Real-time Smart Navigation System for Visually Impaired People

2022-277

Final Report – Individual

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DECLARATION

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(Date) (Keshara S.R.D.S.)

The above candidate is carrying out research for the undergraduate Dissertation under my supervision

………………………… ……………………..…….

(Date) (Signature of the supervisor)

ABSTRACT

Due to the technological advancement of various automated systems, the field of personal identification has gained a lot of attention and is currently being implemented in several sectors of the working industry such as employee verification, law enforcement activities and many others. Personal identity of an individual consists of unique biometric characteristics which enables a person to possess a unique digital identity. Aspects of an individual's facial features ranging from the face structure to even the most sensitive features such as eye color have made face verification systems more accurate in positively identifying an individual. Society consists of many gifted individuals however, when it comes to the portion of the less fortunate such as visually impaired individuals, among the many difficulties that they face in their day to day lives, it is unfortunate that they are unable to identify or locate their family members, relatives, or friends within a crowd or even their own household. If they are ever faced with a situation that requires the assistance of their beloved ones, it is important that they can locate any known person in the vicinity as soon as possible to avoid any sort of harmful situation. Although there are many facial detection systems that have been setup to assist ordinary citizens, there is a significant lack in systems to assist the less fortunate, therefore we proposed a system to assist visually impaired people to navigate safely and smartly through features such as facial recognition of family members and friends. Emotion detection model has been incorporated into the facial recognition system so that the system conveys real time information regarding the emotional aspects of the other person to assist the user to engage in a more productive interaction.

Keywords: Image Processing, Face Detection, Machine Learning, Emotion Detection

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

TF	TensorFlow
CNN	Convolutional Neural Networks
API	Application Programming Interfac

1. INTRODUCTION

1.1.Background Literature

1.1.1. Background

One of the most important organs that we possess are our eyes, where we achieve almost eighty percent of our natural perception, and it also plays out a major supporting role to our other sensory organs. It acts as a sensory base where we build up our mobility, navigation and other important survival instincts. While most of the people in the world have been blessed with proper eyesight, there exists a community who suffers from a disability named as visual impairment and therefore struggles to build the life that they desire due to poor vision, lack of environmental identification and have trouble in navigation as well. Though this shortcoming is overcome to a certain extent by the visually impaired people through heightened other senses such as good hearing and navigation using the palms of the hands, they eventually face a roadblock when it comes to reaching further heights in their lives.

There are many supporting systems in place to assist the visually impaired community such as walking sticks and Electronic Travel Aids (ETA). With the technological advancement of the current world and the ever-growing need for improved technical devices, the concept of image processing plays a major role in producing the next generation of ETAs with more advanced features to assist the visually impaired community. Image processing can be considered as one of the major advancements in automated systems where it allows the image to be processed under various operations to get an output of an enhanced image or to obtain valuable information from it. In the present society, the concept of image processing is applied in various sectors ranging from personal identification to making strides in medical technology as well. With the advancement of automated systems, the field of image processing has created a huge impact on the modern society allowing an individual to have a unique digital identity based on various facial features and other unique characteristics.

The current automated systems which are utilized for daily activities are mostly focused on individuals without any form of disability such as employee verification and such. However, through various research activities, it is found that this concept can be applied to assist the less fortunate as well. There is an increase in the need for automated systems to assist people with various disabilities such as vision impairment, physical disability and many others. This system is primarily focused on the concept of smart navigation for visually impaired people.

There are various systems that have been implemented to aid people with this disability but however, there are several factors that have caused only a handful of people to acquire this assistance such as the high price factor in the technology and systems only having a few useful features. This situation creates a need for a system that not only appeals to a large crowd of people with disabilities but also one that is affordable to a reasonable rate.
One of the key features of this system is to be able to identify family members or friends of the user through real time image processing where it accesses the user's database and filters through previously uploaded images of key individuals of the user and provides a confirmation signal when it successfully locates a known individual of the user. This technique allows the user to overcome problems such as being able to easily locate a known person in a crowded environment or to locate anyone if they are ever in a state of emergency. As the system is fully automated, it helps to overcome any drawbacks of any existing systems and also has many new features that the current systems do not possess in its entirety.

1.1.2. Literature Review

Recent studies on global health estimate that 217 million people suffer from visual impairment, and 36 million from blindness [1]. Due to the unfortunate circumstances faced by these individuals, their daily activities such as doing everyday tasks, moving from place to place have become much more difficult to deal with. Vision is an essential factor for a person to perform activities such as survey the environment, recognize different objects and to understand the environment that they live in.

There have been several approaches undertaken by various researchers to assist the visually impaired individuals in the society. Concepts such as navigation, object detection and guidance are the primary focus of tackling these difficulties faced by visually impaired people. However, most of the systems that are in place are yet to be proved as safe, cost effective and accurate.

Over the last 70 years, researchers have worked on various prototypes of electrical obstacle detection devices for BVI people known as electronic travel aids (ETA). This was mainly caused by the fast development of radar and sonar systems, which was encouraged by the Second World War. Some of the most representative prototypes are Leslie Kay's sonar-based Sonic Torch and Binaural Sonic Guide.

The main reason why most of these first devices worked with ultrasonic signals instead of optic or radio frequency seems to lie in propagation speed [2], the large reflection delay of sound waves allowed them to be used for distance measurements (sonar). On the other hand, systems like Laser Cane [3], resorted to techniques such as optical triangulation that resulted in less precision. Other renowned sonar-based devices developed in the 1960s and 1970s were Russell's PathSounder [4], the Nottingham Obstacle Detector [5], (Blind Mobility Research Unit, Nottingham University) and the Mowat Sensor [6]. All of them had similar characteristics, differing mainly in beam width and user interface, where the latter used sounds and/or vibrations to inform the user about the presence or absence of obstacles and, sometimes, even allowed them to make range estimations. Later, in the

1980s, ETA gradually began to add processing capabilities to their designs, allowing them to further expand, filter, or make judgements about the sensors' collected data (e.g., Sonic Pathfinder [7]).Also, user interfaces were improved by making them more efficient and user-friendly (e.g., by including recording speech [8]).

Sighted people often have the best of intentions when they want to help a blind person navigate, but their well-meaning is also often coupled with a lack of knowledge and understanding about how a person navigates without vision [9].

The initial systems that were introduced to assist the visually impaired people primarily focused on providing obstacle avoidance support. For instance, Bat K Cane [10] is a commercial sonar-based ETA designed by Leslie Kay et al. after SonicGuide. Other similar examples are UltraCane and MiniGuide [11], a built-in cane and hand-held device, respectively. These make use of vibrations to provide the user with adapted data from the ultrasound transductors.

The universal indication used by all people to communicate emotion is facial expression. Since automatic facial expression analysis has several uses in sectors including robotics, medicine, driving assistance systems, and lie detectors [12–14], there have been numerous attempts to develop the technology [15]. Since the 20th century, Ekman et al. [16] have identified seven fundamental feelings that, regardless of culture, a person develops together with (anger, feared, happy, sad, contempt [17], disgust, and surprise). Sajid et al. have investigated the effect of facial asymmetry as a marker of age estimate using the facial recognition technology (FERET) dataset [18]. In contrast to left face asymmetry, their findings indicate that right face asymmetry is preferable.

1.2. Research Gap

- Even though there are many difficulties faced by visually impaired people in their daily lives, most of them overcome such difficulties by building up their senses such as touch, hearing and taste. For the most part, these difficulties are overcome using various types of technological tools developed to assist their daily activities.

    - **3-D Sound Maps** – creates a 3-D map by drawing on location data, sound beacons and sound output to build a constantly evolving map of the surrounding environment.

    - **Braille** – system of dots that is used by the visually impaired and blind people to read and write. Due to innovations made on this concept, display included the BraiBook, a Braille e-reader that fits into the palm of a hand, and even an electronic toy called the Braille Buzz, designed to teach Braille to preschoolers.

    - **Smart Glasses** – set of glasses that can be used to read AI, provide navigation information and potentially identify faces.

    - **Electric vehicles** – vehicles that can be programmed to drive using AI at safe speeds while maximizing traveler safety.

Given below are some of the current systems and technologies in place to assist the visually impaired community.

- **A Static Hand Gesture and Face Recognition System for Blind People**

  Hand gesture recognition system and face recognition system has been implemented using which various tasks can be performed. Dynamic images are being taken from a dynamic video and is being processed according to certain algorithms.

