SMART NAVIGATION APPLICATION FOR VISUALLY IMPARED PEOPLE: A CASE STUDY

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Project Proposal Report

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DECLARATION

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Name	Student ID	Signature
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The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

Signature of the supervisor　　　　　　　　　　Date

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ABSTRACT

In this high-tech era, technology has made it possible that everyone can live a comfortable life. Nevertheless, physically challenged people need to depend upon others in their daily lives, even for their basic needs, making them less confident in an unfamiliar environment. Since the 1970, object recognition technologies have matured to a point at which exciting applications are becoming possible for visual substitution[1]. There are thousands of visually impaired people in this world who are usually in need of helping palms. According to the World Health Organization, there are approximately 285 million people who are visual impairments, 39 million of them are blind and 246 million have a decrease of Visual acuity. Almost 90% who are visually impaired are living in low-income countries[2]. For decades, the white cane has become a well-known attribute to blind people's navigation and later efforts have been made to enhance the cane by adding a different sensor[3]. Guide dogs can also be of limited assistance for finding the way to a remote location. The goal is to create a portable, self-contained system that will allow visually impaired individuals to travel through familiar and unfamiliar environments without the assistance of guides. Several electronic devices are currently available for providing guidance to a remote location, but these tend to be expensive, or can be used for only one purpose. The proposed Smart Navigation Application for Visually Impaired People has the ability of identifying obstacles on their way, road signs, their close relatives separately, and the household things. Furthermore, it will inform the blind person via voice through the headphone. By the implementation of the proposed solution will solve most of the problems and challenges of visually impaired people. It will allow them to travel with increased independence, safety, and confidence.

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1. INTRODUCTION

1.1. Background

The visual system, which is the most complex sensory system, transmits the majority of information for navigation and active mobility cues to humans. Because visual information is the foundation for most navigational tasks, an individual with poor vision is at a disadvantage because adequate environmental information is not available. Independence is essential for accomplishing life's desires, goals, and objectives. It is difficult for visually challenged people to go out on their own. Thousands of sight impaired people across the world require assistance from palms of their hands. The white cane has been a well-known feature of blind people's navigation for decades, and later efforts to improve the cane by adding a different sensor have been made. When using a white cane to go down the street or up the stairs, blind persons have difficulty because of their high haptic sensitivity. The computerized walking stick will aid blind individuals by providing a more convenient way of life. There are a variety of steering structures available to assist visually challenged passengers in navigating quickly and comprehensively across borders and various threats. A white cane or a steerage canine are common mobility aids for blind people.

According to a World Health Organization census, there are approximately 250 million visually impaired persons worldwide, with 40 to 45 million of them being completely blind [4]. For many years, blind people have relied on two low-tech aids: the long cane and the guide dog [5]. A number of electronic mobility aids that employ sonar [6]–[7] to identify obstacles have also been developed, but market acceptance is poor because the valuable information obtained from them is not considerably greater than that obtained from a long cane. The generated outputs are similarly difficult to comprehend.

Electronic Travel Aids are a variety of devices that let blind people move around with the help of contemporary technology (ETAs). For the blind, the most important element of ETA is the ability to obtain statistics in the form of the street and the placement of constraints when they are in unfamiliar regions. They must arrive at their destinations with these data in hand, avoiding any unanticipated obstacles. As a result, recent research efforts have been focused on developing a novel navigational system that uses a digital video camera as a visual sensor. vOICe [8, NAVI [9], SVETA [10], and CASBLIP [11] are examples of ETA devices.

The image is taken using a single video camera mounted on a helmet, and the image is scanned from left to right for sound creation in vOICe. The sound is created by converting the image's top half into high-frequency tones and the bottom half into low-frequency tones. The brightness of the pixels determines the volume of the sound. In NAVI, similar work has been done, where the collected image is downsized to 32x32 pixels and the gray scale is decreased to four levels. Image processing techniques are used to separate the foreground and background of the image. High and low intensity values are applied to the foreground and background, accordingly. The image is then transformed into stereo sound, with the loudness of the sound being proportional to the intensity of the image pixels and the frequency being inversely related to the vertical orientation of the pixels.

To calculate dense disparity pictures in SVETA, an improved area based stereo matching is done over the modified images. To reduce noise and highlight obstructions, a low texture filter and a left/right consistency check are used. The sonification process is used to transfer the disparity image to stereo musical sound. Sensors and stereo vision are used in CASBLIP to detect the object. In addition, the GPS system is used to calculate orientation. This system runs on an FPGA (Field Programmable Gate Array) (FPGA).

The most significant elements that enable blind users to readily adopt these gadgets are portability, low cost, and, most importantly, control simplicity. As a result, the ETA gadget should be tiny and light in order to be portable. Because a blind person cannot see the display panel or control buttons, the equipment must be simple to operate. Furthermore, the ETA gadget should be inexpensive enough for the average person to afford. The main goal of our proposed project is to solve all those problems and share our knowledge and resources with persons who are blind or disabled in society.

Literature Survey

Before proceeding with the project, it is searched for similar approaches taken to solve the issue and have found the following systems. There was not any system within Sri Lanka which was directly addressed the above issue, but there were some systems which were addressed the main topic, "Navigation Systems for Visually impaired people".

There was a system called, "The Blind Guider: An IT Solution for Visually Impaired People" proposed by Mallawarachchi Yashas, Maalik K. S., Ashfaq M.Z.M. , De Silva K.P.S.H. , Ragulan.S. Image Processing, OpenCV, Background subtraction, Object detection, GPS, voice recognitions were used as technologies. This application is a real time application for detecting obstacles such as staircases, potholes, pedestrian crossings and moving vehicle detection and getting current location by GPS and giving directions to travel from place to place using the mobile phone camera with voice instructions[]. This Android application will alert the user about potential roadblocks. For object detection, the system uses the Haar-Cascade, BLOB, and SURF algorithms. A machine learning technique is used by the system to detect key matching objects and for voice directions. The designed system will identify impediments for the user within a given distance, it is significantly more accurate than the white cane.

A collection of several methods has been used in the research to provide an accurate and effective results. The method analyzed the frames of the video to detect the movement of the foreground and to extract the object through the color of the object and subtract the background to enhance the foreground. Through the background subtracted image the feature detection been run to identify the foreground. Parallel the audio analysis has also been commenced to recognize the objects that appears in front of the system. The system has divided in to seven main parts.

1. Pothole Detection
2. Staircases Detection
3. Pedestrian-Crossing Detection
4. Moving vehicle detection
5. Obstacle Detection
6. Accurate Determination of Position
7. Enable Voice Conversation

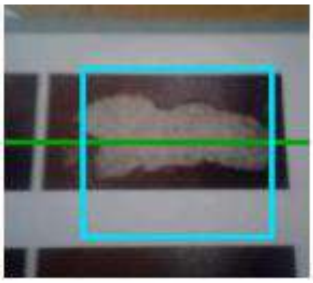

Figure 1.1.1.: Image of a pothole detection

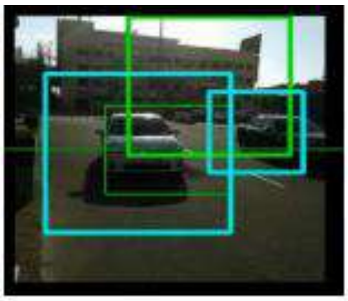

Figure 1.1.2.: Image from camera frame

Figure 1.1.3.: Determination of the position

The results have been conducted to evaluate the performance of the proposed method. Those results have been obtained using the detection and tracking algorithms that have been discussed above. Fig.2 shows the pothole detection. Fig.3 shows the results for moving vehicle detection and fig.4 shows the determination of the position. After recognition of features, outputs are given as audio using headphones.

Though the system is accurate there are some limitations. This system cannot be used in the dim light and the night-time, and the user can see only one side at one time. The developed system has successfully modelled the object detection using Image processing. This application has developed user friendly and more effectively for blind users. Due to a combination of several methods, the application's accuracy and efficiency have been increased. There have been used background subtraction, motion detection, edge detection and also feature extraction in open-source computer vision (OpenCV) to develop this application. After the obstacles were detected through the camera of the mobile phone, the image processing results have been converted into voice instructions to the user. This application is a low-cost application when comparing to other equipment available in the market. Thus, this system has been increased the confidence of blind people by giving them the proper information of the objects around them and enabling them to move independently in indoor and outdoor environment.

CUP----"Blind Assist" is also a system proposed by Oluwaseyitan Joshua Durodola, Nathaniel Sims and Chris Uruquhart from Department of Electrical and Computer Engineering Howard University. The aim of this project is to propose a portable device, designed for visually impaired individuals to assist them with getting around. This device, unlike most commercially available assistive devices, it gives instructions to sites and warn the user of difficulties along their way. The system offers these functionalities through components including a sonar sensor, GPS receiver, and an Internet modem. The avoidance system has used sonar to detect objects to protect users from collisions with obstacles. The sonar sensor is connected to a microcontroller that sends data back to the Tunnel Creek Board for processing. Then the system sends a command to the user alerting them of upcoming obstacles. But the device is not intended to replace the use of walking canes or guide dogs.

Trekker is a talking GPS system. The Trekker Breeze is a one-handed talking GPS that can be used anywhere. While walking, it broadcasts the names of streets, intersections, and landmarks. This device allows the blind person greater freedom and the independence of having to stop and getting help by others. The Breeze is also quick to pick up on new routes that you take. With the addition of a simple push button, they also offer a feature that allows you to effortlessly retrace your steps if you get lost.

The Kapten Plus is also a GPS unit for the visually impaired. It has a high-performance GPS system as well as free navigation modes that deliver real-time speech descriptions of what's going on around the user. It has automated speech recognition, allowing the user to control the gadget just by speaking. It also has a multitransport navigation mode that distinguishes between walking, biking, riding a motorcycle, and driving. A voice-activated FM radio and an MP3 player are also included with the Kapten.

The WuFu is a device that measures closeness. Ultrasonic distance measurements are used in this gadget. It employs ultrasonic sensors to detect obstructions in the user's path. It then sends a signal to motors on the wearer's wrists, which vibrate, alerting them to an obstacle.

HandGuide Talking Solutions detects items within four feet using high-tech infrared sensors. It has two modes for detecting things and determining their distance from you. Pitch variation is used in audio modes, whereas vibration variation is used in vibration mode.

Sign Classification for the Visually Impaired – is proposed by Marwan A. Mattar, Allen R. Hanson and Eric G. Learned-Miller. The system is composed of two main components, sign detection and recognition. The sign detector uses a conditional maximum entropy model to find regions in an image that correspond to a sign. The sign recognizer matches the hypothesized sign regions with sign images in a database. The system determines if the most likely sign is correct or whether the hypothesized sign region belongs to a database sign. Changes in lighting, orientation, and viewing angle are all examples of variability in data sets. This paper gives a general overview of the system as well as the performance of its two main components, with a focus on the recognition phase. They have tested on 3,975 sign images from two different data sets, the recognition phase has achieved 99.5% with 35 distinct signs and 92.8% with 65 distinct signs.

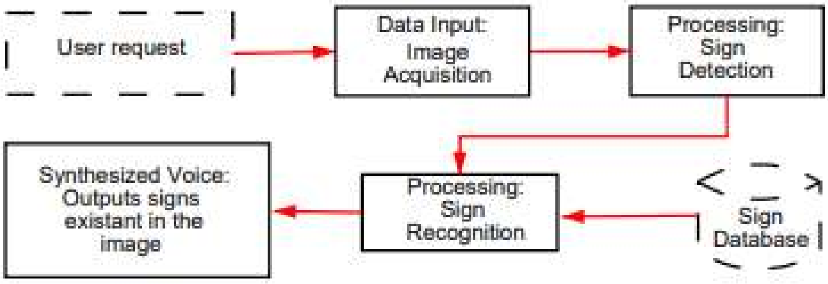

Figure 1.1.4.: System Layout: An overview of the four modules.

The wearable system will be composed of four modules (Figure 1). They have presented algorithms for sign detection and recognition for a wearable system to be used by the blind. To discover sign areas in an image, the sign detector employs a variety of characteristics and a conditional random field classifier. The sign recognizer compares each of the hypothesized sign areas to a database of sign classes, then determines if the highest matched class is the correct one or if the region does not belong to any of the sign classes.

1.2.Research Gap

	Research A [1]	Research B [2]	Research C [3]	Research D [4]	Researc h E [5]	Research F [6]	**Smart Navigation Tool**
Indoor Sign Detection	✓	✗	✗	✗	✗	✗	✓
Outdoor Sign Detection	✓	✗	✗	✗	✗	✗	✓
Notify user via Voice mode	✓	✓	✓	✓	✗	✗	✓
Identify text in signs	✓	✗	✓	✗	✗	✗	✓
Overcome lighting conditions.	✗	✓	✗	✗	✓	✓	✓
Overcome different viewing angels	✗	✓	✗	✗	✗	✗	✓
Occlusion and Cutter	✗	✗	✗	✗	✗	✗	✓
Cover all the colours and shapes that signs can posses	✗	✗	✗	✗	✗	✗	✓

Figure 1.2.1. Research gap table

The majority of the studies and apps I cited previously are incapable of making decisions. The majority of the study is focused on developing new machine learning models and identifying new technologies that can more effectively detect basic road signs and indoor signage. Research A[1] is the only one which is able to detect indoor and outdoor sign, texts in signs and which is able to notify user via voice mode. Research B[2] is the only system which has abled to overcome lighting conditions and different viewing angels' problems. Notifying user via voice mode has achieved by research A, B,C and D. So, we can see there is not any other system which is able to decision making. In our proposed system, user will be able to make decisions using the tool. When there are two pedestrian crossings near by the user, they will notify about the closest pedestrian crossing. So, user can make decision about, which pedestrian crossing they are going to use.

1.3 Research Problem

Figure 1.3.1 signs

Computer vision and image processing techniques have been used in a variety of autonomous systems throughout the last two decades. In this branch of research, there has been tremendous advancement. Existing computer vision research reveals that identification systems with a high recognition rate can detect and discriminate a wide range of items, including license plates, road signs, and handwriting [13, 14, 12]. Facial recognition, malignant cell detection, and other medical disease analyzers are examples of important systems that have emerged from this discipline [15, 16, 17, 18, 19]. Only a few articles, however, have focused on computer-visual-aid systems for the blind. Furthermore, the majority of articles have not yet been fully incorporated [20,21]. The majority of existing solutions are theoretical and in the early stages of development.

Due to external environmental issues such as crowded backgrounds, obscured objects, changing illumination, and other restrictions, many computer vision problems remain unresolved. Pattern recognition and picture understanding are two of the most difficult problems to solve. There is still much to be done in this field of research, thus more research efforts are critical.

One of the objectives of this suggested study is to contribute to computer vision research by developing a reliable and effective sign recognition system. This technology seeks to assist visually impaired people in real-time navigating unfamiliar situations. I, for one, will only support a limited number of navigational markers with clean backgrounds and minimal color distraction. This system will notify the user of the presence and orientation of a sign (from a selected group) in front of them in order to effectively assist them.

2. OBJECTIVES

2.1. Main objectives

Wayfinding and navigation are aided by signage, which helps blind persons navigate unfamiliar areas. Proposed system will offer a novel camera-based approach for automatically detecting and recognizing restroom and road signage in the context of surrounding settings in this research. The proposed system will present a real-time system that can recognize a variety of indoor and outdoor navigational indicators placed over clear backgrounds to help them with this difficulty. The sign selection will be made up of common samples from a variety of indoor and outdoor sign kinds. The strategy is to determine the region of interest (ROI) that contains the sign in a taken image and then extract this region for classification using image processing techniques.

2.2. Specific objectives

Road signs play a significant role in assisting people when navigating as they provide directional information.

1). Capture images using a camera.

a). The proposed solution can be equipped with a hand-held or wearable device.

2). Detect the presence of a road sign on a given image.

a). Detect the shape of the road sign using Shape detection algorithm.

