

**Faculty Of Engineering Helwan University**

2024/2025

**Biomedical Engineering Graduation Project**

Smart Glasses for the Visually Impaired

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# Abstract

This graduation project presents the design and development of smart glasses tailored for individuals with visual impairments or blindness. The primary objective of this innovative device is to enhance the independence and quality of life for visually impaired users by providing real-time environmental awareness and navigation assistance. The smart glasses are equipped with advanced technologies, including computer vision, object detection, and colour identification, to identify and interpret surrounding objects, obstacles, and text.

The system integrates a lightweight, ergonomic frame with a high-resolution camera and bone-conduction audio for seamless user interaction. Through machine learning algorithms, the glasses can recognize and verbally describe objects, colours, and text, while also offering haptic feedback for immediate spatial orientation. Additionally, the device features speech-to-text functionality, enabling users to conveniently interact with the device and switch between the different modes of operation it offers.

The glasses used many technologies to perform its tasks which are OCR, (gTTS) and Google translation. Detecting the text in the image was done using the OpenCV and Optical Character Recognition technology (OCR) with Tesseract and Efficient and Accurate Scene Text Detector (EAST). In order to convert the text into speech, it used Text to Speech technology (gTTS). For translating the text, the glasses used Google translation API.

User testing and feedback have been integral to the iterative design process, ensuring the device is both functional and user-friendly. The project demonstrates the potential of wearable technology to bridge accessibility gaps, offering a practical solution for visually impaired individuals to interact more confidently with their surroundings. These smart glasses system represents a significant step forward in assistive technology, with the potential to improve daily living and mobility for millions of people worldwide.

# Introduction

According to the World Health Organization (WHO), at least 2.2 billion people worldwide have a vision impairment or blindness. Approximately 36 million people are blind globally. Around 217 million people have moderate to severe vision impairment. Vision impairment poses a significant economic burden, with global productivity losses estimated to be in the billions of dollars annually.

These statistics highlight the critical need for continued efforts in prevention, treatment, and the development of assistive technologies to improve the quality of life for individuals with visual impairments.

This project introduces an innovative solution aimed at enhancing the quality of life for people with visual impairments: Smart Glasses. These glasses are designed to provide real-time environmental awareness and navigation assistance, leveraging cutting-edge technologies such as computer vision, machine learning, and haptic feedback. By integrating these technologies into a wearable, user-friendly device, the Smart Glasses aim to bridge the gap between visual impairment and independent living.

The primary objective of this project is to develop a device that can accurately detect and interpret surrounding objects, obstacles, and text, and convey this information to the user through audio and haptic feedback.

The Smart Glasses are equipped with a high-resolution camera, depth sensors, and GPS capabilities, enabling them to assist users in both indoor and outdoor environments. The device is designed to be lightweight, ergonomic, and aesthetically pleasing, ensuring comfort and ease of use.

This project not only addresses the technical challenges of creating such a device but also emphasizes the importance of user-centered design. Through iterative testing and feedback from visually impaired individuals, the Smart Glasses are continually refined to meet the specific needs and preferences of the target user group.

In summary, the Smart Glasses project represents a significant step forward in assistive technology, offering a practical and innovative solution to improve the daily lives of visually impaired individuals. By enhancing environmental awareness and navigation capabilities, this project aims to empower users with greater independence and confidence in their interactions with the world around them.

## 1.1 Project Background

There are special schools and universities for people with special needs. There are different levels of needs and not all levels require special places and special schools. For instance, people with vision difficulties can study with normal students if they have an appropriate chance. Most blind people and people with vision difficulties did not study and that is because special schools for people with special needs not everywhere and most of them are private and expensive or they study at home acquiring basic knowledge from their parents.

Most blind people are smart people and can study if they have the chance to be able to study in normal schools because they are government school everywhere. Most people thought blind people and people with vision difficulties cannot live alone and they need help all the times. In fact, they do not need help all the times, they can depend on them self in most of the times and they have the chance to live like a normal person in this life. The main reason for implement “Smart Glasses” for blind people was to prove for all people that blind people and people with vision difficulties have the chance to live a normal life with normal people and study in any school or university without the need for help all the times. By “Smart Glasses”, the percentage of educated people will increase.

