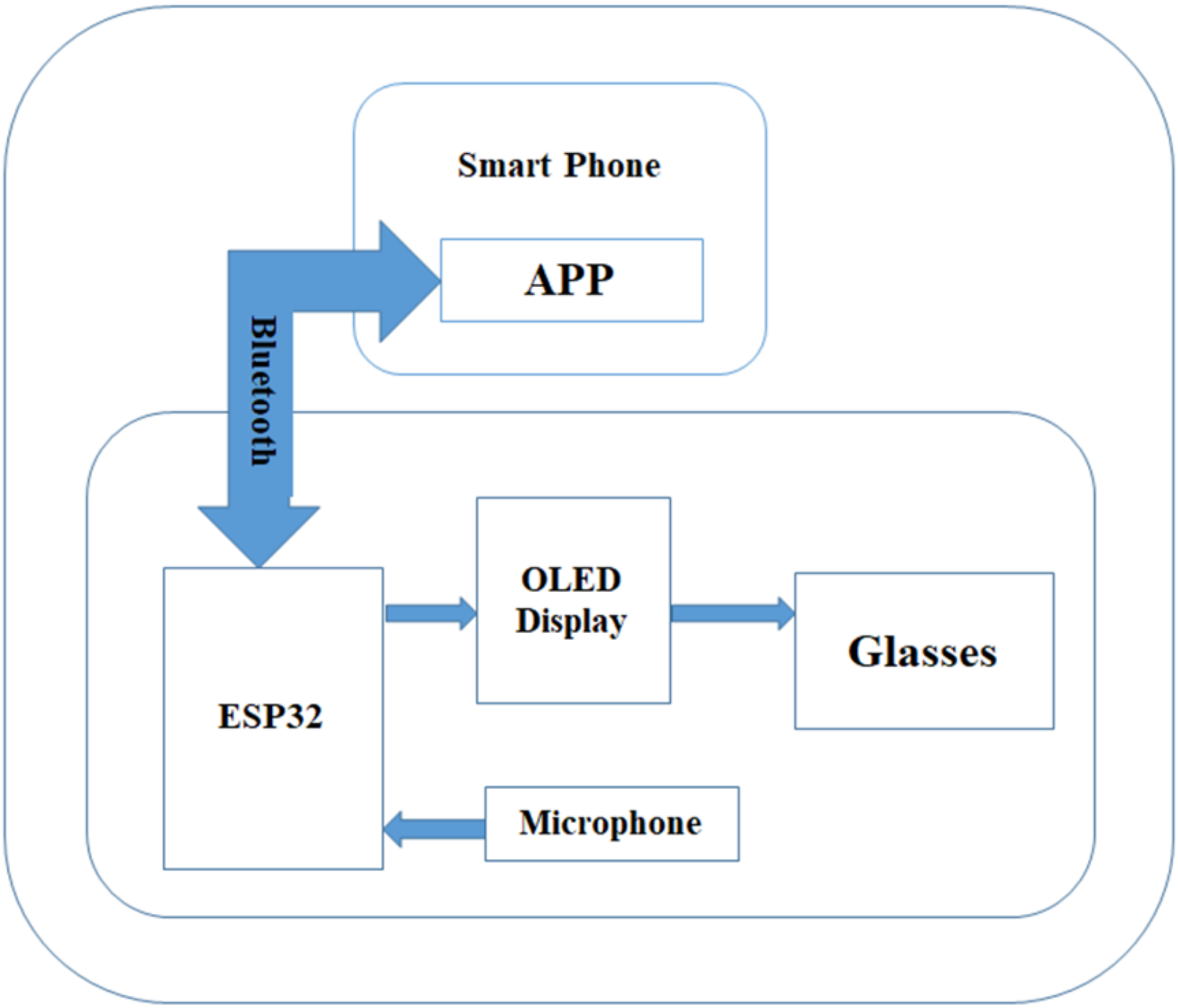


Figure 3.13: Block Diagram

3.5.1 Conceptual System Description

The word spoken by the driver is detected and sent via Bluetooth to the person being called as a message. The time, date, incoming calls, and SMS messages are sent via Bluetooth to the ESP32 to be displayed on the reflector in front of the glass lens, as shown in Figure 3.14.

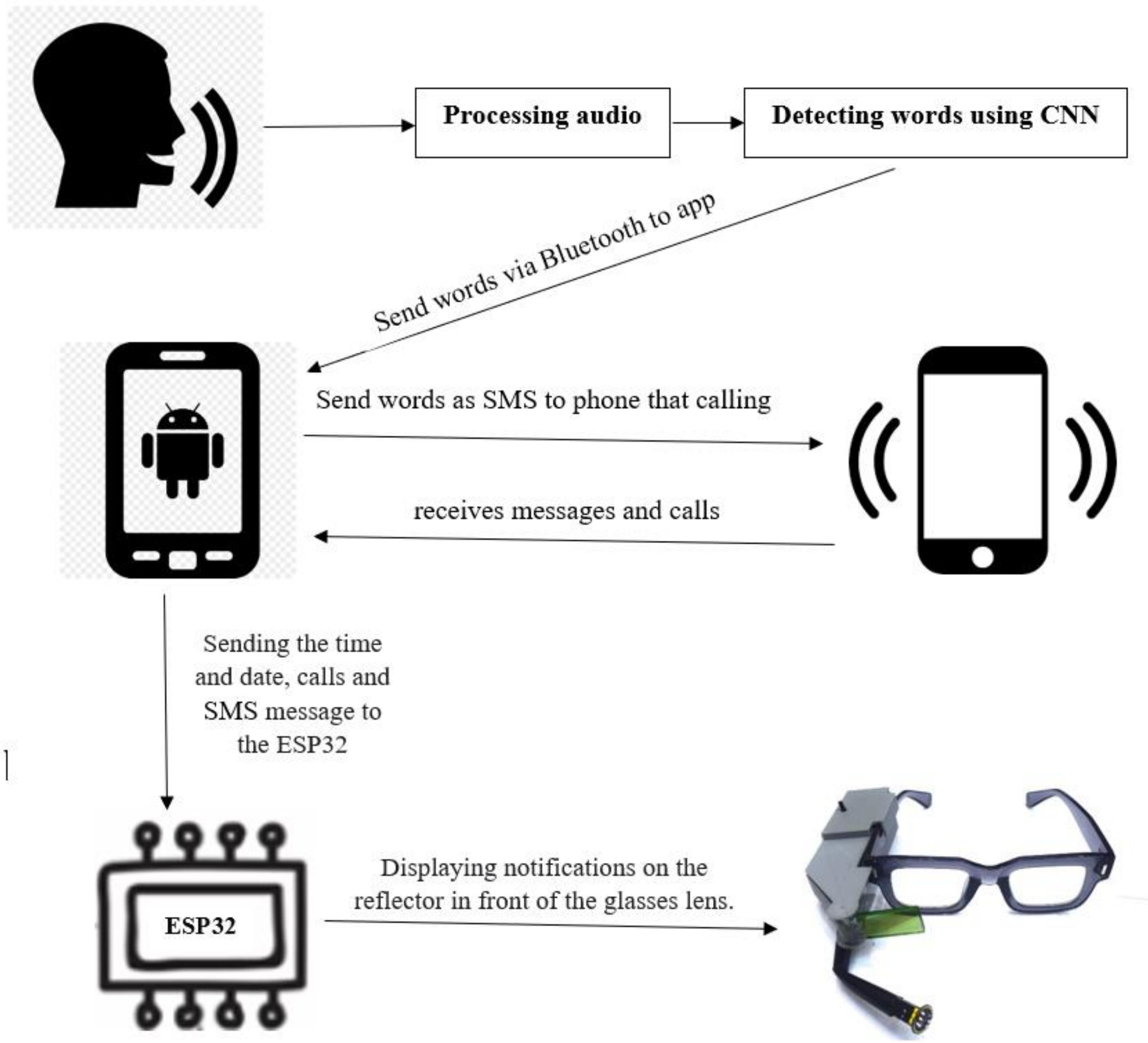


Figure 3.14: Conceptual System Description

This figure 3.15 illustrates the process of data transfer from a mobile application via Bluetooth to an ESP32, then to an OLED display, and from an INMP441 microphone to the ESP32.