- **Smartphone based face recognition tool for the blind**

  The tool utilizes Smartphone technology in conjunction with a wireless network to provide audio feedback of the people in front of the blind user.

- **Ultrasonic smart glasses for blind**

  This device includes a pair of glasses and an obstacle detection module fitted in it in the center, a processing unit, an output device i.e. a beeping component, and a power supply.

- **Intelligent eye: A mobile application for assisting blind people**

  The application provides assistance to visually impaired people by providing a set of useful features: light detection, color detection, object recognition, and banknote recognition.

- **Third Eye: An Eye for the Blind to Identify Objects Using Human-Powered Technology**

  The proposed solution is developing a mobile application that uses human-powered technology to help the visually impaired cope with the many challenges they face. This application is developed using an Arabic language interface to enhance the content of Arabic mobile applications and targets Arabic blind users

Features	**A**	**B**	**C**	**D**	**E**	**F**
Face identification	✓	✓	✓	✗	✗	✓
Color detection	✓	✓	✓	✓	✗	✓
Inbuilt voice output system	✓	✗	✓	✓	✓	✓
Emotion detection	✗	✗	✗	✗	✗	✓

A - Static Hand Gesture and Face Recognition System for Blind People
B - Smartphone based face recognition tool for the blind
C - Ultrasonic smart glasses for blind
D - Intelligent eye: A mobile application for assisting blind people
E - Third Eye: An Eye for the Blind to Identify Objects Using Human-Powered Technology
F – **Current Research Project and Solutions**

1.3. Research Problem

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When considering the solutions that have been implemented to support the visually impaired community, the use of Electronic Travel Aids (EDA) has become immensely popular however these devices lack several important features when it comes to overcoming problems such as identifying a known individual of the user in various environments. Many EDAs need to implement this feature to overcome certain shortcomings faced by the user.

People in the visually impaired community have grown to become distant from the society they live in due to their handicapped situation and this causes further emotional stress for the person as they are forced to give up their lifestyle and become more dependent on the help of others to carry out their work. Their social interactions become one sided as they can not identify the people they meet without their introduction and often the conversations have less meaning as they are unable to perceive the different emotions being displayed by other person.

Given below are some of the shortcomings the current system plans to overcome in order to assist the visually impaired community.

- Lack of ability to recognize known individuals by the user to obtain assistance in terms of an emergency or just for a casual meet and greet.
- Users just tend to their normal walk routine using current EDAs without face identification feature.
- This causes the user to become one sided in interacting with society and tend to cause further emotional stress for the user.
- Integrating face recognition feature with Emotion Detection function allows the users to identify and interact freely with their social circle.

1.4. Research Objectives

1.4.1. Main Objective

- ❖ The main objective of this system is to provide assistance for the visually impaired people in the community so that they may be able to carry out their day-to-day activities in a more efficient and safe manner through features such as obstacle detection, safe navigation and face detection for relatives and friends.

1.4.2. Sub Objective

- ❖ Make the system more efficient
  - ✓ The system is more effective and efficient. The accuracy level is also very high.

- ❖ Achieve a better knowledge in image processing
  - ✓ High techniques in image processing technique are used in this system.

2. METHODOLOGY

2.1. Methodology

2.1.1. Data Collection

The data set for the images for the face detection system are acquired through an API installed in the smartphone of the user where an acquaintance uses the API to upload pictures of known individuals of the user and save them under the name of the individual and retrieve the images through the same API when running the face detection system.

The images for the emotion detection system are acquired through the Emotion Detection dataset (2013) with 7 emotion types. Emotion types are as follows: angry, disgusted, fearful, happy, neutral, sad and surprised.

