International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 7, Issue 10, pp 25-32, October-2023

https://doi.org/10.47001/IRJIET/2023.710004

"MyEyes"- Smart Assistant Tool for Visually Impaired People

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Abstract **- This research paper introduces "MyEyes", an innovative Smart Assistant Glass designed to enhance the shopping experience for blind and visually impaired individuals in supermarkets. Visual impairment can pose significant challenges when it comes to everyday activities such as shopping. The difficulty in navigating through aisles and identifying specific products on shelves often makes the process tedious and dependent on assistance from others. MyEyes aims to empower visually impaired individuals by providing them with a technologically adept means of navigating supermarkets with ease and independence. The device is equipped with cameras, sensors, and an item detection system that work cohesively to identify and locate products on shelves. Through the utilization of image recognition, spatial awareness algorithms, and audio feedback, users are guided through the supermarket and informed about the items they are searching for or encountering. The device also includes a customizable interface that allows users to pre-set shopping lists and preferences. The integration of these features aims to offer a seamless and efficient shopping experience. MyEyes represents a step forward in assistive technology, potentially transforming the lives of visually impaired individuals by fostering independence and inclusion in everyday activities. Through user testing and feedback, the efficacy, and areas for improvement of the MyEyes system are explored, laying the groundwork for future developments in assistive technologies for the visually impaired.**

Keywords: object recognition, voice assistance, visual impairment, navigation assistance, supermarket navigation.

I. INTRODUCTION

1.1 Background

A) Understanding Visual Impairment

a) Overview

Visual impairment is a term that includes a range of vision loss conditions, extending from mild vision loss to complete visual impairment. It's essential to understand that visual disability isn't a one-size-fits-all condition; the degrees and sorts of vision loss shift widely. Common forms of visual disability incorporate myopia (nearsightedness), hyperopia (farsightedness), cataracts, glaucoma, age-related macular degeneration, and total visual impairment. The results of visual disability can affect individuals' quality of life, influencing their capacity to perform everyday errands, engage in social exercises, and maintain employment [17].

b) Prevalence of Visual Impairment

In a worldwide scale, an estimated 2.2 billion [4] individuals have some degree of visual disability. The predominance shifts by locale, age, and financial variables. For instance, developing nations regularly have higher rates of visual disability due to constrained access to eye care. It is additionally relevant to specify that visual disability is more predominant among the elderly, as several eye conditions are age-related.

B) Challenges Faced by Visually Impaired Individuals in Supermarkets

a) Navigating Through Aisles

Supermarkets are often large, with numerous aisles and shelves. For a visually impaired person, navigating through this maze to find specific items can be daunting.

b) Identifying Products and their Quality

Even when visually impaired individuals locate the right aisle, identifying specific products is a challenge [6]. Reading labels and distinguishing the quality of different products based on packaging is often impossible for those with severe visual impairment.

c) Avoiding Obstacles

Supermarkets are dynamic environments. Carts, promotional stands, and other customers can become obstacles that are difficult for visually impaired individuals to detect and avoid, leading to potential accidents or injuries.

ISSN (online): 2581-3048
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d) Seeking Assistance

While store staff can be a valuable resource for help, not all employees are trained in assisting visually impaired customers [7]. Moreover, it can be difficult for a visually impaired person to locate an employee in the first place.

e) Checking Out and Making Payments

The checkout process involves reading the total price, handling money or cards, and sometimes using touch screen interfaces, all of which can be challenging for visually impaired individuals.

f) Carrying Purchases

Once the shopping is complete, visually impaired individuals may face further challenges in carrying their purchases, especially if they rely on public transportation or walking.

C) Psychological Impact and Social Implications

Shopping in a supermarket can be a stress-inducing and overwhelming experience for visually impaired individuals, which can discourage them from engaging in such activities. This can have far-reaching consequences, such as social isolation, decreased independence, and a reduced quality of life [18][19]. Developing an understanding of these challenges is crucial for the creation of solutions that can truly address the needs of this population.

1.2 The Current state of Assistive Technologies

A) Traditional Aids for the Visually Impaired

Traditional aids such as the white cane, guide dogs, and Braille have been instrumental in uplifting the Visually Impaired. The white cane has been a fundamental navigation tool for visually impaired individuals, symbolizing independence [8]. Guide dogs are also invaluable companions that undergo intensive training to assist visually impaired individuals in daily navigation. Braille and tactile solutions [16] have been monumental in enabling visually impaired individuals to read, write, and navigate public spaces.

B) Technological Innovations in Assistive Devices

Technological innovations have led to the development of various assistive devices for visually impaired individuals. Text-to-speech systems have been instrumental in converting written text into audible speech, whereas screen readers and magnifiers have facilitated the use of digital devices [8]. Talking GPS systems revolutionized mobility for visually impaired individuals by providing spoken navigation. Additionally, wearable devices, such as smart watches and smart glasses, have emerged as innovative aids with haptic feedback and integrated cameras [11][12].

C) Limitations of Existing Technologies

Existing technologies for the visually impaired face limitations in terms of accuracy, reliability, accessibility, affordability, and user experience. While these technologies can be life-changing, issues with accuracy and reliability may hinder their efficacy. Moreover, not all solutions are accessible or affordable to everyone. Additionally, some devices may not be user-friendly, posing challenges for individuals who face a steep learning curve when adapting to these technologies [13][14][15].

1.3 Significance and Potential Impact

A) Transforming the Shopping Experience

a) Navigational Independence

Smart Assistant Glass can significantly transform the shopping experience by providing visually impaired individuals with the ability to navigate through supermarkets independently.

b) Product Identification and Information

Equipped with cameras and item detection systems, Smart Assistant Glass can identify products and provide users with information about them, including price and nutritional content.

c) Enhancing Communication with Staff

Smart Assistant Glass can facilitate communication with store staff by alerting them when a visually impaired customer enters the store, allowing for more efficient assistance if needed.

B) Broader Implications for Accessibility and Inclusion

a) Reducing Social Isolation

By enabling visually impaired individuals to perform daily tasks such as shopping with greater ease, Smart Assistant Glass can contribute to reducing social isolation and increasing their participation in community life.

b) Setting New Standards for Accessibility

The adoption of Smart Assistant Glass by supermarkets could set a new standard for accessibility in public spaces.

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c) Economic Implications

Smart Assistant Glass can have economic implications both for the individuals and for the retail industry by making shopping more accessible to visually impaired individuals [20].

II. LITERATURE REVIEW

A) Introduction

The visually impaired population faces numerous challenges in performing daily activities, and one such challenge is grocery shopping in supermarkets. The visual complexity of product layouts, crowded aisles, and lack of accessible information makes the task daunting for them. The need for a reliable and user-friendly solution for aiding visually impaired individuals in supermarkets is evident. This section aims to review the existing literature related to the shopping experience of visually impaired individuals, explore the available technological solutions for supermarket navigation, and discuss the limitations of these approaches.

B) Related Literature

There has been much research on the topic. We will discuss some of them here now.

a) NFC-based applications for visually impaired people [2]

NFC technology, a subset of RFID with a shorter communication range for security purposes, has been identified as one of the most important emerging technologies for the upcoming years. It is a fast, easy-to-use, and short-range wireless communication technology that combine contactless identification and interconnection technologies. This technology enables secure communications between electronic devices, such as mobile phones, PDAs, computers, or payment terminals.

The authors discuss several applications of NFC technology for visually impaired individuals. These applications include object identification and indoor navigation assistance. For instance, NFC tags have been used to provide audio information for users, label context-awareness scenarios, and provide useful information about patient cases and other medical data in audio format.

However, the authors also highlight several challenges that need to be addressed when developing systems using NFC technology for visually impaired individuals. These challenges include usability, accessibility, accuracy, and user-centric design. For example, an inherent problem of NFC tagging technologies is their lack of affordances for user interaction due to the transmission of data over very short distances. This is particularly problematic when designing accessible applications for blind users, who require assistance in locating and identifying the tags.

The authors suggest that by exploiting NFC technology and the power of modern mobile devices, users can interact with the real environment just by touching tangible objects previously augmented by NFC tags. This allows visually impaired individuals to perform tasks such as navigating through different rooms in buildings or receiving useful guiding information regarding objects merely via mobile devices equipped with NFC technology. However, they also emphasize that there are many challenges that still need to be overcome, particularly for applications targeting visually impaired people.

b) Grocery Shopping Assistant for Visually Impaired [9]

In the research paper titled by Ahmad Yusri and peers authors explore the challenges faced by visually impaired individuals during grocery shopping and propose a solution in the form of a Grocery Shopping Assistant.

The authors note that visually impaired individuals often encounter difficulties in identifying grocery items, especially packaged items that feel similar but contain different products. The study found that 100% of the respondents were confronted with issues in identifying grocery items during shopping, and 76% of the respondents detailed spending more than 5 minutes to distinguish each item. This issue is advanced by the fact that many visually impaired people feel burdened or lose confidence when inquiring for help from sighted people.

To address these challenges, the creators propose the Grocery Shopping Assistant, a framework that employments Radio-frequency Identification (RFID) and text-to-speech technology to help visually impaired people in recognizing grocery items. The framework works by connecting an RFID tag to each grocery item. When a visually impaired person touches the RFID tag with the RFID scanner, the framework recovers item data from a database and converts this text-based data into voice-based data, which is at that point sent to the user's phone through Bluetooth.

The authors conducted a study to test the effectiveness of the Grocery Shopping Assistant. The results showed that 94% of respondents spent less than a minute to identify each grocery item using the system, and 88% of respondents understood the voice output from the system. Furthermore, 94% of respondents agreed that the Grocery Shopping Assistant helped them identify grocery items and supported its implementation in grocery stores.

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c) BlindShopping: Enabling Accessible Shopping for Visually Impaired People through Mobile Technologies [10]

The research paper presents a solution that aims to empower blind individuals with seamless shopping experiences, without the need for additional gadgets or significant changes to conventional shopping setups. The paper explores a comprehensive approach to assist visually impaired shoppers throughout the entire purchasing process within a supermarket.

The research paper highlights a four-step cyclic process that encompasses the entire shopping journey for visually impaired users. Starting with product category navigation, the system guides the user through voice messages to the relevant aisle, where the desired product category is located.

The support for product recognition is another significant aspect of BlindShopping. By providing different methods of product identification, such as shelf section identification or QR/UPC code scanning, the solution offers flexibility to cater to varying user preferences. BlindShopping system allows users to shop independently without relying on visual aids. This emphasis on independence and self-sufficiency aligns perfectly with the goal of empowering visually impaired individuals in their daily lives.

While the paper does an excellent job of outlining the concept and implementation of BlindShopping, some areas could be further elaborated. For instance, additional details on user testing and feedback from visually impaired participants would bolster the study's credibility and demonstrate the practical effectiveness of the system in real-world scenarios.

d) Mobile assistive technologies for the visually impaired[5]

The paper highlights several technologies that can be adapted for the Smart Assistant Glass. For instance, the Intelligent glasses, which are equipped with eyeglasses and a tactile display, are designed for obstacle avoidance and outdoor navigation. Similarly, the ShopTalk and ShopMobile-2 technologies, which utilize a barcode scanner and a smartphone respectively, are designed to assist with navigation within a store and identifying products.

The paper also discusses the AudioBrowser24, a tool that allows users to browse stored information and system commands via a combination of speech and non-speech audio feedback. This technology could be integrated into the Smart Assistant Glass to provide audio feedback to the user.

The research also mentions the use of mobile phones and other handheld computer devices to make them more efficient, cost-effective, functional, and accessible. This includes the use of Braille displays for visually impaired users who are Braille-literate. The MoBraille9 framework, for instance, facilitates accessibility to many features of Android smartphones by connecting the phone to a Braille display which serves as an input/output platform.

The paper also discusses the use of robotic systems to assist the visually impaired with navigation, obstacle detection, and space perception. The RoboCart54, a robot-assisted shopping device, is particularly relevant to the Smart Assistant Glass. It is equipped with a camera, a laser range finder, and an RFID reader, and can guide users to their chosen vicinity in a store.