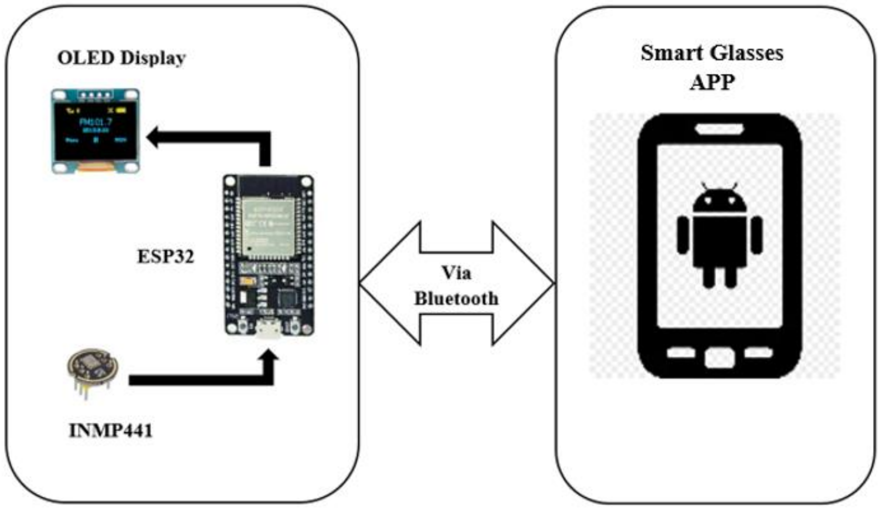


Figure 3.15: Diagram of The System Design

3.6 Pseudo-code

When the ESP32 and the smartphone are connect via Bluetooth, the time, date, calls, and SMS are sent.

```
**Smart Glasses APP**
Initialize Bluetooth connection
Connecting the phone to the ESP32 via Bluetooth
While the program is running do
    Send date and time to esp32
    If there is a call
        Send calling to esp32
    If there is a SMS massage
        Send SMS to esp32
End while
```

The ESP32 receives the time, date, SMS messages, and calls from the smartphone. If the button is pressed once, it starts recording audio. If the button is pressed again, it sends the converted voice to text to the phone via Bluetooth to be sent as a text SMS to the caller.

```
**ESP32**
Initialize Bluetooth connection
Connecting the phone to the ESP32 via Bluetooth
While the program is running do
        Receive date and time
        If there is a call
                Receive calling
        If there is a SMS massage
                Receive SMS
        If the button is pressed
                Input voice from user
                Process the input and recognize the command
                Convert the recognized command to a text
                Send the text as SMS to the person last called.
End while
```

3.7 Schematic diagram

The schematic diagram of the system is illustrated in Figure 3.12 schematic of the cart system in this project, outlining the diverse hardware components and their interconnections.

The connections are as follows: GND connects all component grounds together, and VCC provides 3.3V power to the microphone, LiPo battery, and OLED. The SCL pin is connected to pin 21 (SCL) on the ESP32 board, the SDA pin is connected to pin 22 (SDA), the SCK pin is connected to pin 26 (SCK), the SD pin is connected to pin 33 (SD), and the WS pin is connected to pin 32 (WS). The L/R pin is connected to ground, and the button's pin is connected to pin 15 (GPIO15) on the ESP32 board.

Circuit Function: This circuit sends the time, date, calls, and SMS to be displayed on an OLED display. If the driveres want to respond to an incoming call, they can press the button twice to record their voice, convert it to text, and then send it to the phone to be sent as an SMS

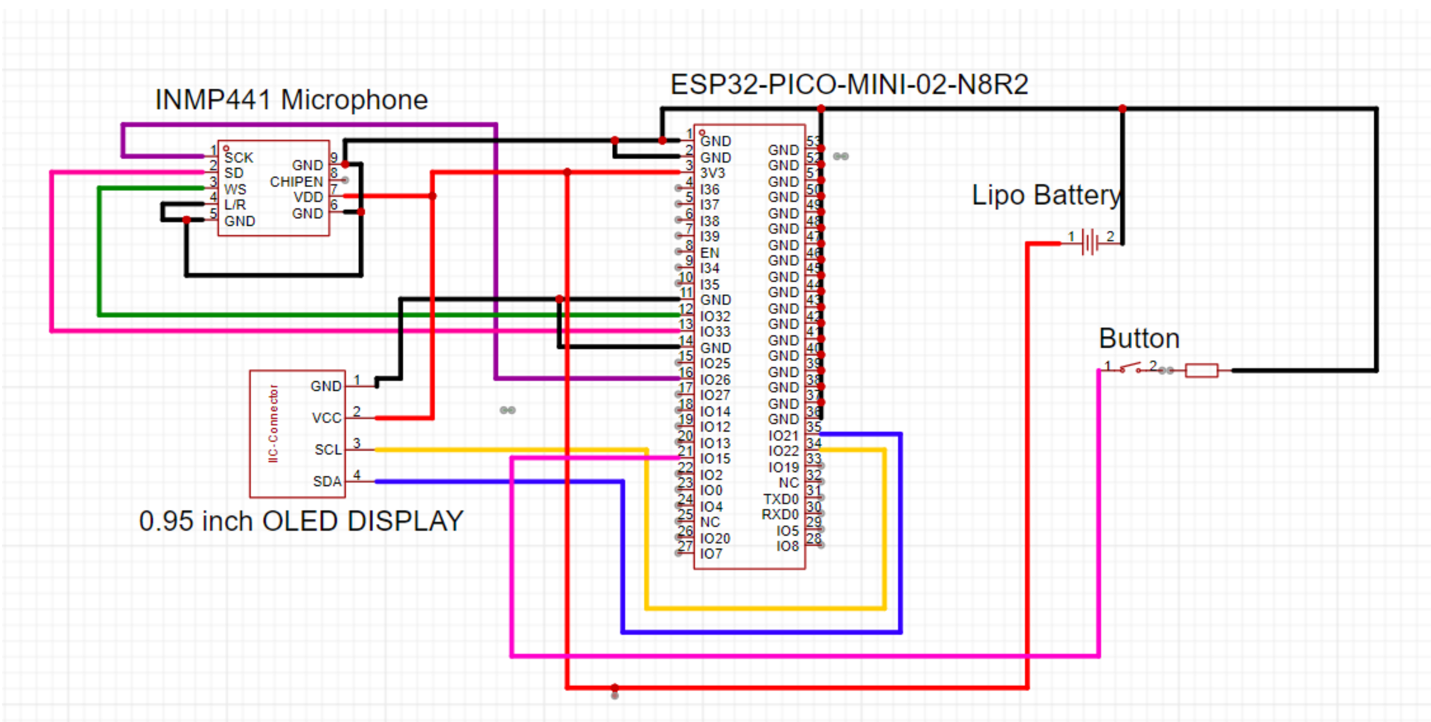


Figure 3.16: Schematic Diagram

3.8 Conclusion and Summary

This chapter shows the available hardware and software options for the system. It covers the choice of hardware components such as an OLED display, Bluetooth module, ESP32 Arduino nano, mirror glass, focal lens and Reflector, as well as the adoption of software tools like mobile application development.