Most Schools will be able to accept people with vision difficulties instead of open special schools. Next year Prince Mohammad bin Fahd University (PMU) will accept blind people to study. The team would like to start using “Smart Glasses” for the first time in this chance and help students to improve their education level without help and be able to study as a normal person.

# Previous Work

We reviewed the market for products that offer similar functionality to our smart glasses project, below are our findings:

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| --- | --- | --- | --- | --- | --- |
| **Product Name** | **Creator** | **Idea Behind the Product** | **Benefits** | **Disadvantages** | **Areas of Improvement** |
| **eSight** | eSight Corporation | High-tech glasses that enhance vision for people with low vision using a camera and display. | Improves vision for legally blind individuals; customizable settings for different visual needs. | Expensive (thousands of dollars); bulky design; requires some residual vision to function. | Reduce cost and size; improve battery life; expand compatibility with more eye conditions. |
| **OrCam MyEye** | OrCam Technologies | Wearable device that reads text, recognizes faces, and identifies objects via voice output. | Hands-free operation; lightweight; helps with daily tasks like reading and identifying objects. | High cost; limited field of view; requires some training to use effectively. | Expand functionality; improve object recognition in complex environments; reduce price. |
| **Aira** | Aira Tech Corporation | Smart glasses connected to a remote agent who assists users in real-time via video feed. | Provides real-time assistance for navigation and tasks; works with existing glasses. | Requires a subscription service; dependent on internet connectivity; not fully autonomous. | Develop AI for autonomous functionality; reduce subscription costs; improve offline features. |
| **NuEyes Pro** | NuEyes | Smart glasses with augmented reality (AR) to assist low-vision users in daily activities. | Lightweight; customizable magnification; integrates with smartphones and apps. | Expensive; limited field of view; requires some technical knowledge to set up. | Improve field of view; simplify setup process; reduce cost. |
| **OxSight (previously Smart Specs)** | OxSight (University of Oxford spin-off) | Uses augmented reality to enhance remaining vision for people with low vision. | Affordable compared to competitors; enhances contrast and edges for better visibility. | Limited availability; still in development for some features; may not work for all eye conditions. | Expand availability; refine AR algorithms; improve compatibility with severe visual impairments. |
| **MyEye 2** | OrCam Technologies | Advanced version of OrCam MyEye with improved features for object recognition and text reading. | Compact design; improved accuracy; helps with reading, face recognition, and object identification. | High cost; requires some residual vision; limited to specific tasks. | Expand functionality; reduce price; improve usability for people with no residual vision. |

As it evident in the data above, most of the devices on the market are rather expensive, work on a subscription service, or are not geared towards the blind/visually impaired.

# Architecture and Components

What the team had in mind when it came to the architecture of the device and component selection process for this project was simplicity and accessibility. We want the device to be simple enough in architecture with components that are not overly expensive so the product is accessible to all.

As a start, we drafted the list of components we will require:

* Webcam
* Headphones
* Controller
* Battery
* Glasses Frame
* Push Button
* Jumper Wires
* Resistors
* Breadboard

# Tasks Breakdown

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| Team Member | Tasks | Start Date | End Date |
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| Youssef Hussein |  |  |  |
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| Tarek Hesham |  |  |  |
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| Abdelrahman Ziad |  |  |  |
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# Timeline and Milestones

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| **Weeks** | **Milestone** |
| Week 1 |  |
| Week 2 |  |
| Week 3 |  |
| Week 4 |  |
| Week 5 |  |
| Week 6 |  |
| Week 7 |  |
| Week 8 |  |
| Week 9 |  |
| Week 10 |  |
| Week 11 |  |
| Week 12 |  |
| Week 13 |  |
| Week 14 |  |
| Week 15 |  |
| Week 16 |  |
| Week 17 |  |
| Week 18 |  |
| Week 19 |  |
| Week 20 |  |
| Week 21 |  |
| Week 22 |  |

# Requirements Analysis

## Requirements Specification

### Project Objectives:

• Convert printed text to audio.

• Increase spatial awareness.

• Makes life easier for the visually impaired and allow them to live a normal life.

• Help with navigation and locomotion.

### Project Specification: