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

Vision is one of most significant human senses and it perform a major part in human perception of the world. Visually impaired people face so many difficulties in day to day. As result thousands of research papers and articles on these topics have been published. Several guiding systems for vision-impaired persons have been created, however they are often costly and require a client-server method. The majority of assistive technologies presume a regulated and controlled environment, severely restricting their usability. So, our objective is to develop a portable, low-cost technology that will enable blind individuals to move through both familiar and unfamiliar surroundings without aid of guides. our navigation system is made up of four parts: perceiving the near environment for blind individuals to move through (e.g., barriers and dangers), detecting road signs and indoor signs, recognizing user relations, and discovering home items. The designed system will identify impediments for the user within a given distance, it is significantly more accurate than the white cane. Our system identifying obstacles and surface texture and provides sufficient information form audio output to user. We will develop realistic datasets for a variety of settings and used them to test deep neural networks for object detection. By use of our system, it would help them to see the world and assistance them for safety journey. All these modules make life easier for blind people. In this approach, we want to further expand the initiative so that blind individuals may enjoy their lives.

Contents

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1. Background

According to the world Blind union there are around 253 million persons who are blind or partially sighted. Worldwide 36 million of them are blind and rest 217 million of them have an impairment in visually acuity. Visually handicapped people make up about 90% of the population in law income nations. Despite having just 51 percent of world's population, three Asian regions are home to 62 percent of the world's persons with vision impairment.

Mobility is one of the most significant issues that visually impaired people face in day today lives. They have used navigational aids such as white canes, guided dogs, and other similar devices for decades. A long white cane is a classic mobility device used by blind people to identify obstacles in their route. Guide dogs can also provide some navigational help.

Numerous various forms of navigational aids are now available to assist the blind as a result of the advancement of modern technology. Electronic travel aids are the popular name for them. Since the first ETs were launched twelve years ago researchers have focused their effort on developing better aids, but they have yet to materialized [20]. Until, yet none of the existing aids has met all of the criteria for fully satisfying user expectations.

Our goal is to develop high accuracy and fast obstacle detection tool for law cost. Visually impaired people will be able to move through familiar and unfamiliar location without any hesitate.

As the solution for this problem, we are proposing a navigation application (SNA) for visually impaired people. Using SNA, they can walk as a robust. The system will help blind people to see the world and assist them for safe journey. The proposed Smart Navigation Application for Visually Impaired People has the ability of identifying obstacles on their way, identifying indoor and outdoor road signs, their close relatives separately, and the household things.

In the proposed system my responsibility is to identify obstacles on their way and provide information about the obstacle surface. The suggested system takes real time photos. Then pre-process them, … the background and foreground and applies the DNN module with a pre trained YOLO model. To identify the item, retrieved features are compared to known object's features. The object name is delivered to user through voice output once the obstacle has been correctly detected.

The major function of this object in the system is to recognize obstacles in real time and assign them to previously defined classes. The algorithms we used are more efficient in terms of computation. Previously, object detection was accomplished using RFID and IR technologies, which necessitated the purchase of specialized hardware. However, with the introduction of image processing and neural networks, we no longer require nearly as much additional gear. Nowadays, almost everything has a camera, from pens to cell phones. This has spawned a new discipline known as computer vision, which involves using images and videos to recognize, separate, and track things in order to comprehend a real-world scenario. We are hoping to use technologies like background subtraction, motion detection, edge detection and also feature extraction in open-source computer vision (OpenCV) to develop this application.

Literature Survey

At the very least, there have been some attempts to assist visually impaired people with their regular routines. The majority of initiatives combine new revolutionary technologies with old goods carried by blind persons. This reduces the number of objects that blind persons must carry. Remote human assistance services are also available, in which blind people are aided remotely on various chores via telecommunications. Large corporations are more likely to use the latter.

Foo et al [7] released another intriguing paper targeted at assisting visually challenged people with grocery shopping. Buying groceries with visually challenged people can be highly expensive for supermarket retailers. This app has the ability to assist people in purchasing food on their own. Food consumption is a regular requirement for visually challenged persons; therefore, this might make their lives easier. This tool used core computer vision technologies: object recognition, audio localization and text-to-speech notifications.

One of the hallmarks of the Grozi project was its ability to help a person locate an aisle using sound localization and recognize products and aisle sections using object recognition. A multi-dimensional microphone system was utilized to locate the true 3-dimensional scene location of each isle after a certain audio was played repeatedly. While this is a realistic option, it can only be used in quiet areas. This is exceedingly implausible, given how noisy grocery stores may be throughout the day. An image-based recognition technique that recognizes QR-codes placed at the start of aisles, on the other hand, may be more effective.