Chapter Four

System Implementation

Chapter Four: System Implementation

4.1 Preface

This Chapter introduces a description of the implementation, implementation issues, implementation challenges, edge impulse, and description of the method used to validate the system.

4.2 Description of The Implementation

In this section, we explained software implementation tools and described how the system works

4.2.1 Software Implementation Tools

We installed the Arduino IDE and the ESP32 driver to upload our programs to the controller. The C++ code is utilized to program the ESP32 microcontroller for implementing the application, while Android Studio, using Java, is employed. Additionally, we ensured that we downloaded the necessary libraries and the latest version of the software.

4.2.2 Description of The Implementation

The first step was purchasing electronic parts and components, in addition to the ESP32 microcontroller, where we tested all the parts in an initial test. The OLED display is connected to the ESP32 controller to display notifications and information, as shown in Figure 4.1 below.

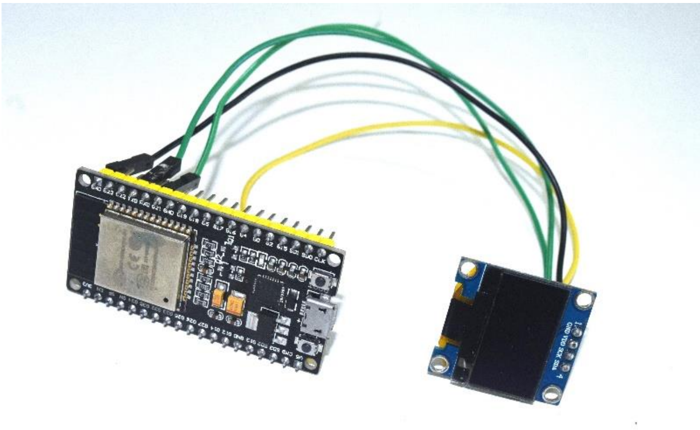


Figure 4.1: OLED Display With ESP32

By connecting the INMP441 microphone to the ESP32, the driver's voice can be received and then sent to the application to respond to the last caller, as shown in Figure 4.2 below.

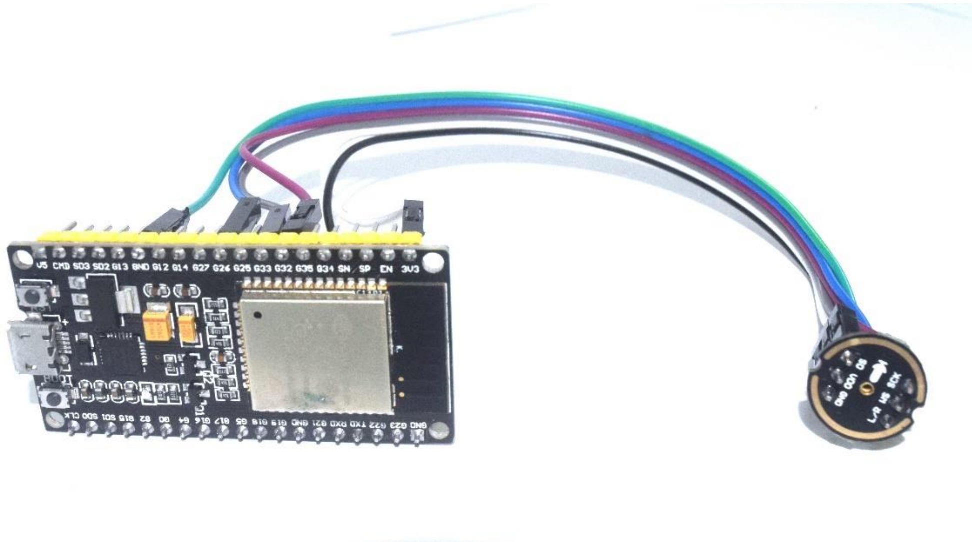


Figure 4.2: INMP441 Microphone With ESP32

By connecting the ESP32 to a battery, it receives a power source, ensuring continuous and independent operation, as shown in Figures 4.3 below.

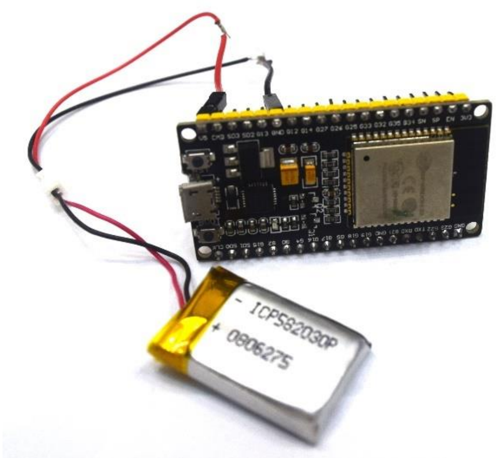


Figure 4.3: Lipo Battery With ESP32

For the button, upon the first press, it initiates the voice recording and conversion process. Upon pressing it again, the converted speech is sent to the caller as a message. As shown in the figures 4.4 below.

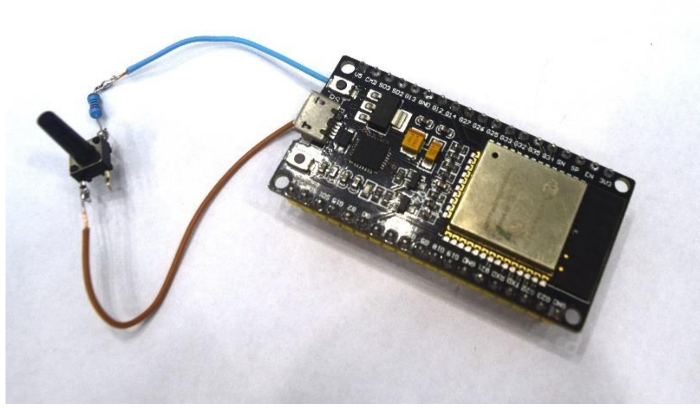


Figure 4.4: Button With ESP32

The second step involved designing a model of the case using CATIA software with the needed dimensions that were carefully studied to determine the most suitable measurements. As shown in the figures 4.5 and 4.6 below.

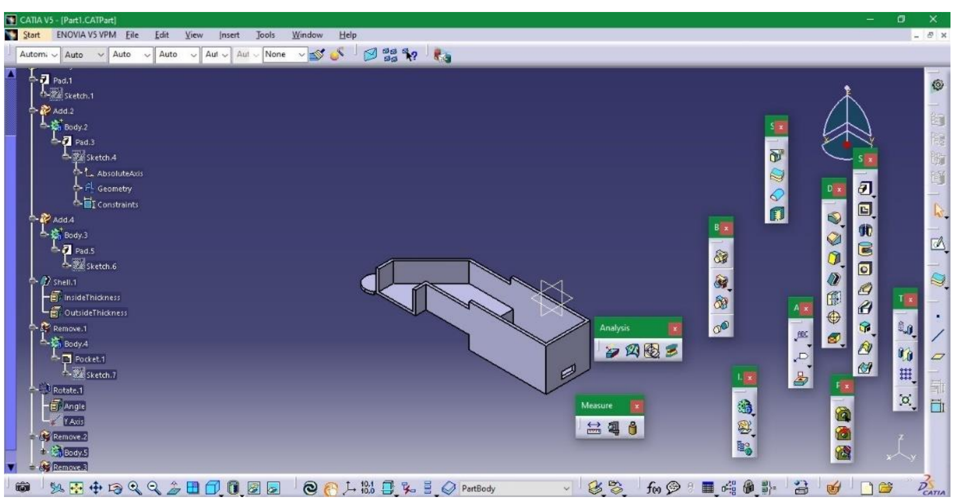


Figure 4.5: The Design of Case Body Using CATIA v.5 Software

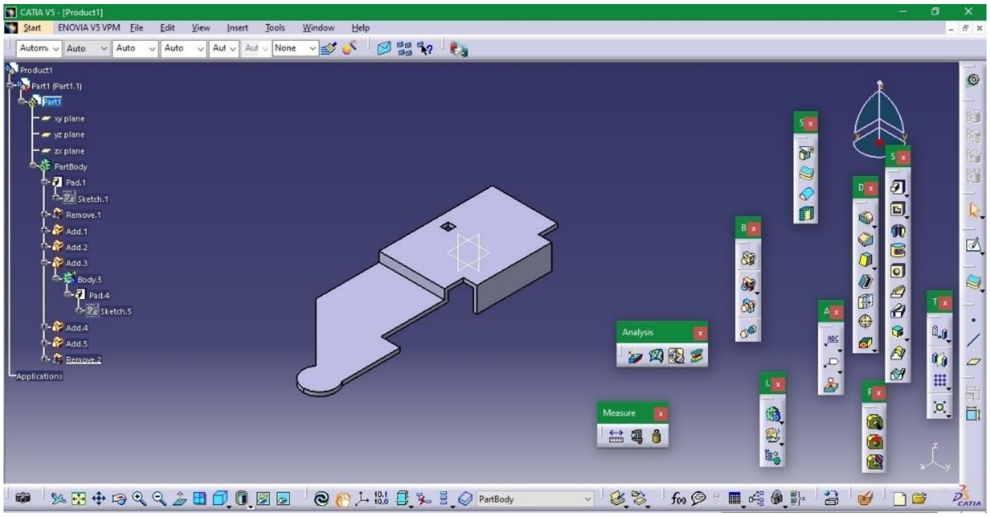


Figure 4.6: The Design of Case Cover Using CATIA v.5 Software

The third step was to print the design using a 3D printer and using PLA filament to obtain the case, It took 6 hours and 25 minutes to complete the two designs . As shown in the figures 4.7 and 4.8 below.

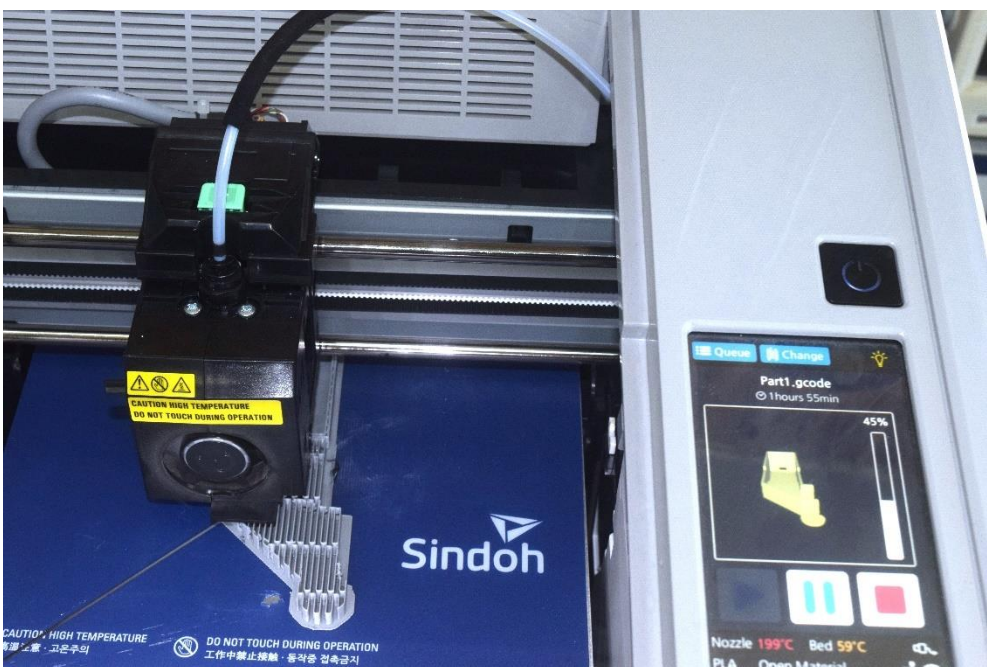


Figure 4.7: Print The Design Using a 3D Printer

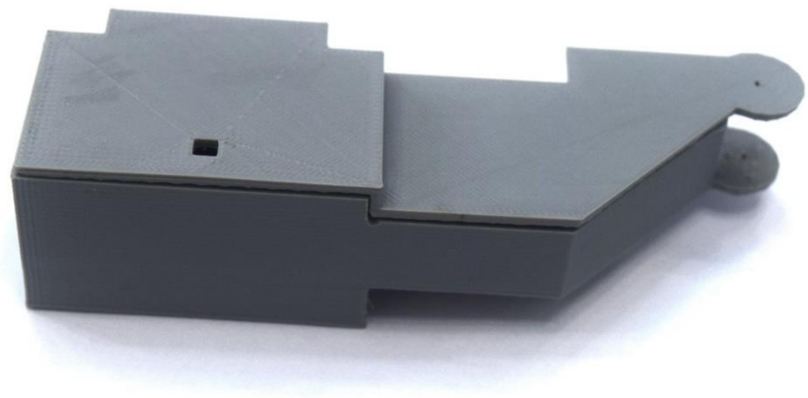


Figure 4.8: After Being Printed

.

The fourth step involves installing the mirror glass, the focal lens, and the reflector at specific angles that have been studied and tested. This ensures that the mirror reflects the text displayed on the OLED screen, and the focal lens projects the text clearly onto the reflector in front of the driver's glasses lens. As shown in Figure 4.9.

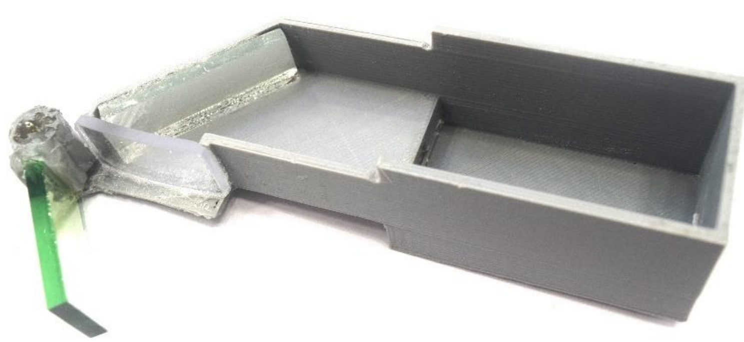


Figure 4.9: Mirror Glass, Focal Lens and Reflector Within the Case

After completing all the connections and printing the design, we use android Studio to create the application and provide a user interface to connect with the ESP32 via Bluetooth. This is to send the time, date, and notifications such as messages and calls to be displayed on the OLED display. Additionally, it receives the recorded message from the driver’s voice through the INMP441 microphone, converts it into written text using the ESP32, and sends it to the last caller or last sender.