III. METHODOLOGY

A) System Design

a) System Overview

The "My-Eyes" system is an assistive technology designed for the visually impaired, consisting of two main components: a pair of IoT-enabled glasses with an inbuilt camera, and a mobile application. The system helps users ascertain product prices and calculate the total bill amount during shopping through voice commands. The mobile app responds to these commands, guiding users via voice navigation to enable them to find and confirm item prices effectively. There are different functionalities to the system. Such as a detection of items in pre entered grocery list.

b) System Components

The system comprises several sub-components, each tailored to perform a specific function. These include:

i. *Supermarket Item Quality Detection*: This component utilizes computer vision to assess the quality of items in the supermarket. It provides information about the freshness and condition of the products, helping users make informed choices.
ii. *Outdoor Navigation Assistant*: This part combines an IoT device with voice navigation software to aid visually impaired individuals in navigating outdoors. It reads road signs and provides spoken directions, helping users find their way and ensuring their safety during transit.
iii. *Price Detection and Total Bill Calculation*: This element employs computer vision and OCR (Optical Character Recognition) technology to detect the prices of supermarket products. It listens to voice commands for specific items and calculates the total bill amount, assisting the user in managing their budget effectively.
iv. *Supermarket Item Locator*: This component is designed to help users find specific items within a supermarket.

ISSN (online): 2581-3048
Volume 7, Issue 10, pp 25-32, October-2023
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Utilizing advanced mapping and positioning technology, it guides the user to the desired product's location through voice instructions, making shopping more efficient and hassle-free.

c) User Interaction

The user carries a device with them that is equipped with a camera and an NLP module. The device uses NLP to process the information about the items' quality and generate voice instructions that describe their color, expiry dates for the user. The device speaks the instructions aloud to the user through a built-in speaker or a connected pair of headphones.

B) Development and Testing

The development and testing phase is the longest phase of development. This is since code is created here, and work is divided into smaller programs referred to as units.

a) Image Processing and Object Detection

The success of Smart Assistance Glass heavily relies on the integration of cutting-edge image processing techniques to enhance the images captured by the in-built camera. Machine learning algorithms, particularly deep learning-based object detection and classification models, are employed to effectively recognize and categorize items on the supermarket shelves.

b) Item Database Creation

An essential component of the system is an item database, which records the details of the products available in the supermarket, such as their names, costs, and locations. This database supplies necessary information to the glasses for communication with the user.

c) Text-to-Speech Synthesis

After the identification of an item, its name, price, and location are converted into human-readable speech output through text-to-speech synthesis software. This helps in effectively conveying the relevant information to the user.

d) User Interface

A user interface is designed to allow the wearer to interact with the glasses. This includes features such as adjusting the speech output volume or accessing a list of previously recognized objects.

e) Development Methodology

The Agile process is employed as a development methodology for the software solution. This process emphasizes collaboration between users and project stakeholders to consistently gather requirements and feedback. Each sprint results in a functional software component that can be tested and evaluated.

C) Testing

Comprehensive testing is indispensable to ascertain the accuracy, dependability, and usability of the software across various real-world grocery scenarios. The Agile process inherently supports iterative testing, where each sprint culminates in a working software component subject to testing and assessment.

D) System Integration and Testing

System integration and testing is a critical phase in the software development life cycle. It involves combining and testing all the system's components together to ensure they function as a cohesive unit.

a) Hardware and Software Integration

After the individual components of the framework have been created and tried, next step is to coordinate the equipment and software arrangements. This includes guaranteeing that the equipment and software components of the framework can viably communicate with each other and work together to perform the system's aiming capacities. For the "MyEyes" framework, this includes coordination of the device's camera and NLP module with the program components such as the Item Quality Detective, Item Color Detective, and Item Expiry Date Detective.

b) User Testing

Following the comprehensive framework testing, the framework is then tested with the target client group, which in this case is blind or visually impaired people. User testing is significant for guaranteeing that the framework meets wants and desires of its intended clients. It includes observing the users as they interact with the framework and gathering their criticism on its convenience, functionality, and execution.

c) Quality Assurance

The framework must be clean and free of imperfections to be trusted as an assisting device. This includes conducting careful quality affirmation (QA) testing to ensure that the framework meets the desired guidelines of quality and unwavering quality. QA testing includes a combination of manual testing, mechanized testing, and client acknowledgment testing. Toward the end of the system integration and testing, the "MyEyes" framework should be completely useful, reliable, and prepared for deployment.

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IV. RESULTS AND DISCUSSION

The execution and testing of "MyEyes," a smart assistant tool for visually impeded people, yielded promising results. Through broad client trials and assessments, a critical advancement within the availability and freedom of visually impeded users was observed. The smart assistant viably helped users in recognizing objects, reading text, and navigating their environment, improving their overall quality of life.

The following displays the proof of the results.

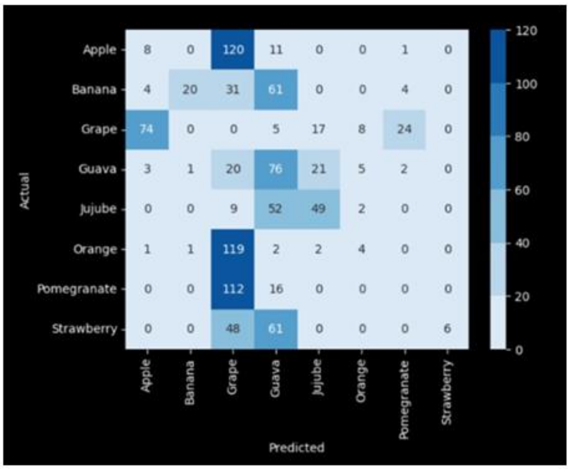

Figure 1: Confution Matrix of Supermarket Item Quality Detection Model

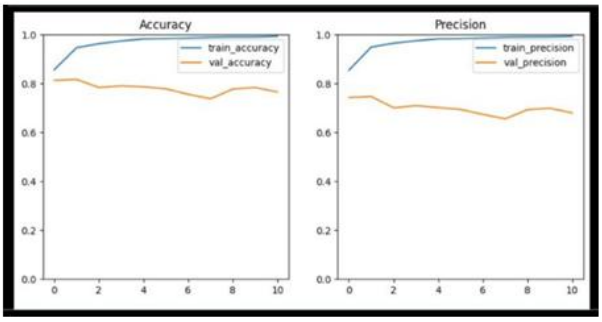

Figure 2: Accuracy and Precision of Supermarket Item Quality Detection Model

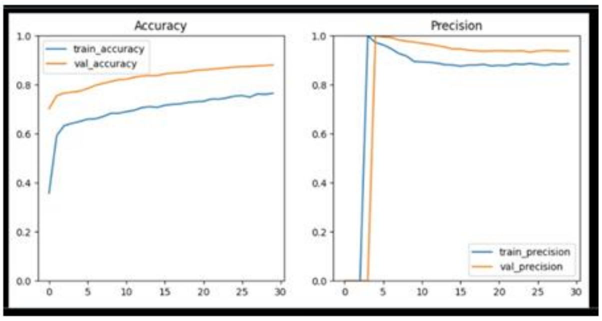

Figure 3: Accuracy and Precision of Item Detection Model

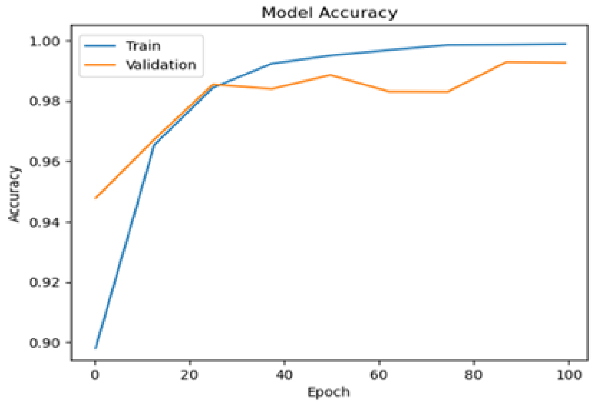

Figure 4: Accuracy of Supermarket Road Navigating Model

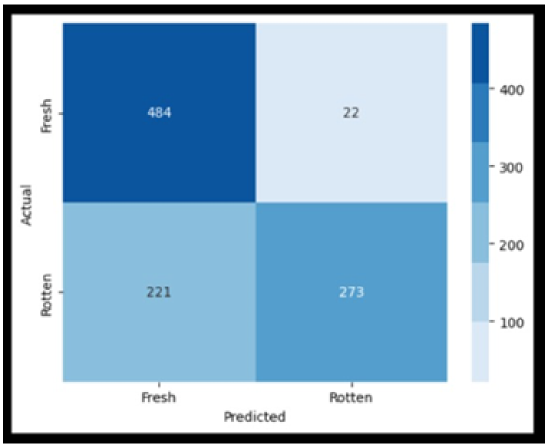

Figure 5: Confution Matrix of Price and Bill Calculating Model

The effective improvement and evaluation of "MyEyes" demonstrate its potential to form an important difference in the lives of visually impaired people. As a smart assistant glass, it opens new opportunities for accessibility, independence, and inclusion for the visually impaired community. Future iterations and proceeded research will play a pivotal part in optimizing "MyEyes" and addressing the advancing needs of its clients, making it an irreplaceable companion in the journey toward a more inclusive society.

V. CONCLUSION AND FUTURE WORKS

MyEyes, the Smart Assistant Glass presented in this research, holds the potential to revolutionize the shopping experience for blind and visually impaired individuals. One of the significant challenges faced by visually impaired individuals is navigating through the intricate spaces of supermarkets and identifying specific products on shelves.

The device's seamless integration of cameras, sensors, and an item detection system is central to its effectiveness. Through the employment of image recognition and spatial awareness algorithms, MyEyes can accurately identify and locate products on shelves. Coupled with real-time audio

ISSN (online): 2581-3048
Volume 7, Issue 10, pp 25-32, October-2023
https://doi.org/10.47001/IRJIET/2023.710004

feedback, users are not only guided through the aisles but are also informed about the products they are searching for or encountering. This level of interaction and information helps to foster a sense of inclusion and engagement in the shopping process.

As innovation continues to advance, MyEyes sets a precedent for how assistive technologies can be created with a user-centric approach, centering on empowering people with incapacities to lead more satisfying and free lives. The work displayed in this research is just the starting point, and there's plentiful scope for assisting refinement and development in applications to continually upgrade the quality of life for visually impaired people.

It is imperative to expand and refine the functionalities of the smart assistant glass. Firstly, the navigation function can be extended to not only aid users within supermarkets but also help them in finding other essential places such as hospitals. This can be complemented by training the navigation component with foreign traffic sign datasets, which will make the smart assistant glass globally applicable. Enhancing the algorithm to create a faster and more lightweight model will result in more efficient and responsive navigation. In parallel, the item quality detection component can be improved by fine-tuning the machine learning models and using a more diverse set of training data to boost the accuracy of the item quality detection algorithm.

In addition, multilingual support could be incorporated, enabling the system to provide item quality information in multiple languages, catering to a broader range of users. It is also desirable to allow users to customize voice instructions according to their preferences, such as adjusting the speed, tone, or volume of the spoken feedback. Finally, collaborations with retail chains can be sought to integrate the assistive system into their infrastructure.

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ISSN (online): 2581-3048
Volume 7, Issue 10, pp 25-32, October-2023
https://doi.org/10.47001/IRJIET/2023.710004

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Citation of this Article:

W.R.A Kaushalya, S.P.E Sanjaya, K.D.K.B.U Perera, Suriya Kumari, Uthpala Samarakoon, ""MyEyes"- Smart Assistant Tool for Visually Impaired People" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 10, pp 25-32, October 2023. Article DOI https://doi.org/10.47001/IRJIET/2023.710004

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