Object Identification and Geolocation Navigation for the Blind

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ABSTRACT
Blindness is a huge challenge that causes many problems, such as lack of social relationships, limited activities, and lack of employment. Existing solutions such as the white stick, assistive pets, and technologies that help blind people avoid obstacles are still in development. Unfortunately, not all blind people have a companion in life, and they face the struggles of life on their own. This study helps blind people recognize objects that they cannot see, distinguish people using face recognition, and help them move from one place to another, without assistance. The device is integrated with GPS feature and have its own mobile application where a family member can monitor or track the location of the actual blind person. The proponents are motivated to bridge the gap between blind people to their community and the outside world, this would be a huge blessing for these physically challenged people who would mostly be able to see the objects and people in front, travel to other places, and mostly detect obstacles that can harm them.

Keywords
Blind, Vision-Impaired, Object Identification, Face recognition, Geolocation Navigation, Assistive System, Image processing.

1. INTRODUCTION
Eyesight is the most important sense in people's lives, and many people are not able to see what is around them. According to Investigate Ophthalmology and Visual Science, there are an estimated 49.1 million people who are blind and these people have a hard time keeping up with their way of life. Dealing with blindness is a huge challenge and it causes many problems such as lack of social relationships, limited activities, and lack of employment. Blind people need to be part of society and communication and mobility are important for them to gain independence. Non-technological solutions to aid blind persons include the white cane, assistive pets, and wearable navigation assistance system.

The proponents adopted the use of wearable navigation assistance that is more effective and convenient solution that will improve the range and accuracy in detecting obstacles. [1] The Low-Cost Ultrasonic Smart Glasses for Blind by Rohit A., et.al. helps and guides blind people every day and avoids obstacles. It features a built-in sensor that, while scanning a maximum of 5–6 meters of a 30° range, emits ultrasonic waves in the direction the user is moving. The proponents adopted and improved the use of obstacle detection integrated into a normal glass and generating audio feedback more accurately in avoiding obstacles to lessen accidents for blind people. This study also helped the blind be productive people and bridge the gap between blind people to their community and the outside world. This project helps those who are blind gain independence and bring them out of the darkness that limits their lives. It includes a camera that converts visual images into audio output, a GPS feature, and a mobile application to monitor the blind person's location. The project helps the blind identify objects, recognize people, and navigate safely from one place to another with the help of geolocation navigation and obstacle detection.

2. RELATED LITERATURE
One of the research projects related to this study is EyeRis. The Pi-camera is positioned in the center of the palm by EyeRis and serves as a source for a live video transmission. The camera divides the stream it recorded into frames. A single deep neural network processes each frame, rendering approximative bounding boxes with various aspect ratios. The best fit box is then chosen for the object based on the prediction score of each bounding box. Each box is evaluated for facial recognition against an ever-growing list of features, and if it fails for one criterion, it is rejected and labeled as not a face region. If a face region is identified, the image is transferred to a residual network, which compares it to the database to determine if it recognizes the face or not. An open-source software called eSpeak NG is used to translate the results of object detection and facial recognition into audio for blind listeners. The study's objective is to make it easier for someone with completely or partially impaired vision to recognize items and faces in front of them. The research employs a technique that examines the live visual stream for object detection and facial recognition [2]. The proponents are inspired by this study and have adopted the methods used in object identification and facial recognition. The translation of the captured images of objects and images will also be used in the proposed project.

Logical deductions can be made regarding when GPS isn't beneficial by having a basic understanding of GPS technology. Stone, concrete, metal, earth, and other obstructions block the satellite signals that are used in modern GPS technology. Due to this flaw, GPS devices would not function very well in subway systems [3]. Blind people can benefit from navigation without asking anyone. The GPS (Global Positioning System) uses raw data to determine the location coordinates where blind people are standing. A PIC microcontroller then processes this data to determine the true coordinates associated with the current position. A specific speech message is then translated from the GPS data and presorted in a voice recorder. The blind person then hears the voice message through the headset [4]. The proponents adopted the use of a navigating system to help the proposed project and make it more efficient, it also helped the blind when navigating outdoors while being tracked by their family members.

Human beings are highly dependent on vision sensors for daily tasks such as walking, eating, searching, driving vehicles, and reading books. Object recognition is the core algorithm in most vision-related tasks [5]. Object detection and recognition are fundamental components of scene understanding. The visual system in humans is strong, selective, robust, and quick. Not only is it highly selective, allowing humans to distinguish between very similar objects like the identical twins' faces, but it is also robust enough to classify same-category objects with large variances [6]. As people walk on the street there are so many obstacles ahead, that's why it's important to have a vision of objects and also of obstacles.

A wide range of daily life activities causes major problems for blind and visually impaired persons (VIPs), including a way of finding information, unfamiliar surroundings, detecting objects and persons, and recognition of faces and facial expressions [7]. Much information is exchanged nonverbally via body posture, gestures, interpersonal proximity, and facial expressions among visually impaired people. Only a few assistive technologies are available, despite the VIP community's demand, that make an effort to help VIPs access nonverbal communication in real-time during social encounters. VIPs who lose their vision as children may face negative repercussions on their social development, ultimately affecting their social inclusion as adults, due to their inability to completely comprehend nonverbal information. Infrared (IR) sensors are extensively used for measuring distances. Therefore, they can be used in robotics for obstacle avoidance. Compared to ultrasonic (US) sensors, they are less expensive and respond more quickly. However, the Infrared (IR) sensors have non-linear characteristics and depends on the reflectance properties of the object surfaces [8]. One of the most difficult tasks faced by the blind and visually impaired is the identification of people. The visually impaired inability to recognize individuals in the absence of audio or haptic clues severely limits their social connections and puts them at danger from a security standpoint.

Face recognition is a method of locating and identifying peoples' faces using different algorithms in a real-time environment given an input image stream. Face detection is mostly used for tasks such as verifying a person's identification, whether unknown or known, and certifying whether a person is who he claims to be [9]. Usually, a blind person identifies another person in front of him or her through the sense of touch or by hearing the voice of the person. The use of facial recognition will be used only for known and trusted people of the blind person.

Obstacle avoidance is another challenge for the blind and visually impaired. Proximity sensors, in particular, have become a popular solution for object identification and collision avoidance in recent years. To detect obstacles, blind people use sticks when they are walking but this instrument just cannot help them find objects on the ground. Obstacle detection is a field of effort that has led to vast progress in primary safety systems and primary-secondary safety systems interaction [10].

3. PRESENTATION OF ANALYSIS OF DATA

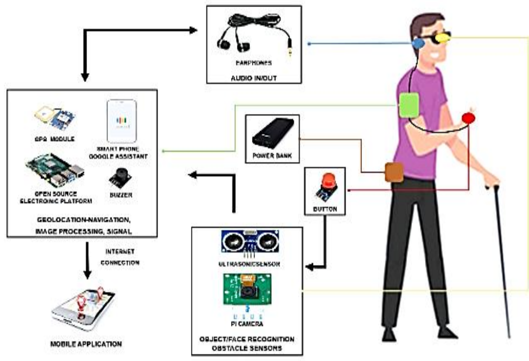

Figure 1. Operational Framework of the Project

To develop the proposed project, Audio-Assisted Object Identification and Geolocation Navigation for the Blind, based on the Operational Framework for the Proposed Project, as shown on Figure 1, the proponents used an open-source electronic platform with built-in Wi-Fi, a camera, earphones, an Ultrasonic sensor, a buzzer, a button, and a GPS module. The open-source electronic platform served as the microcontroller that can be programmed, and this is where all the components are connected. The camera is used to capture images to be used for object and face identification. The button is used as a trigger in capturing images for object and face detection when using the indoor mode of the system. After capturing images, the system undergoes image processing and produces the data into audio feedback. When the blind person activates the outdoor mode of the system, the Ultrasonic sensor detects obstacles in front of the blind person, with a warning buzzer when obstacles are detected and can be asked by the smartphone's Google Assistant for navigation using speech recognition. The GPS module determines the blind person's location on the map that is used for tracking and monitoring by people such as relatives and friends through the mobile application.

Object detection, face recognition, and navigation are produced as audio feedback for the blind. The blind person can set the point of origin to the desired destination using speech recognition. It also allowed the user to navigate from one place to another with the help of audio assistance and obstacle detection. From that, a registered family member with the mobile application monitors and confirms the blind person's location.

Blind persons struggle every day in identifying and looking for their personal belongings and recognizing the persons in front of them. They also have a hard time navigating from one place to another. The project aimed to help blind persons through a wearable assistive device that can detect the objects and faces of their family members. It also helped blind persons in navigating outdoors by detecting obstacles in front and guiding them to their destination from the point of origin. The blind person is monitored through a mobile application that confirms the blind person's location.

During the project's system design phase, the functional and non-functional requirements were defined.

3.1 Functional Requirements

Functional requirements help identify missing requisites. It enables the proponents to determine the system's intended service.

- It can detect necessary objects inside and outside the house premises.
- It can detect the faces of registered family members.
- It can detect obstacles when navigating outdoors.
- It helps the family member monitor the location of the blind person.
- It can help the blind person navigate from the point of origin to the desired destination using a speech command.
- It can provide audio warnings and feedback.

3.2 Non-Functional Requirements

Non-functional requirements are specifications that outlines the project's capabilities, features and limitations in the context of project operations.

- The project must be comfortable to wear.
- The project must be easy to use.
- The project must be available anytime.
- The project must be able to run without interruption.
- The mobile application must be easy to use.

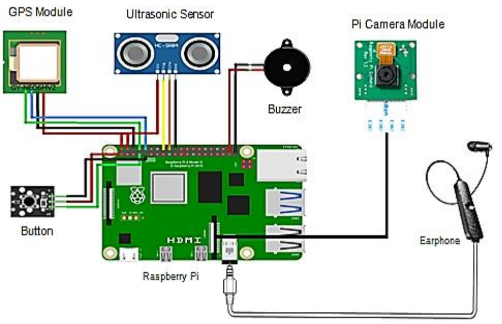

Figure 2. Schematic Diagram of the Project

The schematic diagram in Figure 2 shows the connections between the microcontroller and all of the modules. The open-source electronic platform (Raspberry Pi) serves as the microcontroller in this wireframe, which includes connected sensors and devices. This project makes use of ultrasonic sensors, camera sensors, and GPS modules. To monitor the blind appropriately, the proponents decided to include a mobile application with location monitoring and navigation. The mobile application connects to Firebase via the internet, allowing the blind's relatives to monitor them. The system is usable if the user has a mobile application and access to the internet.

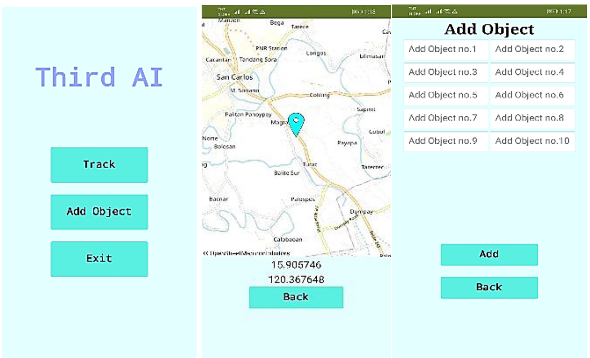

Figure 3. Mobile Application

The proponents designed the main screen or the first display of the mobile application, as illustrated on Figure 3. The first screen contains the logo and the second screen. When clicking the button Track, the main screen moves to the second screen of the mobile application where the location monitoring is, and when clicking the second button which is the Add Object the main screen moves to the third screen where the adding object is. The location monitoring is put in this screen where the user can track the location of the blind, through the use of a GPS module, the marker pinned out the location of it so it can see how the blind will go from one place to another, the coordinates are also seen in this screen. It also has a back button where you can go back to the main screen. When the user clicks the Add object button, another screen displays where the user can add an object by inputting it in the text box.

Figure 4. Modules based on Schematic Diagram

The proponents began the integration of modules for the prototype, coding the system in a step-by-step process to fulfill all the required features of the project. A suited algorithm is used as well as the language supported by the open-source electronic platform. During this phase, the proponents set a timeframe to complete the step-by-step process and must apply a variety of project management methods to track and monitor the project's development.

Following the development of the units, the proponents conducted unit testing to ensure that all of the program's smaller units' function properly and to assess whether the system is ready for the next phase of the project. This stage is repeated until the system satisfies the requirements established by the users.

After connecting the modules and sensors to the microcontroller, the proponent created a capsule that houses all of the modules and sensors as well as the microcontroller. The prototype was created by integrating it with eyewear, where other sensors and modules were also installed, as shown on Figure 4.

Figure 5. Proponents testing the Object Identification Indoor

The Thonny IDE was used to upload code and programs to the microcontroller for the sensor and modules to function wproperly as shown in Figure 5. This software is used to write code, compile code, and upload code to the Raspberry Pi. The supporters chose this software because it is both appropriate for the project and widely used. The code for detecting obstacles on the Raspberry Pi was uploaded so that supporters could determine whether or not the microcontroller was working. The ultrasonic sensor detects obstacles after uploading the code. After testing the microcontroller, the project's supporters were able to code it by connecting the Object Identification module to the Raspberry Pi. By including the Object identification module, you must also include the library required for this sensor to function. When activated, the ultrasonic sensor detects obstacles. The proponents also tested the camera module.