4.2.3 Edge Impulse

In this project, we're working on building a strong system that can recognize specific words from audio recordings. We're using a dataset called Google Speech Commands, which has lots of short audio clips with different voices and ways of speaking. Our aim is to make the system more accurate and reliable by using smart techniques to change the data, extract important features, and use the best machine learning methods available. Once we've trained our model, we plan to put it on an Arduino device to make a useful and efficient tool for real-life situations [27]

- **Data Collection**

  We collected the data by downloading the Google Speech Commands dataset, which contains a collection of audio recordings of specific words. Each recording lasts for one second and includes various voices and pronunciations. as shown in Figure 4.10 below.[27]

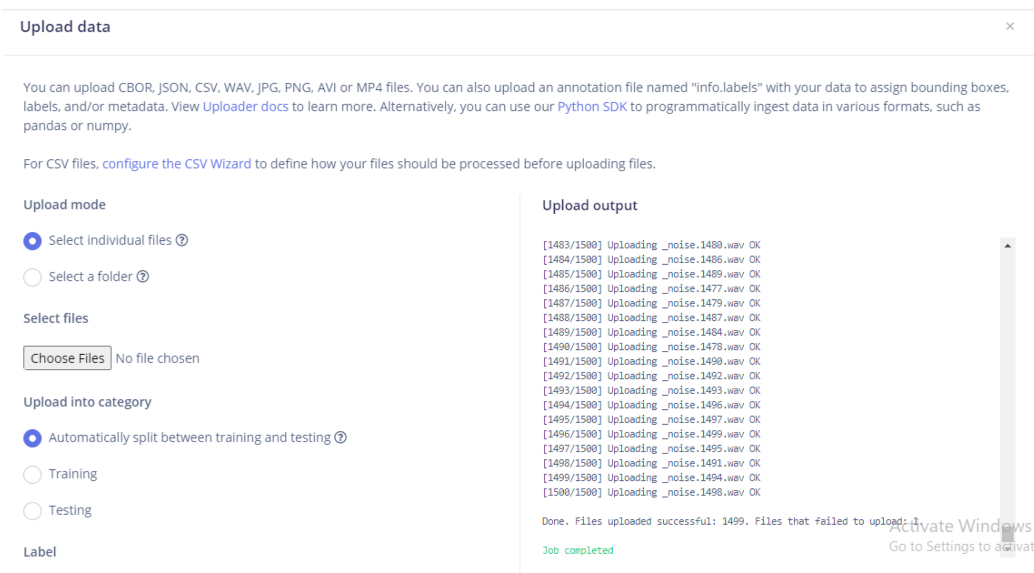


Figure 4.10: Uploading Data

- **Data Augmentation and Curation**

We mixed in some background noise (to help the model recognize the keyword in a variety of environments) and curated the data so that we ended up with about 1500 samples in each of our categories (noise, unknown, keyword 1, keyword 2, and so on). As shown in Figure 4.11 below. [27]

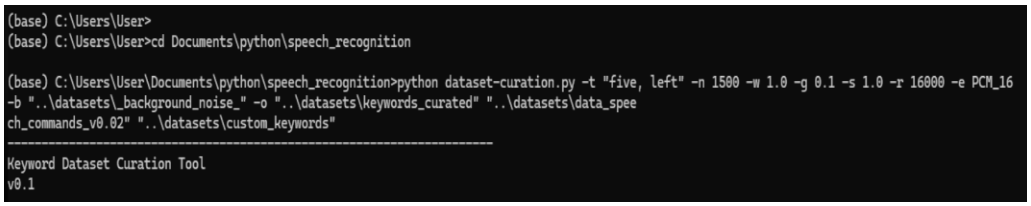


Figure 4.11: Data Augmentation and Curation

- **Model Training with Edge Impulse**

We have uploaded all audio recordings to the Edge Impulse platform. This platform will use a sliding window over each audio sample to produce Mel Frequency Cepstral Coefficients (MFCCs) for that audio sample. Then, it employs a neural network block (Keras). This is a Convolutional Neural Network (CNN) used to classify MFCC inputs. Interestingly, MFCCs resemble images to a great extent, so we can use a common image classifier, CNN, to help identify keywords in each sample. Subsequently, Edge Impulse will compute MFCCs for each training and testing sample. As shown in Figures 4.12 and 4.13 below.[27]

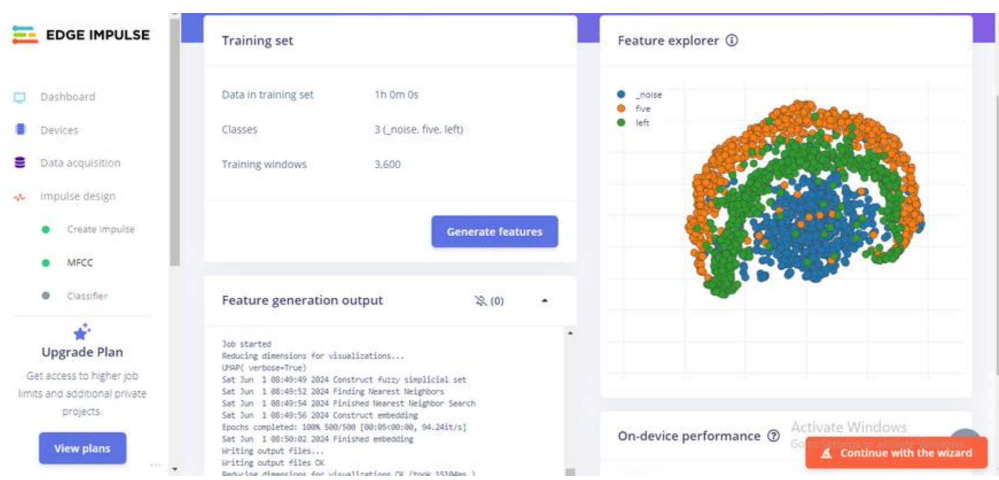


Figure 4.12: Training the Algorithm on Some Words Such as Five, Left....

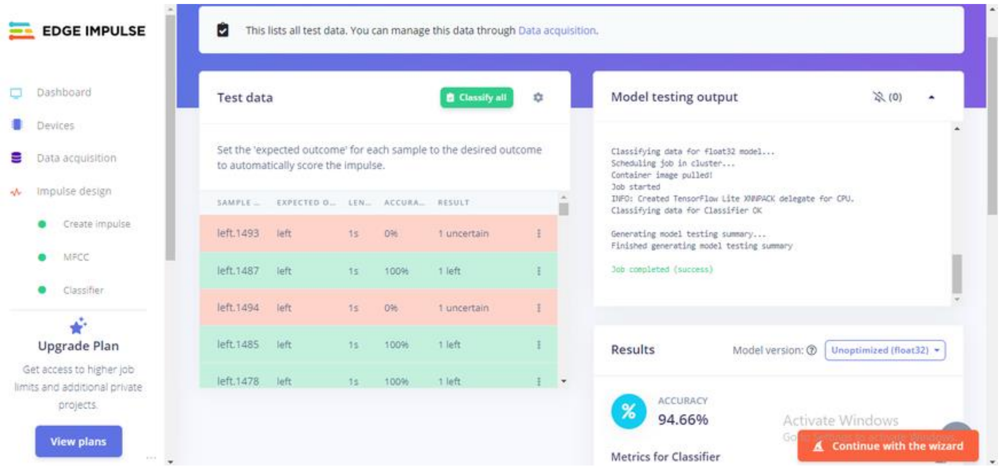


Figure 4.13: Test Data

- **Deploy to Arduino**

The Edge Impulse platform is supposed to automatically install the automatically generated library that we downloaded. We then included it in Arduino and used it in our project. As shown in Figure 4.14 below