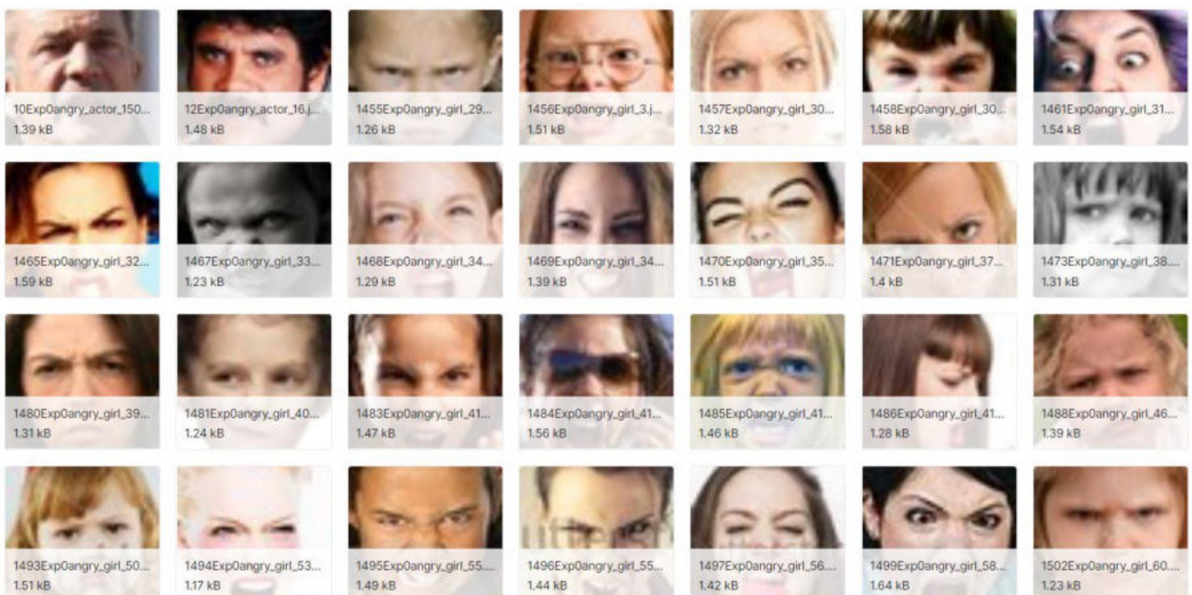


Figure 2.1.1 Snapshot of the images under the class – “Angry”

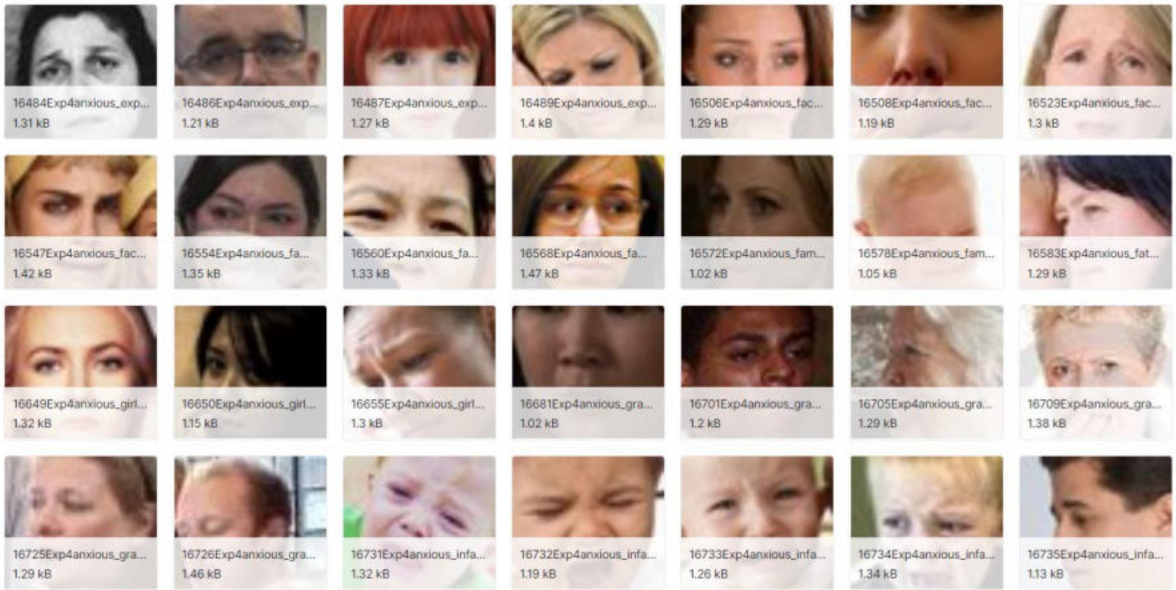


Figure 2.1.2 Snapshot of the images under the class – “Sad”

2.1.2. Image Processing and Model Build

A. Image Preprocessing

To accurately identify the individual and the emotion being displayed, some significant improvements made to the facial appearance. One of the key steps in an image processing approach may be picture pre-processing. The sounds in the images, including hair, clothes, and other artifacts, are being eliminated throughout this process. The main goal of image processing is to improve the quality of the representation of facial features by eliminating associated elements. Because it eliminates the speckle noise, the gaussian filter is extremely controlled.