In [12], the authors proposed a blind stick for visually impaired people for navigation. They created the system and integrated it into the smart pole to help with obstacle detection and path finding. The ultrasonic sensor detects obstacles, while the buzzer serves as an alert. The method is only used for a short distance, and the visually impaired person can only find within that region. In addition, the stick gives blind people personal independence.

They developed a low-cost, user-friendly smart blind navigation system in [13], which they deployed for the mobility of visually impaired persons within a short distance. The barrier's reflected range is measured using an infrared sensor device. The microcontroller is in charge of the reflected range and the entire system.

The infrared sensor is used to detect up and down movement in the stairs, making it an effective smart stick for blind people [14]. The ultrasonic sensing element is used to identify obstacles, and the entire system is controlled by a microprocessor. The entire integrated system is wired, with the potential for wireless expansion in the future.

Ultrasonic Blind walking Stick [15], is developed using Ultrasonic sensor. The primary goal of this instrument is to address the drawbacks of traditional stick instruments. The ultrasonic sensing element is used to detect obstacles in the field of vision of visually impaired people. This device can detect slopes, as well as up and down locations, with pinpoint accuracy. This blind stick can identify impediments and obstacles, especially when disabled people are travelling alone in higher muddy areas.

Mishra and Koley [16] developed a very low-cost equipment to find the location and whereabout of the sight affected or blind person. The goal is to eliminate the need for a guide to discover a location for a vision-impaired individual in a distant area and to produce low-cost equipment. For location information, a GPS tracking system is used, and an ultrasonic sensor is used to detect obstacles. For data transmission and receiving, the system also included a voice-based system communication protocol.

The authors created an electronic traveler aid for visually impaired individuals in [17]. The system described above is a single-board processing system. The author uses this kit to record a picture that is in front of blind people, process it using fuzzy clustering algorithms to create real-time images, and then transport it to blind individuals using stereo earphones. The image is processed, and the outcome is stereo sound. The system is built on several image processing procedures that automatically determine the position and location using fuzzy logic systems, which are intelligent decision-making techniques.

The Smart Stick for Blind Those [18] is proposed, and it is used to change the lifestyle of people who are visually impaired. The ultrasonic sensor element is used to identify the barrier in this system, and the Arduino uno is employed as the microcontroller. The technology uses location tracking to track visually challenged persons by family members, which is particularly valuable for monitoring them.

Researchers have developed and implemented a variety of methods and equipment to assist visually impaired persons, however due to recent technology advancements, there is still room for additional discoveries and advances. A survey of those folks is absolutely needed today to find out about their difficulties, anguish, and struggles so that we can go on with these results and developments.

Indriya, which means "organ," is a handheld tiny gadget or companion for the blind. It is one of the most recent and important developments in this smart guidance system. AI is also being used in the development of new products for the visually handicapped. The AI glasses, which include intelligent approaches for location finding and impediment identification and are a real aid or companion to the blind, are one key product to consider.

1.2. Research Gap

Feature	Research A [1]	Research B [2]	Research C [3]	Research D [4]	Research E [5]	Smart Navigation Application
Object detection	✓	✓	✓	✓	✓	✓
Close object warning	✗	✗	✓	✗	✗	✓
Voice assistant	✗	✓	✗	✓	✓	✓
Surface detection	✗	✗	✗	✗	✗	✓
Pothole detection	✗	✗	✗	✗	✓	✓

Figure 1.2.1 Research Gap Table

Most of the research and applications I have mentioned earlier is not used to detect surface for blind people. Most of the research have done to develop new machine learning models and identify new technologies which can detect basic objects and obstacles more accurately. Research E [5] is the only one which can detect objects and pothole, and which is able to give the voice assistant too. Also, research C [3] is the only one which can identify close objects and notify the user about it. Any of the existing solutions are not able to detect surface of the object and notify user about it. In our proposed system, surface of the path or an obstacle will be captured by the camera and analyze them using image processing and machine learning technologies. Then the user will be notified about dangerous and slippery surfaces.

1.3. Research Problem

The current human world population is 7.9 billion by January 2022 [8] and out of this, a whopping 2.2 billion suffer some sort of vision impairment including near vision impairment, distance vision impairment, partial blindness, and complete blindness [9]. It was estimated in 2010 that approximately a 45 million of the world population are blind and 246 million of them suffer low vision [10]. Moreover, about 87% of the visually impaired people live in developing countries and a clear majority of all visually impaired (82%) are aged over 50 [11].

As per above statistics, a considerable vast community suffers from blindness or other forms of vision impairments. Also, it can be observed that a vast majority of them are over 50 years of age which results disability caused by the visual limitations. Vision lost is one of the leading causes of disability specially among older adults [12] and will cause reduced quality of life which in turn increases depression, anxiety, other sicknesses due to limited motion. As Pawel Strumillo states "Vision loss is the most serious sensory disability that causes approx. 90% depravation of entire multi sense perception for a human" [11].

and other pedestrian aids and guide dog accessories were evolved. But these conventional methods of mobility aids for the blinds can only be as discussed above, since a majority of visually impaired people reside in developing countries and survive in low-income settings, it creates an additional hindrance in performing their daily chores and limit their development within the society. Even basic aspects such as independently walking from some place to another is a challenge for a visually impaired person which in return further shrink their scope of being a part of a society and an economy [15]. To address this issue and to try and ease the sensory disability, mobility aiding products such as braille signs and labels, magnifiers, special lighting to aid low vision, canes stretched so far which is still far from perfection. To minimize this gap, modern technology has stepped up with various products. Within this framework, two major research areas were developed. The first one is to deal with the identification of vision factors and the other one is to deal with the sensing of moving objects around the user to facilitate independent safe travel from one place to another [13][14].

Since the currently available technical solutions for the above-mentioned objectives are expensive [14], aim of this innovation is to develop a cheaper alternative for this.

2. OBJECTIVES

2.1. Main objectives

Object recognition is a classical problem in computer vision: The task of identifying of the image data contains a given object is known as object recognition, and it is observed that general object recognition algorithms leverage features extraction. Local features are the ones that have gotten the most attention in recent years. The key concept is to concentrate on the locations with the most discriminative data.

2.2.Specific Objectives

They will be able to recognize different objects just by pointing the camera around themselves in order to determine the object's size and relative distance from them.

1). Capture images using a camera.

> a). In proposing system objects detection and classification will be done using MobileNet SSD + deep neural network (DNN) module in OpenCV which detects the object and walking surface and classifies them into different categories.
> b). Masked out the background of the obstacle and surface.

2). After classification, the distance of the object from the camera will be found.

> a). After calculating the minimum distance from that is taken because at one time many objects are recognized, and it will create chaos for the user as the user will be hearing about the object and the distance via voice sound.
> b). So, the minimum distance object is taken into consideration.

3). Different properties like size, name and their relative distance from the user is gathered.

4). All the functionalities are communicated to the user through voice commands.

5). If the object is too close, User will get a warning voice command to alert the user for possible collision.

3. METHODOLOGY

The suggest “SNA tool” (smart navigation application) is smart navigation for who are blind or visually impaired that has capability of,

1. Obstacle and surface detection
2. Indoor and outdoor road sign detection
3. Detect face and recognized relatives
4. Detect household.

The SNA will be designed to offer portable remedies to problem such as unable to identify uneven surface, open manhole, pothole and indoor and outdoor road signs.

For obstacle detection open manhole, pothole and surface detect several solutions have previously been created. That use machine learning, image processing and deep learning technologies. However, utilizing the best technology to recognize parts of an image with more accuracy while lowering detection time is challenging task.

There are three basic object detection approaches to deep learning-based object detection:

- Faster R-CNNs (Ren et al., 2015)
- You Only Look Once (YOLO) (Redmon et al., 2015)
- Single Shot Detectors (SSDs) (Liu et al., 2015)

To create our object detector, we'll utilize the MobileNet SSD + deep neural network (DNN) module in OpenCV. Because single shot detectors (SSDs) are faster than YOLO and algorithm is more straightforward. Also get a considerably higher FPS throughput than Ren et al., ranging from 22 to 46 FPS depending on whatever network variation we utilize. SSDs are also more accurate than YOLO drives.

The Backbone Model and the SSD Head are the two components of an SSD. As a feature extractor, the Backbone Model is a pre-trained image categorization network. In most models, the fully linked classification layer is omitted. SSD Head is a series of convolutional layers that has been added to this backbone, and the outputs are interpreted as bounding boxes and classifications of objects in the spatial position of the activations of the final layer.

SSD splits the image into grids, with each grid cell is charge of detecting things in that area. If no item is discovered, we output nothing, or to be more accurate, we output a "0" indicating that no object was found.

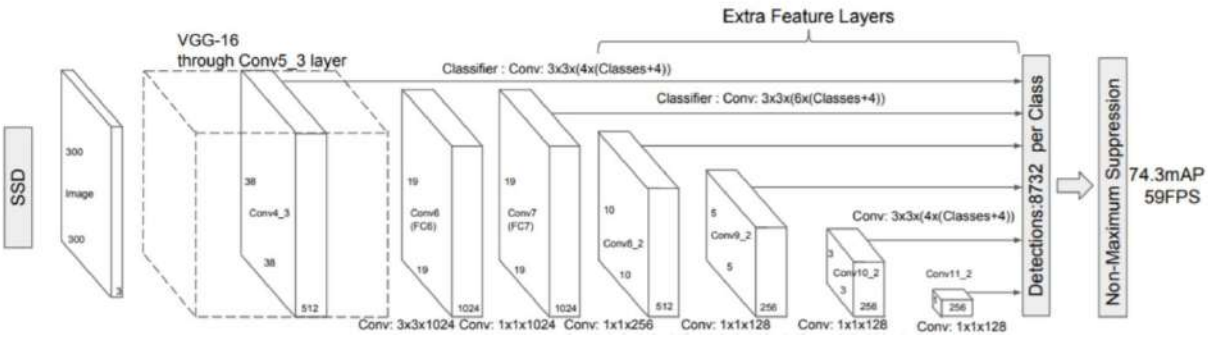

Figure 3.1.1.: ssd model

Researchers often use an existing network architecture, such as VGG or ResNet, to develop object detection networks, and then use it inside the object detection process. The issue is that these network topologies may be rather massive, ranging from 200 to 500 megabytes. Instead, we will use another paper by Google researchers, MobileNets (Howard et al., 2017). Because these networks are built for resource-constrained devices like smartphone. The use of depth wise separable convolution distinguishes MobileNets from traditional CNNs. (***Figure 2 below***)

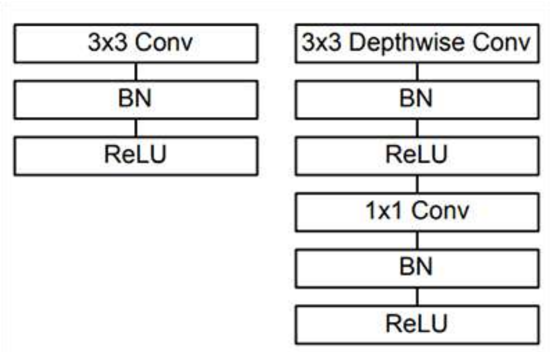

Figure 2: *(Left)* Standard convolutional layer with batch normalization and ReLU. *(Right)* Depth wise separable convolution with depth wise and pointwise layers followed by batch normalization and ReLU (figure and caption from Liuet al.).

The MobileNet SSD was trained on datasets before being fine-tuned on PASCAL VOC. After that we can develop a speedy, efficient deep learning-based object identification approach by combining the MobileNet architecture and the Single Shot Detector (SSD) framework. Here we will train our model for detect to surface textures, obstacles, potholes and open manholes.

3.1. System Architecture

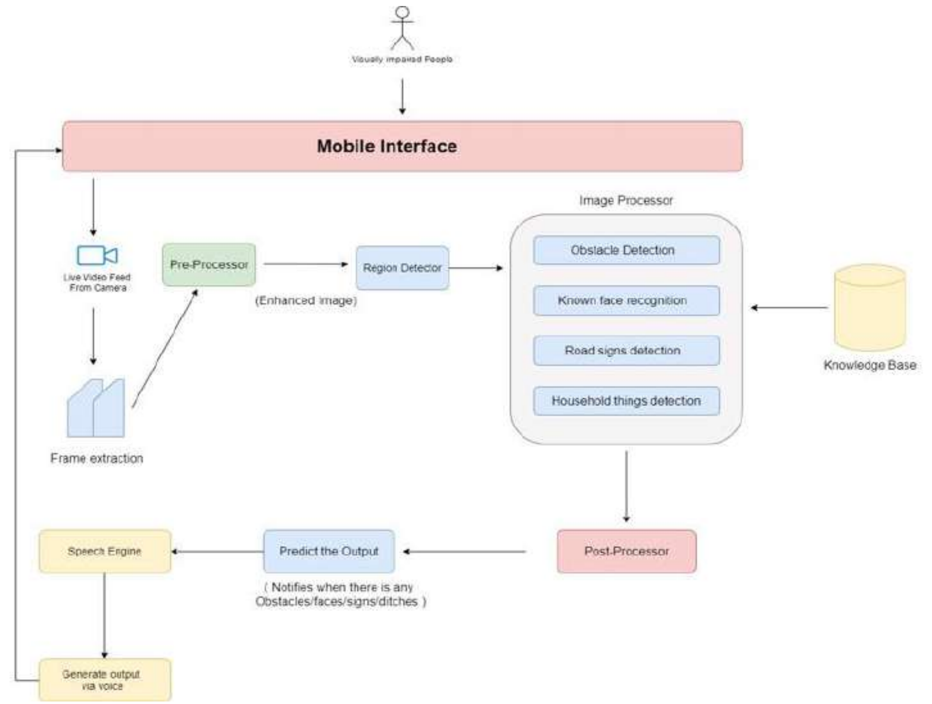

Figure 3.1.1.: system architecture

Object Detection and Surface Detection Diagram

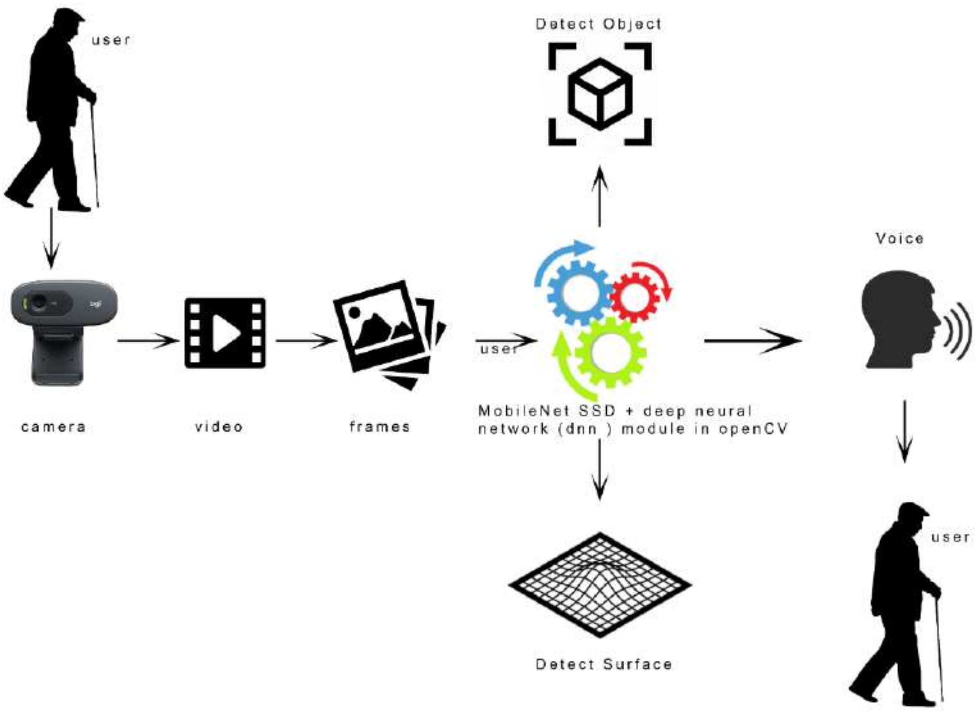

Figure 3.1.2.: individual functional diagram

3.1.1. Software Solution

Agile is one such fast-paced technique. The software development life cycle under consideration will be an accelerated methodology. Scrum is a simple, quick-to-implement project management framework that can be used to manage and control a wide range of operational and development projects. This results in progressive and iterative development, with each iteration building on the last.

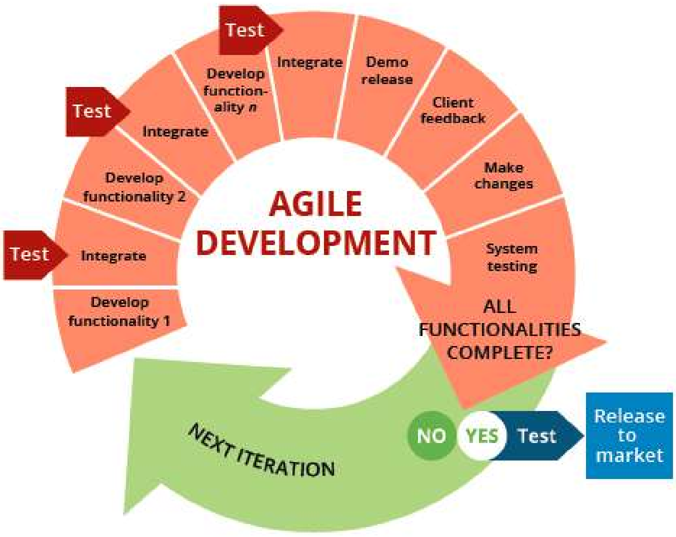

Figure 3.1.1.1.: agile chart

Feasibility Study

- Schedule feasibility

The proposed project should be completed within the timeframes provided, with each phase producing credible outputs while staying on track and delivering the end product on time.

- Technical feasibility

Basic knowledge of machine learning, deep learning, and image processing using OpenCV is required. Feature Extraction is crucial since it influences the accuracy of the detected obstacle, especially when employing supervised, unsupervised, and model training techniques in machine learning. It aids in feature extraction, object classification, and obstacle and surface identification.

3.1.2. Hardwar solution

The two cameras embedded in the glasses can detect nearby obstacles and moving objects, including translucent objects like glass. The device can also use AI to recognize faces, read signs, and identify objects. Finally, included High quality speakers can provide audible commands.

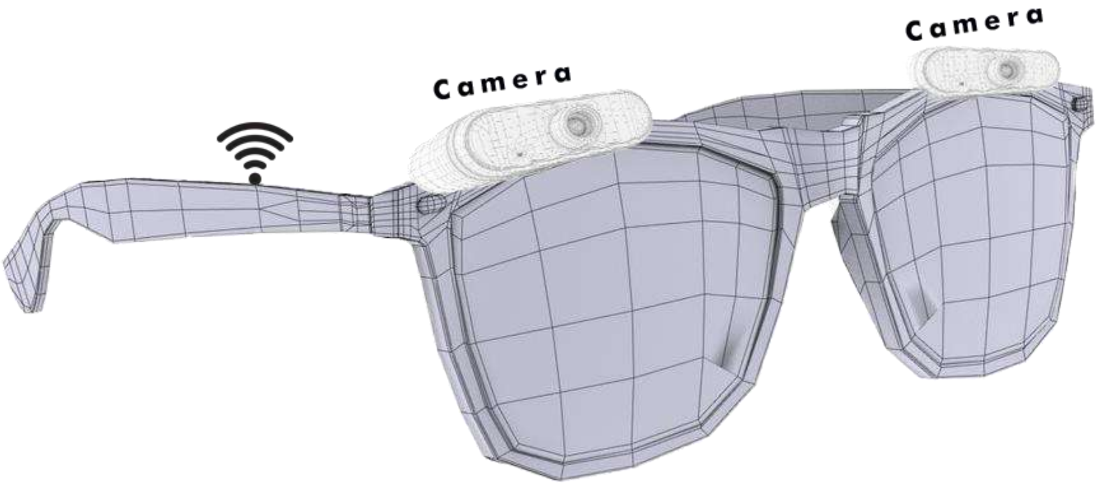

Figure 3.1.2.1.: 3D model of SNA Glasses

3.1.3. Evolution plan

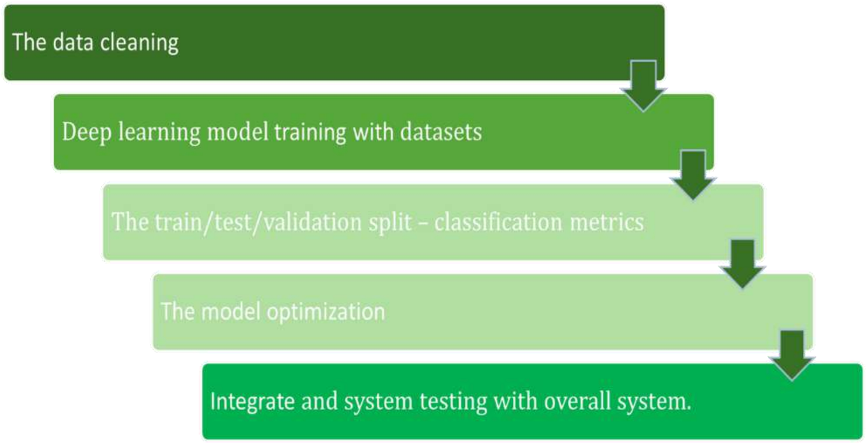

Figure 3.1.3.1.: Evolution plan

4. DESCRIPTION OF PERSONAL AND FACILITIES

The suggested system will use image processing to model object detection. For blind users, this program will be created in a more user-friendly and effective manner. The application's accuracy and efficiency will be improved as a result of the combination of several methods. This application will be built using open-source computer vision (OpenCV) techniques such as background subtraction, motion detection, edge detection, and feature extraction. The image processing findings will be translated into audio directions for the user when the barriers are spotted using the mobile phone's camera. When compared to comparable equipment on the market, the proposed application will be a low-cost application. As a result, this system will boost blind people's confidence by providing them with accurate information about the items around them and allowing them to walk around independently in both indoor and outdoor environments.

5. REQUIREMENTS

5.1.Functional Requirement

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 of the objects.
2	Identify obstacles	Using real time images for detect the obstacle using by DNN model + SSD.
3	Identify walking surface	Using real time images for detect the walking surface nature using by DNN model + SSD.
4	Make a warning message for close objects.	According to obstacle distance give user to waring message.
5	Generate a voice notification about obstacles and surface.	After identifying the obstacle and surface, convert them into voice command.

5.2. Non-Functional Requirement

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 identify obstacles on their way.
- User should be notifying about the behaviour of the walking surface.
- User should be warned if the objects are too close.
- User should be able to operate the system independently.
- User should be able to get voice assistance.

6. GANTT CHART

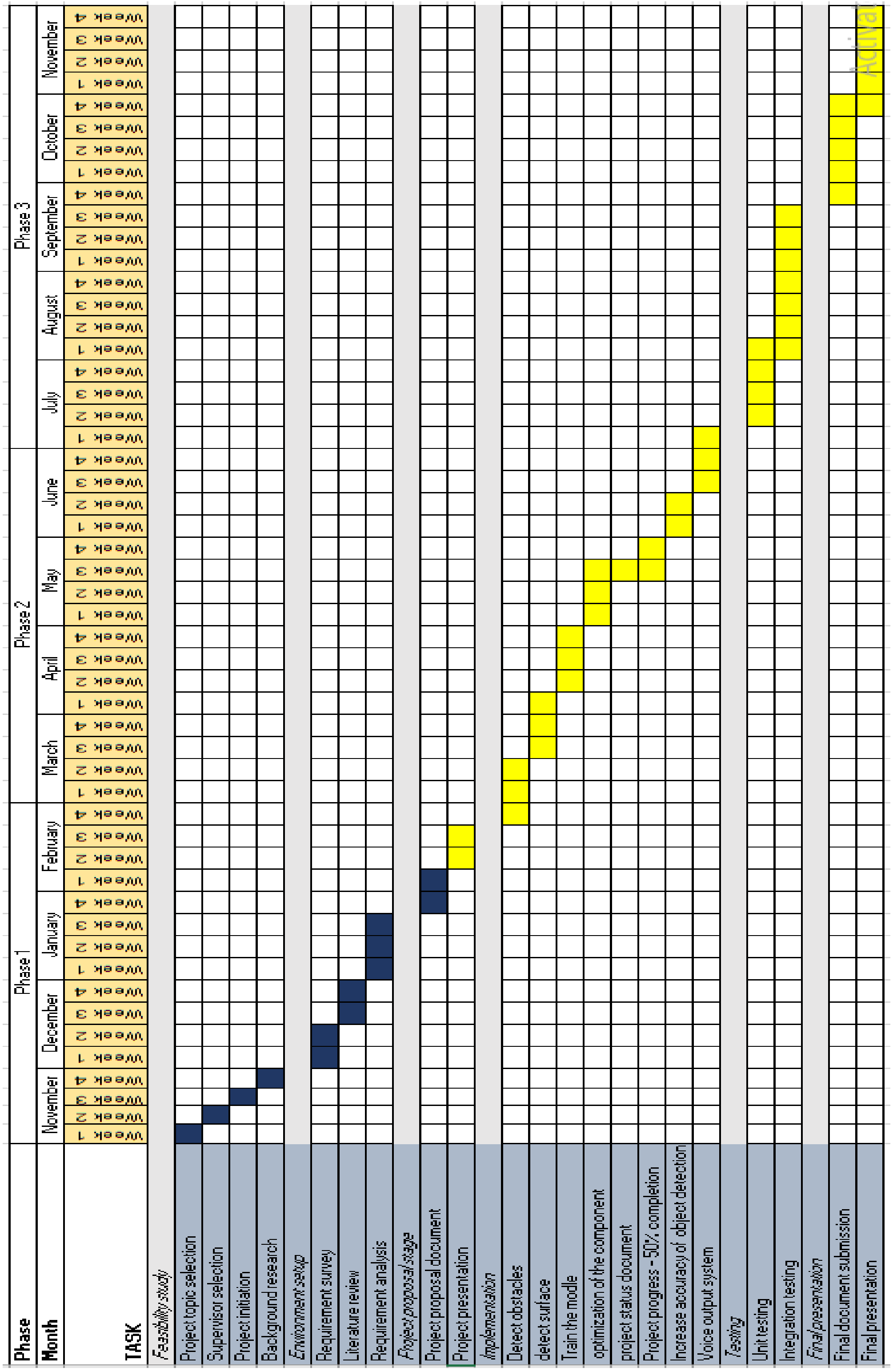

Figure 6.1.1.:Gantt chart

6.1.Work breakdown Structure

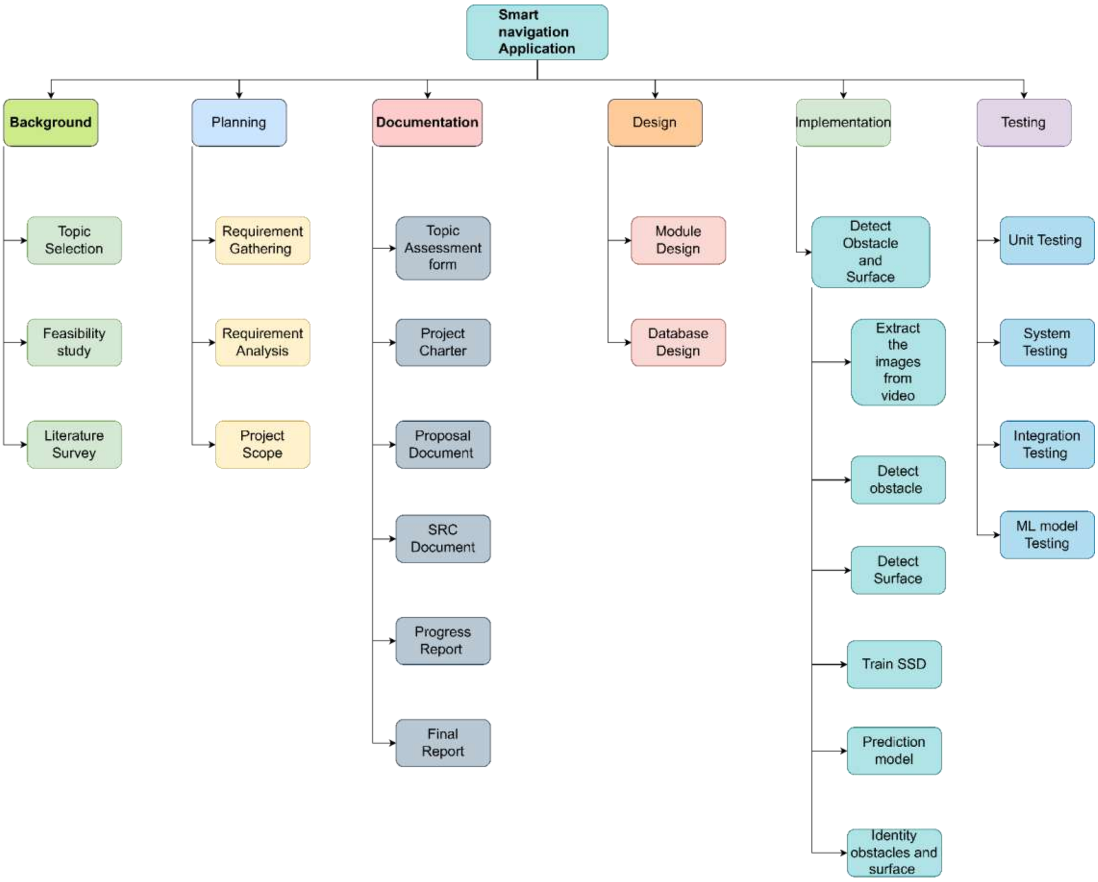

Figure 6.1.1.: Work Breakdown Structure

7. BUDGET AND BUDGET JUSTIFICATION

Table 7.1.: 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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