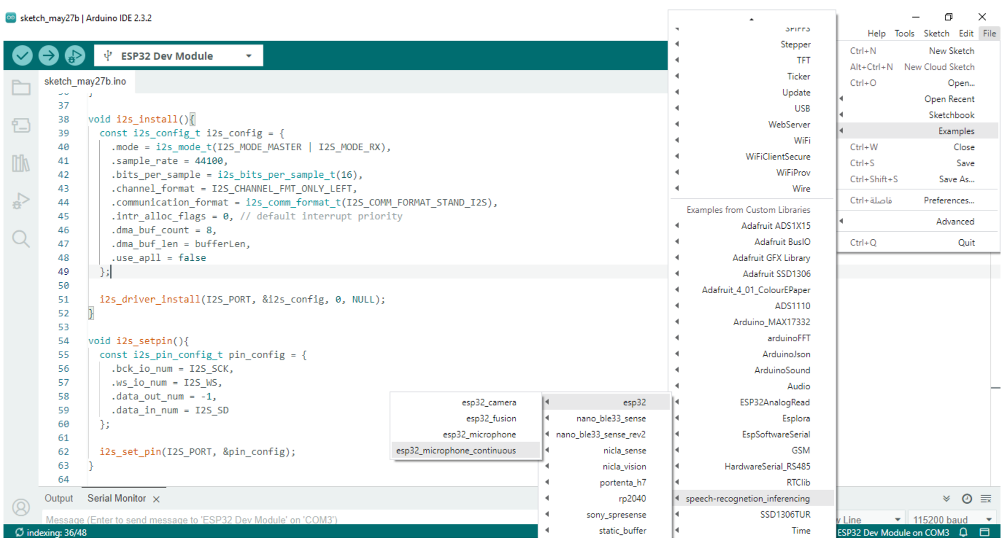


Figure 4.14: Deploy Library to Arduino

After creating a library that converts speech to text through the Edge Impulse website and incorporating this library into Arduino, we modified some properties in the code obtained from the library, where we changed the channel format from right to left. As shown in Figures 4.15 and 4.16 below.

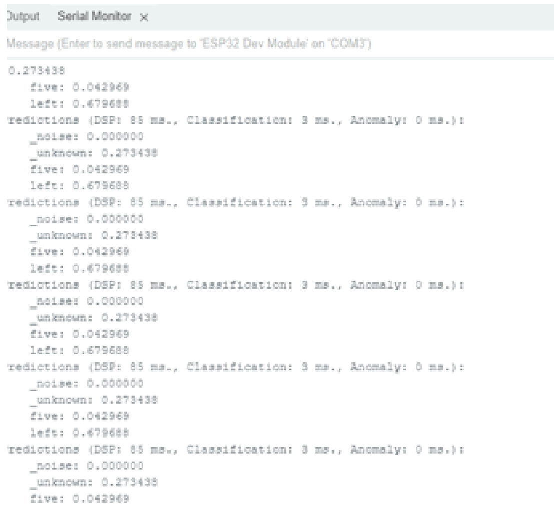


Figure 4.15: Results of The Algorithm Using The Left Channel

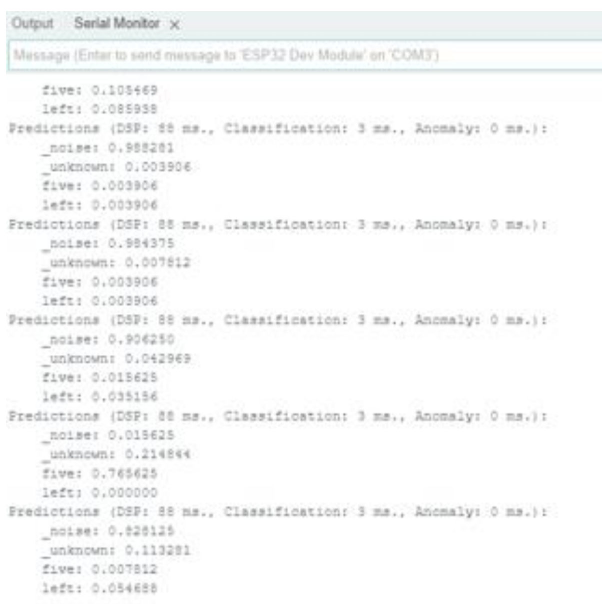


Figure 4.16: Results of The Algorithm Using The Right Channel

4.3 Application Implementation

The application was developed using Android Studio, a great tool for implementing mobile applications on the Android platform.

When the user opens the application, the program directs the user to the splash screen.

After that, the user is taken to the next screen, which displays nearby Bluetooth devices that can be paired with.

These are images of our mobile application pages.

1. The following figures show the interface where the Bluetooth scanner is activated to display nearby Bluetooth devices that can be paired with. As shown in Figures 4.17 and 4.18 below

Figure 4.17: Bluetooth Interface Before Scan. Figure 4.18: Bluetooth Interface After Scan.

2. The ESP32 was connected after scanning for Bluetooth devices. As shown in Figure 4.19 below

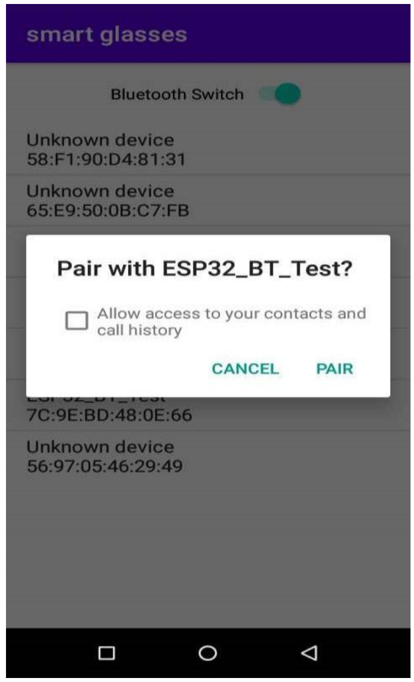


Figure 4.19: Connect the application to ESP32.

4.4 Implementation Challenges

1. The Arduino software version is not compatible with ESP32, which caused an error when uploading the code. Therefore, we downloaded the latest version of the software.
2. We encountered a problem in connecting the application to ESP32 via Bluetooth, and after several attempts, we found the solution by changing the Universally Unique. Identifier (UUID) in the Android Studio application to be compatible with ESP32.
3. We noticed the inability to display the time and date on the OLED display, and the solution is to change the language of the device to match the language of the application.
4. Due to the variety of lenses for farsightedness, we were unable to choose the Focal lens, so we consulted specialists to find the correct lens that was compatible with our project.
5. The variety of reflectors made it difficult for us to find the suitable reflector with the appropriate clarity for our project.

4.5 Summary

This chapter explains the software implementation tools and a general description of the steps of the smart glasses system and how it works in an integrated manner to achieve the functional requirements mentioned previously.

We explained the steps for implementing a speech to text algorithm using Edge Impulse and how to integrate it into Arduino.

Then we talked about the mobile application, what its interfaces and contents are, and an explanation of each of them. We concluded the chapter with the challenges and problems we faced during the implementation period and how we worked with them to complete them. And the successful implementation of the smart glasses project.

Chapter Five

Testing and Result

Chapter Five: Testing and Result

5.1 Preface

This chapter includes hardware and software testing, analysis, and discussion about the result and recommendations based on the result.

5.2 Validation and Testing

In this section, we describe our hardware and software systems.

5.2.1 Hardware Testing

We tested an ESP32 with an OLED display and a microphone. We examined the reflection of the text displayed on the OLED on a mirror and its transmission through a focal lens, projecting it onto a reflector in front of the driver's glasses.