The proponents chose MIT App to create the actual mobile application since it has a user-friendly environment and a simple tool for generating user interfaces. Using the programming tool helps the proponents to code with ease because of some extensions such as auto-completing tags and color coding to make it readable. Proponent's code the mobile application's Firebase connection using blocks. Block contains a default command depending on the condition of the block codes, to connect the mobile application to the Raspberry Pi to get and send data. All sensors and modules are tested by the proponents as well as the I.T. expert. A project must be tested on both hardware and software. Before deployment, the project's proponents did a thorough system test, so they should be aware of the defects and errors that must be rectified for the system to function properly as shown in. During the trial, the project's proponents encountered several problems, but they were able to correct them to ensure that the project's objectives were met. Hardware faults included poor cabling for devices and sensors, as well as mistakes in software. The project's proponents rapidly addressed these difficulties, and additional testing was carried out at this point to guarantee that the prototype was built with few faults and matched the project's criteria. Regular testing and monitoring would be beneficial in determining what defects and errors may develop in this project, so that they may be addressed following the project's requirements.

Figure 6. Thonny IDE Output Serial Monitor for Face Recognition Indoor

Hardware and software testing is essential to ensure that a project is safe for users. The project's proponents tested the entire system because identifying faults and problems before project deployment is critical to ensuring system stability. Proponents run the programs to detect bugs and also to see how accurate it is when executing the software (see Figure 6). The deployment phase started with a briefing of the project prototype to the stakeholders. During this part, proponents explained to the clients the functionalities of the project. After the briefing, the proponents started to attach the prototype to the client. After the prototype was attached, the proponents initialized the software and started the testing.

Figure 7. Testing the Outdoor Mode of the Project

Following testing in the Indoor Mode, the project's proponents began testing the Outdoor Mode. The proponents informed the user of the features of the Outdoor Mode and how it differed

from the Indoor Mode at this section. The user then began testing the outdoor mode after the orientation. The user responded "motorcycle" when the proponents asked what they could hear in the earpiece.

The project's obstacle detection was then tested by asking the user to approach the motorcycle in front of them closer. As the user approached, the buzzer beeped to indicate that there was an obstacles ahead, see Figure 7.

Figure 8. Testing the Mobile Application

During the testing of the Outdoor Mode, the obstacle detection and obstacle recognition activates together with the geolocation feature of the system. The user can speak on the smartphone to activate the Google Assistant and ask for navigation. The family member can monitor the blind's outdoor location through a map that can be found inside the application. The proponents also demonstrated other functionalities of the mobile app such as adding an object to the data of object identification in the Indoor mode of the system. By inputting the specific name of the object in the textbox of the mobile application's add object function and rebooting the system to fully add the new object to the dataset, as presented on Figure 8.

4. RESULT AND CONCLUSIONS

Table 1. Blind person, Family member, and IT expert evaluation result

Blind Person	100 %
Family Member	100 %
I.T Expert	92.31 %
Total	**97.44 %**

The survey was conducted and the proponents calculated the survey findings using the survey forms that each respondent had completed and returned. According to the calculated final survey results, the project's effectiveness level is high, at 97.44%, as summarized on Table 1. The survey's findings indicate that the project needs to be improved more in order to achieve greater effectiveness, including the size and comfort of the eyeglasses.

Audio-Assisted Object Identification and Geolocation Navigation for the Blind helped the visionless in identifying known objects within the house premises and recognizing registered faces of their family members. The device aided the clients in detecting their personal belongings that they need in their daily life; the clients were also able to determine their family members in front of them.

Geolocation Navigation of the project was also reliable in giving directions when navigating from one place to another. The project also helped the blind in detecting obstacles by giving them a warning through the sound of the buzzer so that they can avoid obstacles in their path. It is a huge help that the proponents also developed a mobile application that can track the blind person's location helping the family members in monitoring their loved ones. The proponents concluded that communicating with the device through the help of Google Assistant was effectively used in the project without interruptions.

The project was evaluated by the stakeholders after testing and deployment, who gave it a 97.44% effectiveness rate. The project's supporters came to the conclusion that it has been successful in assisting blind people in recognizing objects and the faces of their family members. The project also succeeds in safely guiding the blind when they are navigating from one location to another by providing directions and identifying potential hazards. The project's supporters came to the conclusion that there is still much work to be done before it can truly benefit blind people.

5. RECOMMENDATIONS

It is recommended that the prototype's eyeglasses need to be more compact and lightweight. The cables utilized should be uniform across all modules and sufficiently flexible for both the prototype and the user. For the system to work more effectively, a more reliable internet connection is required. Additionally, it is advised that the prototype should run off of a built-in battery rather than a power bank. To make the device lighter for the blind person to carry, the Google Assistant's navigation feature should also be integrated in the system.

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