B. Feature Extraction and Classification

Feature extraction and classification of the correct individual and emotion is an important step that must be properly implemented, in order to achieve that Convolutional Neural Networks (CNN) are used. TensorFlow is an open-source Python toolkit that combines a variety of methods and models to make it possible for users to create deep neural networks for use in tasks like image identification and classification. The high-level Keras API will make advantage of TensorFlow's features. TensorFlow's numerous, potent, but generally challenging functions are implemented as simply as possible by Keras. TensorFlow served as the backend and Python and Keras were used to enforce the CNN designs.

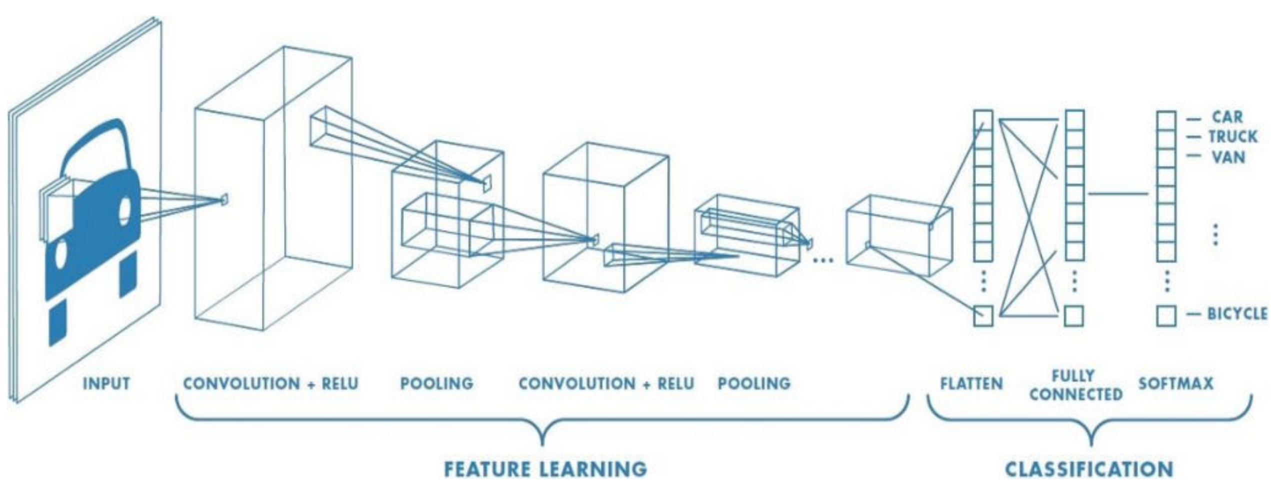


Figure 2.1.3 Convolutional Neural Networks Architecture

A subcategory of deep learning neural networks includes CNNs. This is very widely used in picture extraction and categorization. Convolutional and max-pooling layers of the CNN architecture serve as feature extractors, and the absolutely connected layer, together with the output layer, serves as the classifier by applying non-linear transformations to the extracted data.