3). Classify the sign by color and shape.

a). Unify the colors of the image. (Red, Green, Blue, Yellow) (Using machine learning algorithm called K-means Clustering)

i). Identify prohibiting signs – red
ii). Identify common guiding-signs – green
iii). Identify caution signs – yellow
iv). Identify room-labelling signs - blue

b). Sign Recognition: SURF

4). Mask out the background of the sign.

5). If the sign has been recognized, notify the user about the specific sign via voice sounds.

3. METHODOLOGY

The proposed system "SNA" tool is smart navigation application for visually impaired people. The system is capable of,

- Identifying obstacles on their way
- Identifying road signs
- Identifying their close relatives separately
- Identifying the household things

Specifically, Traffic Sign Recognition (TSR) reflects standards in place to keep you safe in an urban setting, and it helps to deliver information to drivers and pedestrians that can assist preserve order and decrease accidents. Automatic traffic sign detection and identification that is fast and accurate in real time can help and relieve visually impaired pedestrians, increasing their safety and comfort. In general, traffic signs give a range of information to pedestrians for safe and efficient travel.

The concept of traffic sign classification and recognition will be used here, as well as the dataset we'll utilize to train our own custom traffic sign classifier. After that, we'll use Road Sign Net, a Convolutional Neural Network that we'll train using our dataset.

Here I have divided traffic sign recognition in to two parts:

1. **Localization:** Detect and localize where in an input image/frame a traffic sign is.

2. **Recognition:** Take the localized ROI and recognize and *classify* the traffic sign.

In a single forward-pass of the network, deep learning object detectors will conduct localization and recognition.

When we are going to train our model, CNN model has the limitation of not being able to be trained on images of diverse dimensions. As a result, images of the same dimension must be included in the dataset. First, we have to look at the dimensions of all the images in the collection to see if we can process them to be the same size. If images in our dataset contain a wide variety of dimension so, Images must be compressed or interpolated to a single dimension. To compress a large amount of data while not stretching the image too much, we must choose a dimension that is halfway between the two and maintain the image data mainly correct. Then will use chosen 64*64*3 as my dimension. For this process I will use OpenCV and INTER AREA interpolation method will be used. For image decimation, it is preferred. I will now load the dataset and transform it to the specified dimension.

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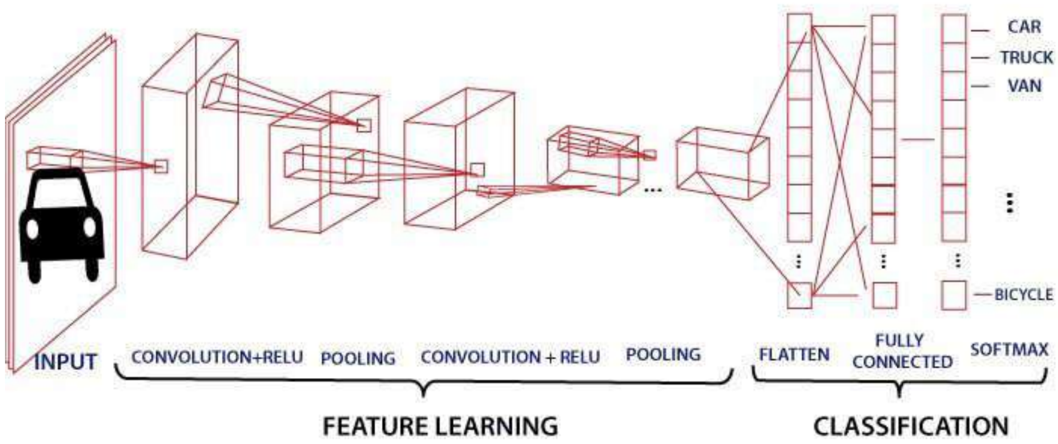
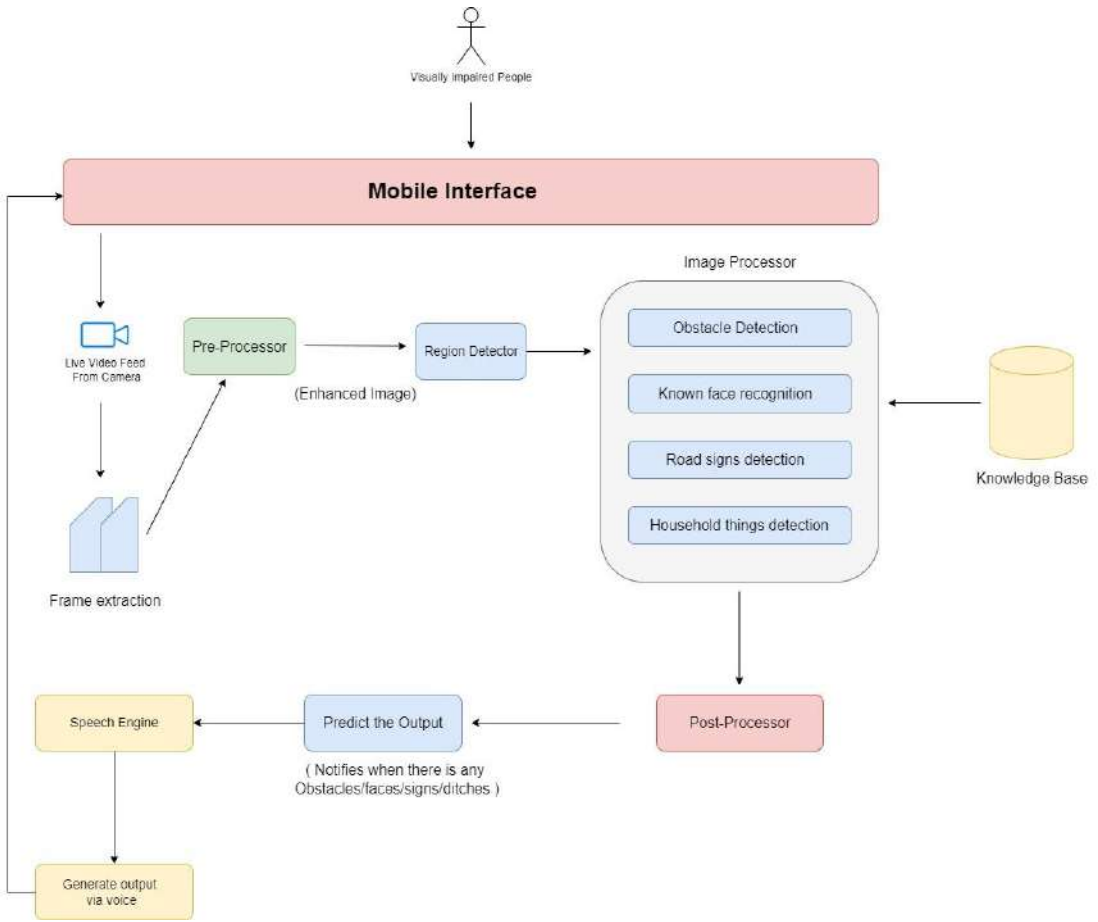


Figure 3.1.1. feature diagram

There are a total of 43 classes in the dataset. In other words, the dataset contains 43 different types of traffic signs, each of which has its own folder with photos of various sizes and clarity. In total, there are 39209 photos in the dataset. After that I will randomize data set and divide into training and testing set. I will use Keras package for training the model. Here we will train our model for detect to Traffic signs and indoor traffic signs.

3.1. System Architecture



Indoor and Outdoor Sign Detection.

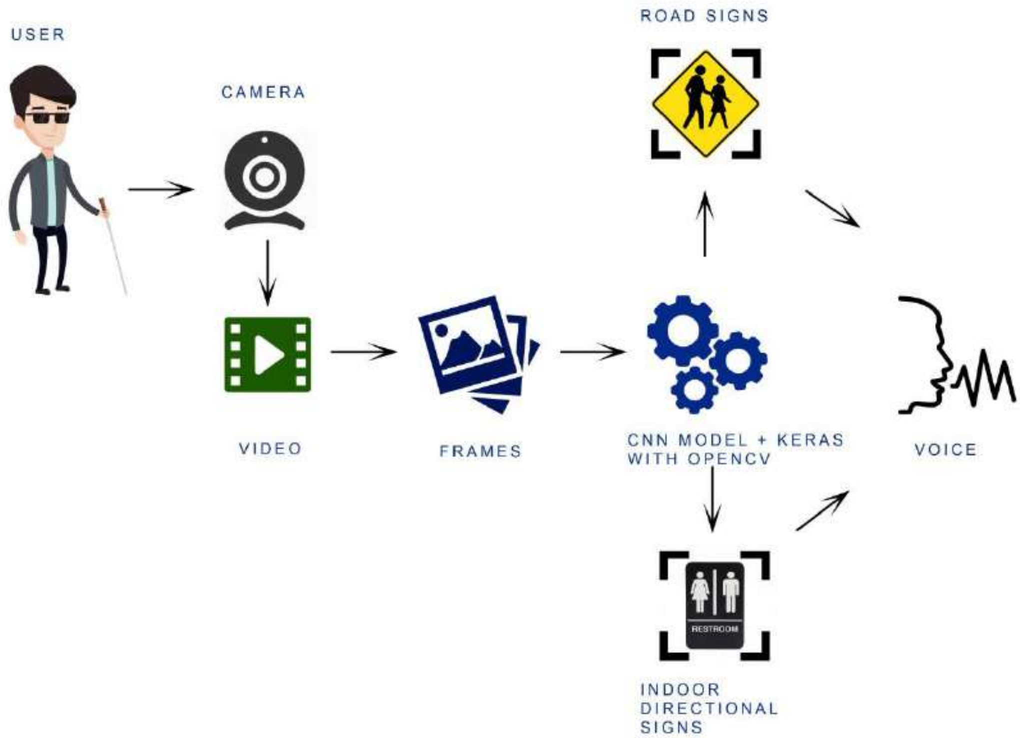


Figure 3.1.3.: individual functional diagram

3.1.1. Software Solution

Agile

Figure 3.1.1.1.: agile methodology

Agile software development is a collection of iterative software development approaches in which requirements and solutions emerge from cooperation among self-organizing cross-functional teams. Agile methods or Agile processes promote a disciplined project management process that encourages frequent inspection and adaptation, a leadership philosophy that encourages teamwork, self-organization, and accountability, a set of engineering best practices that allow for rapid delivery of high-quality software, and a business approach that aligns development with customer needs and company goals. Any development approach that adheres to the Agile Manifesto's principles is referred to as agile development. The Manifesto was written by a group of fourteen software industry leaders, and it reflects their knowledge of what approaches work and don't work in software development.

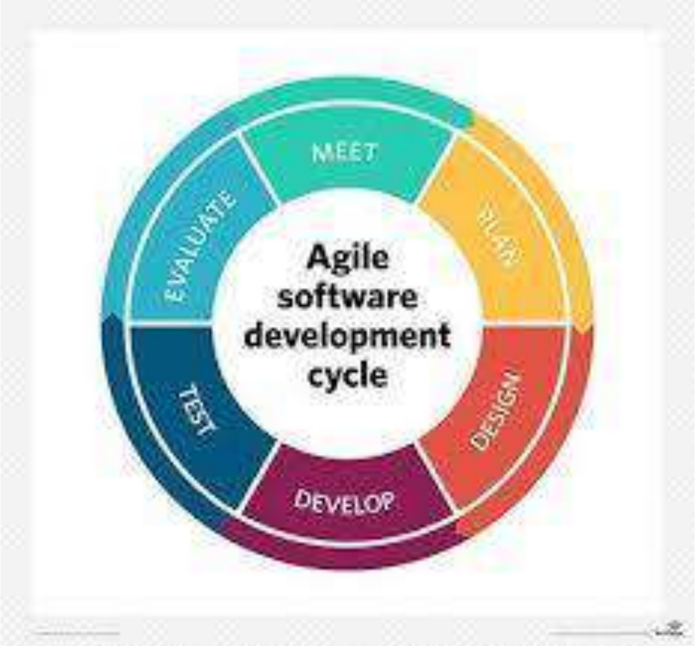


Figure 3.1.1.2.: agile methodology

Local and global image properties can be loosely divided into two types. Global features like texture descriptors are computed throughout the entire image and result in a single feature vector per image. Local features, on the other hand, are computed at many sites throughout the image and characterize the image patches that surround these points. For each image, the outcome is a set of feature vectors. The dimensionality of all feature vectors is the same, but the number of features produced by each image varies depending on the interest point detector utilized and the image content. Global features are easier to utilize with a conventional classification algorithm because they provide a more compact representation of an image (e.g. support vector machines). Local features, on the other hand, have a number of characteristics that make them more suitable for our application. Local features are computed at many places of interest in an image, making them more resistant to clutter and occlusion and obviating the need for segmentation. Given the sign detector's current level of imperfection, we must account for inaccuracies in the sign's outline. Local features have also proven to be quite effective in a variety of object recognition applications.

Color Segmentation.

To extract the pure color information from the redundant intensity information, the photos will be converted from the conventional red-green-blue(RGB) format to a hue-saturation-value(HSV) format. Color segmentation will be accomplished by extracting sections of saturation and hue from HSV images and using a simple median filter to normalize the intensity values. We're looking for the following colors for the indoor signs: red, green, blue, and yellow. To distinguish the sign from the backdrop, a binary mask will be produced for each color. This will be accomplished by canceling all other complementary colors from the color of interest using a bitwise operation.

Shape detection.

The contours of convex regions of a Canny filtered image are used by the shape detection technique. We'll extract all contours in the image and group vectors that create convex regions to find forms. These regions' shapes will then be approximated. Andrew Kirillov's work was used to create our shape extraction methods. To get all of the contours in the image, the technique employs OpenCV's f indContours() function. This divides contours that are close to each other into separate elements. We go through each element, selecting from the collection AllConvexShapes any elements with inner angles smaller than 180.

3.1.2. Hardware solution

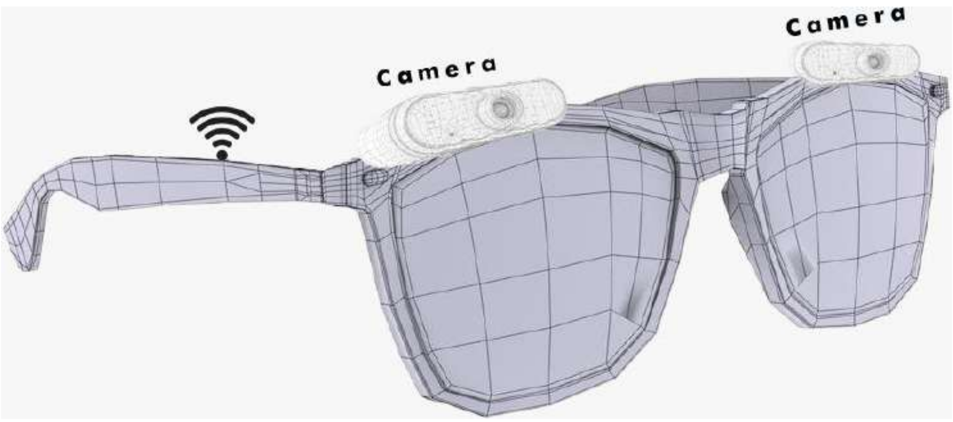


Figure 3.1.2.1.: hardware solution

Nearby impediments and moving things, including translucent objects like glass, can be detected by the two cameras incorporated in the glasses. The device can also recognize faces, read signs, and identify items using artificial intelligence. Finally, the high-quality speakers included in the package can deliver audible commands.

3.1.3. Evolution plan

Figure 3.1.3.1. evaluation plan

4. DESCRIPTION OF PERSONAL AND FACILITIES

Visual information abounds in our world, which a sighted person uses on a regular basis. Unfortunately, the visually challenged are denied access to such information, limiting their mobility in open spaces. To aid with this, we're working on a wearable device that can detect and recognize indicators in natural settings. Sign detection and identification are the two key components of the system. The sign detector finds regions in an image that correlate to a sign using a conditional maximum entropy model. The sign recognizer looks for sign images in a database that match the hypothesized sign regions. The system determines if the most likely sign is correct or whether the hypothesized sign region belongs to a database sign. Our data sets cover a wide range of variables, such as lighting, orientation, and viewing angle variations. We offer an overview of the system as well as the performance of its two main components in this work, with a focus on the recognition phase. Unlike most past research, our approach is not restricted to recognizing a single type of indicator, such as text or traffic. A "sign" is just any physical object that displays information that may be useful to the blind in this application. This system has a number of difficulties, the majority of which derive from the environment's high fluctuation. The wide range of lighting conditions, varying viewing angles, occlusion and clutter, as well as the wide variation in text, symbolic structure, color, and shape that signs can have, may all contribute to this variability.