We conducted a test to display the time and date on the OLED display, As shown in Figure 5.1 below

Figure 5.1: Time and Date on The OLED Display

We conducted a test to display calls on the OLED display, showing the caller's name if it is saved in the contacts and the number if it is not saved. As shown in Figure 5.2 below

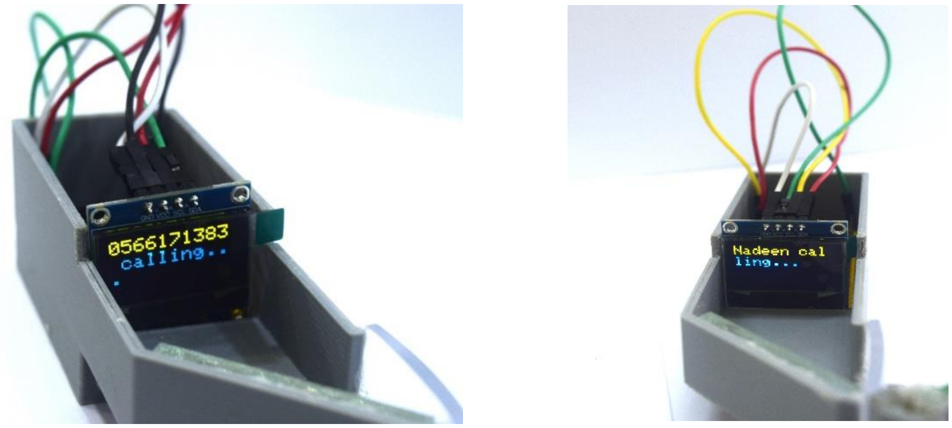


Figure 5.2: Calls on The OLED Display

We conducted a test to display SMS messages on the OLED display, showing the sender's number and the message text. As shown in Figure 5.3 below

Figure 5.3: SMS Messages on The OLED Display

We conducted a test on the INMP441 microphone to ensure it receives sound. As shown in Figure 5.4 below

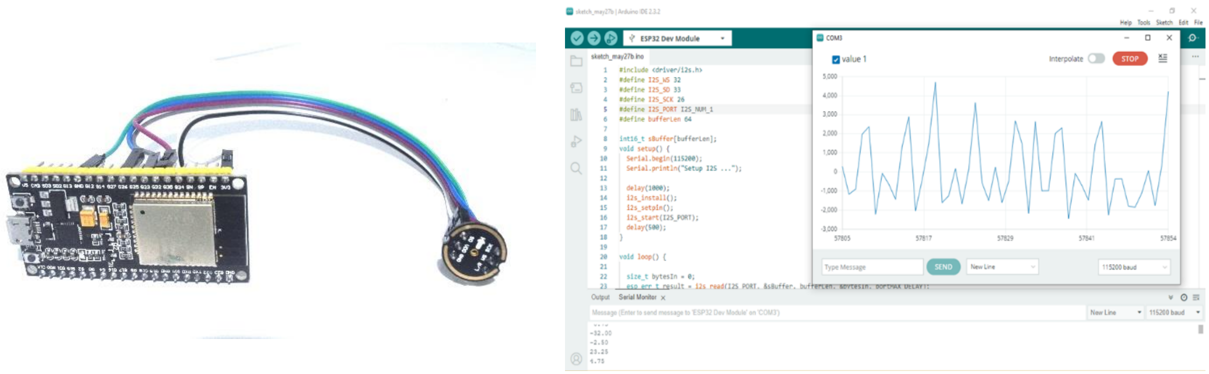


Figure 5.4: INMP441 Microphone Test

We conducted a test for reflecting the text displayed on the OLED display onto a mirror, passing it through a focal lens, and projecting it onto a reflector in front of the driver's glasses. As shown in Figure 5.5 below

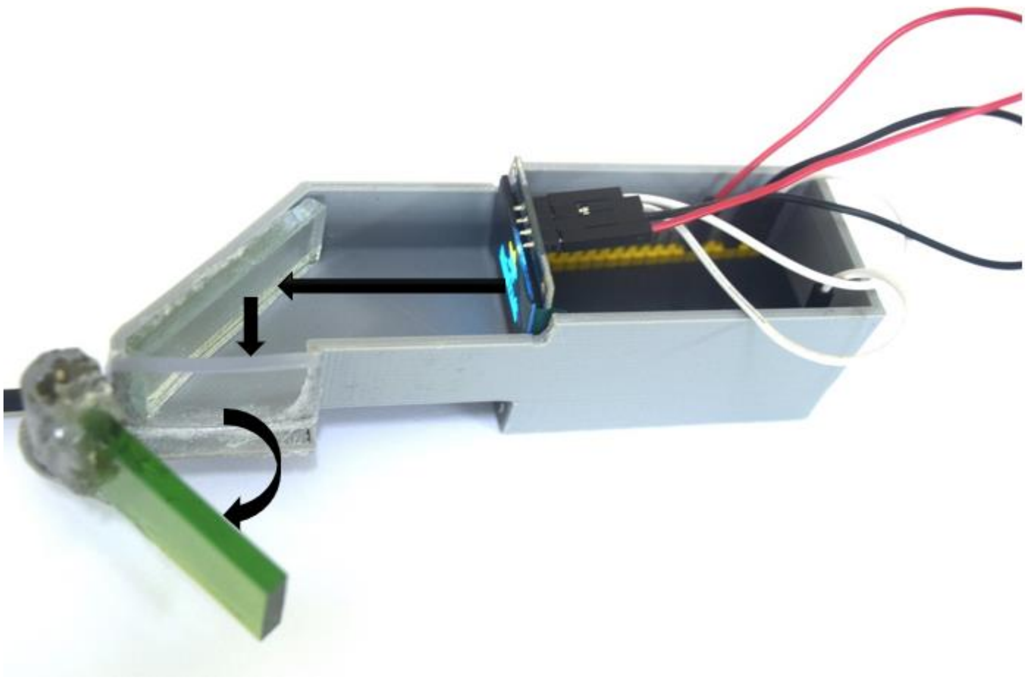


Figure 5.5: Text Reflection Process

We conducted a test on the reflector and how the text appears on it. As shown in Figure 5.6 below

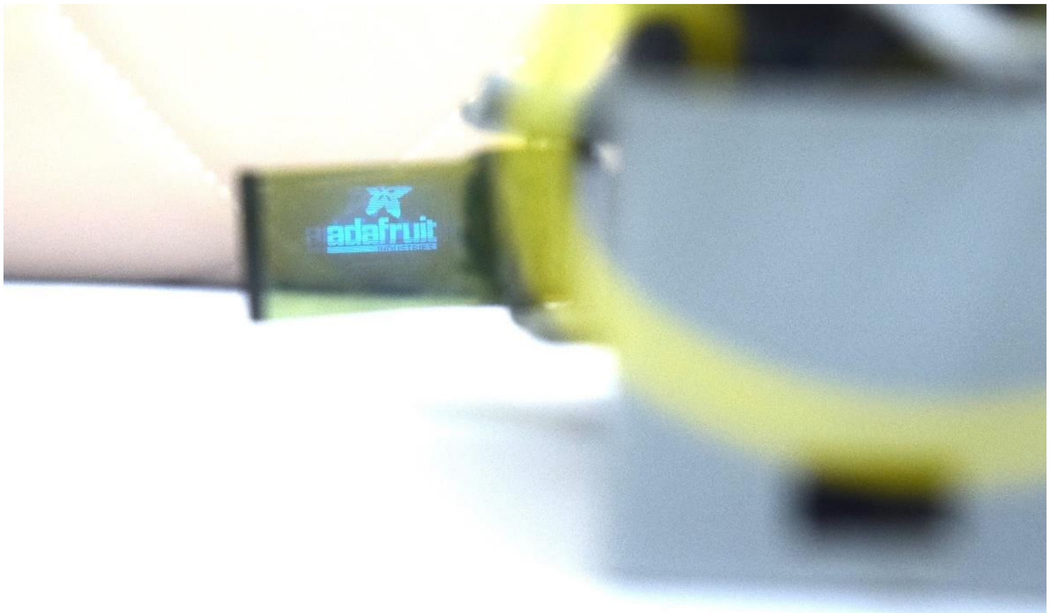


Figure 5.6: The Text on The Reflector

The final appearance of the text on the reflector in front of the driver's glasses. As shown in Figure 5.7 below

Figure 5.7: The Final Appearance of The Text

The final shape of all the pieces together is illustrated in Figure 5.8.