5. REQUIREMENTS

5.1. Functional Requirements

Table 5.1.1.: functional requirements.

Requirement ID	The Requirement	Addressing the Requirement
1	Extract features	The video will be split into frame and the images will be used to detect the indoor or outdoor signage.
2	Identify signage	Using real time images for detect the signage using by CNN model + Keras.
3	Identify closest signage.	Using real time images for detect the signage using by CNN model + Keras.
4	Make a decision for close signage.	According to obstacle distance give user a message about signage.
5	Generate a voice notification about signage.	After identifying the signage, convert them into voice command.

5.2. Non-Functional Requirements

Table 5.1.2.: non-functional requirements

Requirement ID	The non-functional Requirement
1	**Security**- This non-functional requirement ensures that all data is protected from ransomware attacks and unauthorized access inside the device or a portion of it.
2	**Performance** - Defines how quickly a software system or one of its core components responds to the actions of certain users during a given workload.
3	**Reliability** - This quality feature estimates the likelihood of the device or its component operating without failure under predefined conditions for a specific amount of time. It's usually represented as a percentage of the possibility. For example, if the device has an 85 percent dependability for a month, there is an 85 percent chance that the system will not extinguish during that month under normal operating settings.

5.3. User Requirements

- User should be able to notify indoor signs.
- User should be able to notify outdoor signs.
- User should be able to identify the direction of the sign.
- User should be able to get voice assistance.
- User should be able to operate the system independently.

6. GANTT CHART

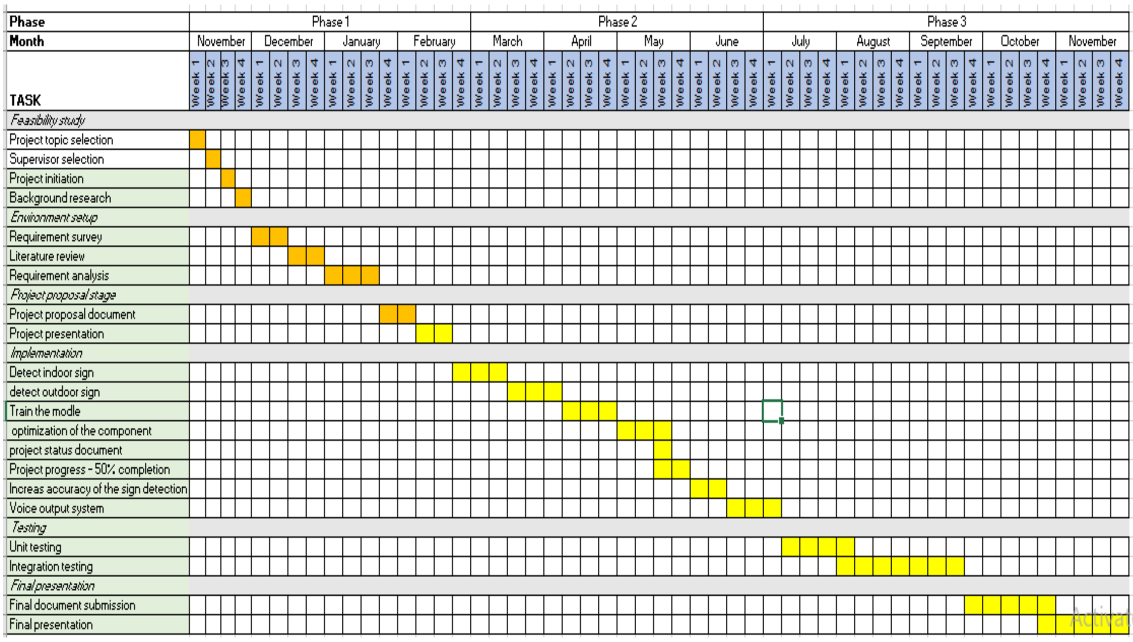


Figure 6.1.: Gantt chart

7. WORK BREAKDOWN STRUCTURE

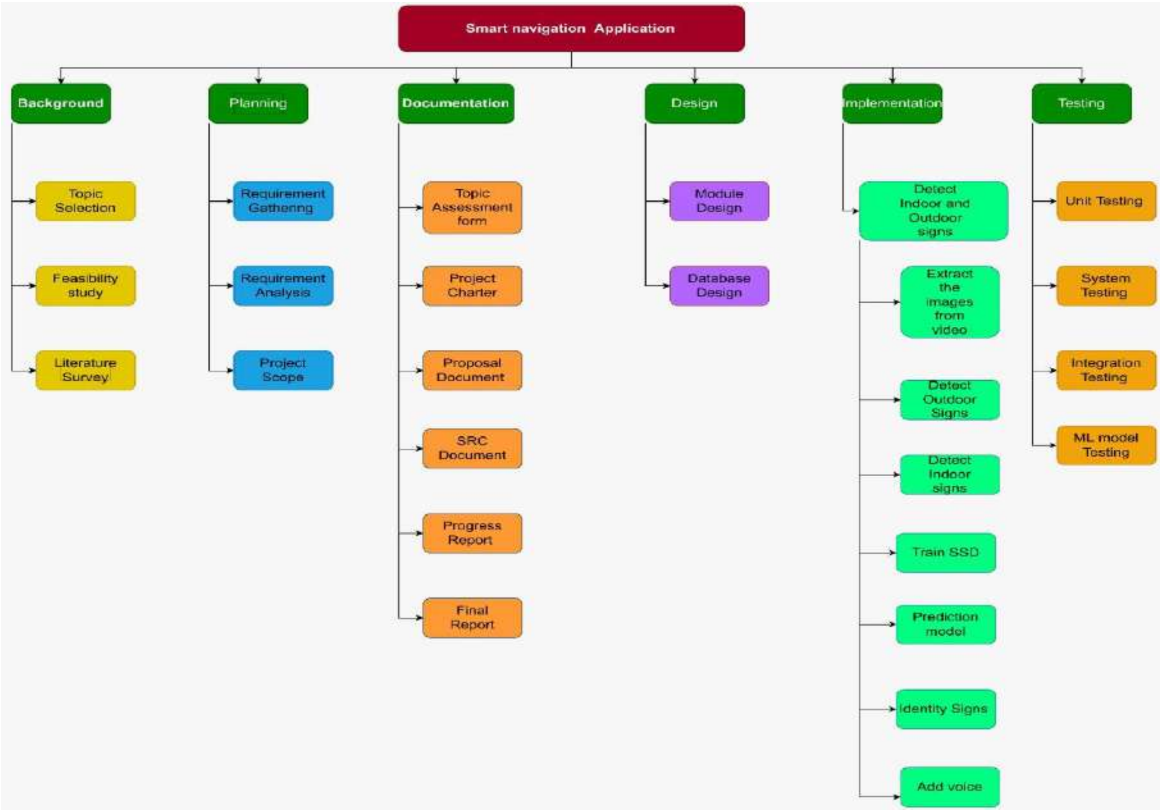
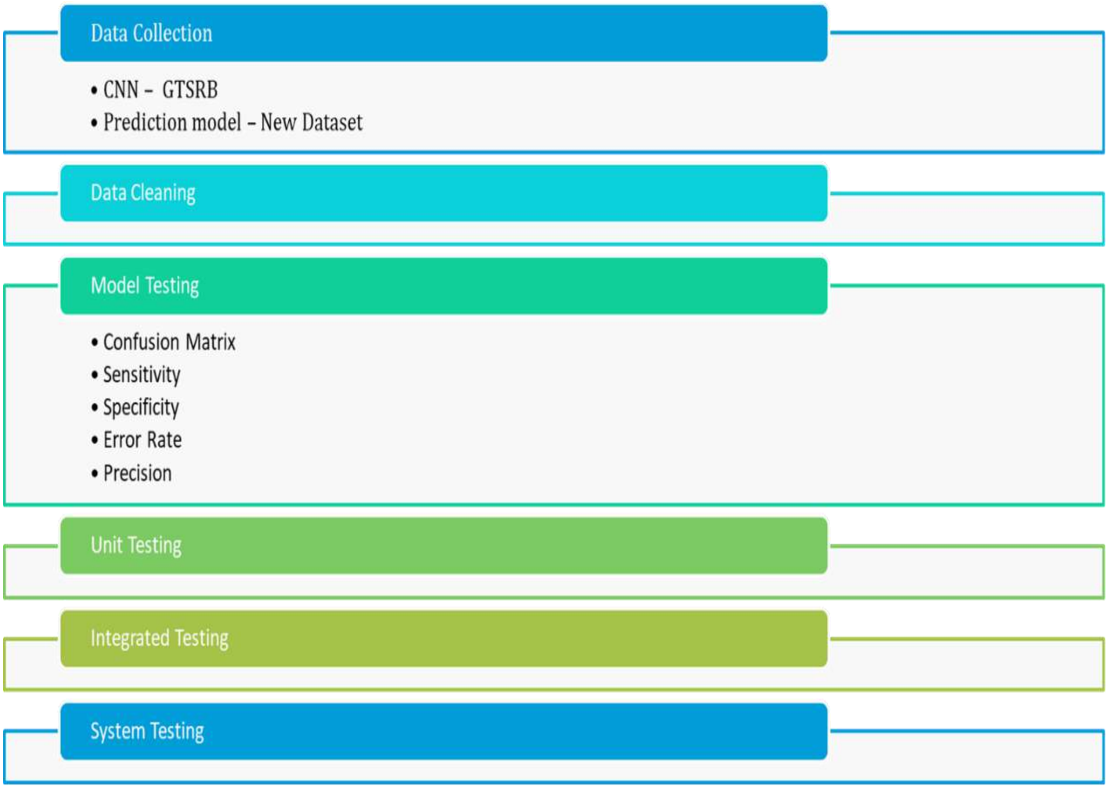


Figure 7.1.: work breakdown chart

8. SELF EVALUATION PLAN



9. BUDGET AND BUDGET JUSTIFICATION

Table 9.1.: budget chart

Resource Type	**Amount [LKR]**
Internet usage for researching	Rs. 5000
Domain name registration (annual)	Rs. 3000
Hosting (annual)	Rs. 10000
Other costs (Data Collection, Travelling Expenses)	Rs. 10000
Total	**Rs. 28000**

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