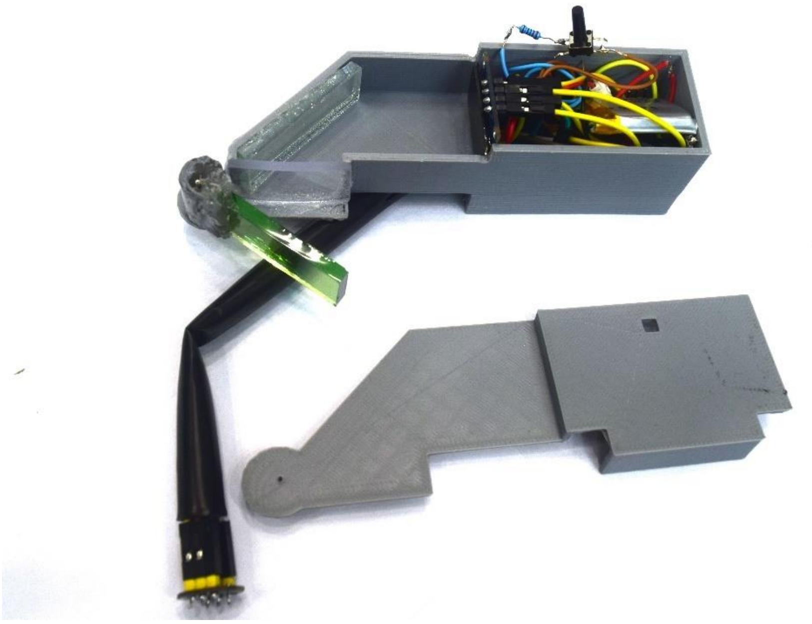


Figure 5.8: Final Connection of The System

5.2.2 Software Testing

During the program's testing process, we performed a variety of tests to ensure that all the program's features were working properly. One of the tests included Bluetooth connectivity and the sending and receiving of data through it.

Our testing focused on the application's ability to send time and date, SMS message notifications, and caller ID to the ESP32 for display on the OLED display.

Our test focused on the ESP32's ability, along with the microphone, to record voice, convert it to text, and then send it as an SMS via Bluetooth to the application. The application then sends it as an SMS to the connected device

Table 5.1, Table 5.2, and Table 5.3 show some of the tests that we have carried out.

Case	Expected Output	Problem while working	Solution for problem	Obtained Output	Pass/ Fail
Bluetooth connection	Bluetooth connection	Problem with UUID	Changing UUID to match ESP32	Bluetooth connection successful	Pass
Receiving time and date	Receives time and date	The time synchronization issue	Adding a library in Arduino for time synchronization	The time and date have been successfully received.	Pass
Receiving SMS messages and calls	It receives messages and calls.	No problem	_	It successfully receives messages and calls.	Pass
Receiving sound	Sound is received from the microphone (INMP441).	Sound is not received when connected to the right channel.	Connecting the L/R input to 3.3V on the ESP32	Sound is received from the microphone when connected to the left channel.	Pass
Converting speech to text using the algorithm.	Receiving sound from the INMP441 microphone and converting it to text using the speech-recognition inferencing algorithm.	It does not receive sound from the right channel, and the algorithm operates on the right channel.		Sound is only received from the left channel, so the speech-to-text algorithm does not work because it operates on the right channel.	

Table 5.1: Unit Test

Case	Expected Output	Problem while working	Obtained Output	Pass/ Fail
The OLED display displays notifications received by the ESP32 via the Bluetooth.	Displaying notifications	No problem	Displaying notifications clearly and successfully.	Pass
Testing that the INMP441 microphone records sound and sends it to the ESP32.	Receiving sound	No problem	Receiving sound from the left channel.	Pass
			Receiving sound from the right channel.	

Table 5.2: System Test

Test	Result
Scanning for Bluetooth and detecting the ESP32's name.	Pass
Establishing a Bluetooth connection with the ESP32.	Pass
Send the word "Hello" from the application to the ESP32.	Pass
Sending the time and date to the ESP32.	Pass
Send calls by name or number to the ESP32.	Pass
Sending messages to the ESP32.	Pass
We sent "Hello" from the ESP32 to the application, and it was successfully sent as a message to the connected device.	Pass

Table 5.3: Application Test

5.3 Result and Discussion

At the outset, this project had several objectives aimed at assisting drivers in knowing the time, date, incoming calls, and SMS, and responding to calls by converting their voice into SMS message without the need to handle and distract themselves with the phone, thereby reducing some specific issues, particularly road accidents resulting from phone usage while driving. This was achieved through a system consisting of various electronic components and a microcontroller, aiding the driver in receiving notifications and responding to calls by sending them to the system via a mobile phone application.

These components were programmed to fulfill the requirements of the smart glasses system that were mentioned previously. Each component was examined separately, and then this system was built and the necessary tests were conducted to ensure that it works as required and whether it achieves the required task or not.

It can be said that the project targeting drivers who use their phones while driving has achieved the desired objectives required by the smart glasses system.

Since this system properly fetches data from the application, the ESP32 microcontroller controls the smart glasses based on incoming notifications. The system displays the time, date, SMS, and incoming calls on a display in front of the driver's glasses lens. Thus, the driver can know the time, date, SMS, and incoming calls in real-time and respond to calls by sending their voice converted into text as SMS to the connected party.

Figure 5.9: Final view of the system

5.4 Summary

In this chapter, the system was tested in three stages. In the first stage, the electronic components were tested separately, and after ensuring their correctness, we moved on to the second stage, which involved testing the system operation after connecting the electronic components to the ESP32 controller according to the pseudo-code in Chapter Three. Finally, in the final stage, the application was tested to ensure the complete integration of the entire system.

Chapter Six

Conclusion and Future Work

Chapter Six: Conclusion and Future Work

6.1 Preface

The chapter introduces a summary of the project, the future directions, and future work.

6.2 Conclusion

Smart glasses system focuses on designing and developing a customized and scalable system. The smart glasses system aims to assist drivers in reducing accidents caused by the use of smartphones. The smart glasses utilize the latest technologies to send important notifications to appear in front of the driver's lens while driving.

At the end of the project, we were able to send the time and date, as well as calls and SMS messages in case there is a call or SMS message, to the smart glasses. We were able to receive the driver's voice when pressing the button, convert it into an SMS message, and send it to the connected person. Finally, we were able to build a preliminary model that executes the functions meeting the project's functional requirements. We found that it worked successfully.

6.3 Future Work

In the future, the system can be improved by adding extra to adding important features to the system, the following is a description:

- Developing the system to utilize Wi-Fi for sending notifications from social media platforms.
- Training the algorithm to take words from the Arabic language
- Improving it to make the system smaller and lighter.

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