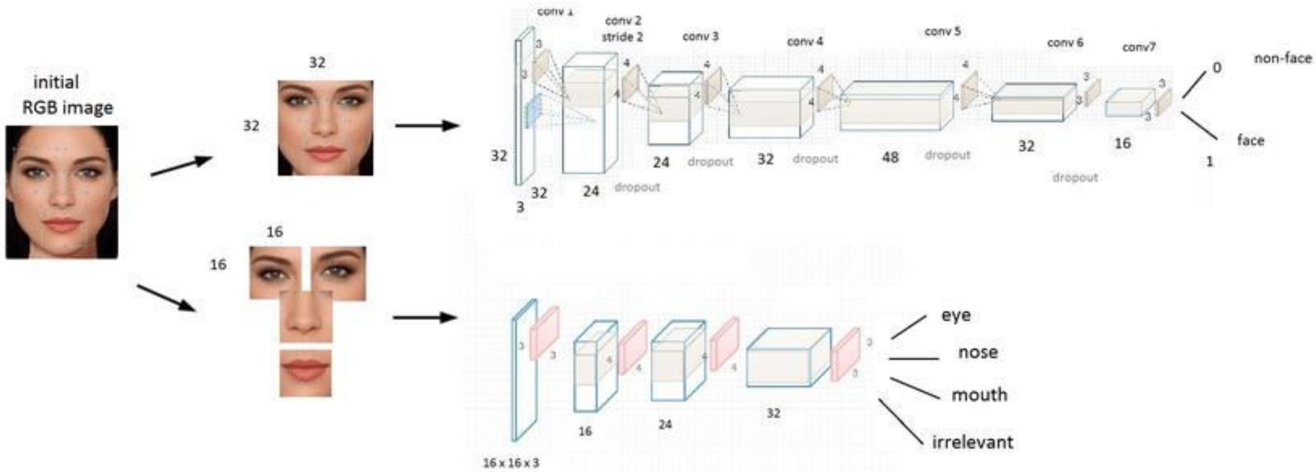


Figure 2.1.4 CNN Architecture for facial feature extraction

In order to automatically extract the characteristics of the photos, CNN converts the input data by fluidly moving across each layer of the network.

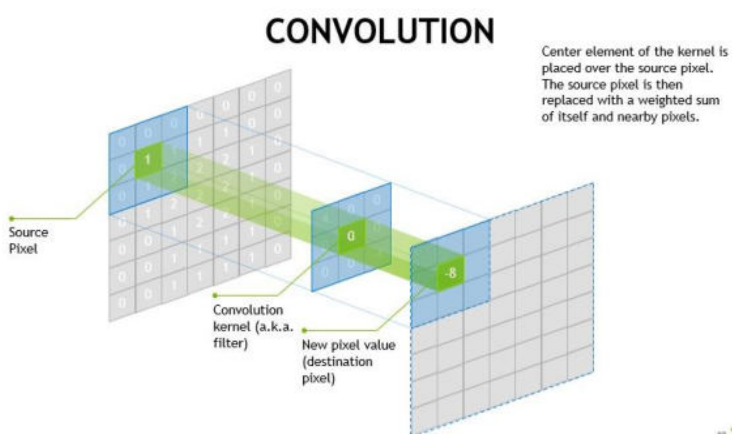


Figure 2.1.5 Convolution layer

Figure 2.1.5's convolution layer, also known as a feature extractor, attempts to locate all of the features in the input picture by utilizing a kernel matrix. It extracts features from the image. Following each convolution, the Rectified Linear Unit is used to create an output utilizing the neurons' activation function.

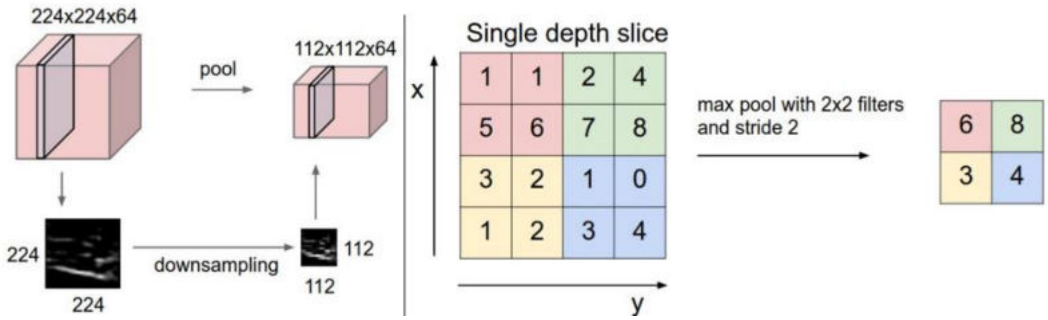


Figure 2.1.6 Pooling layer

Figure 2.1.6 demonstrates the Pooling layer of CNN which decreases the dimensionality of each picture from the preceding layers while retaining the key details. The output of the earlier layers is taken, "flattened," and combined into a single vector that can serve as an input for the following step. In order to forecast the correct label, the totally connected layer applies weights to the feature analysis inputs. To categorize input photographs into several groups, the output layer employs Softmax activation performance.

Figure 2.1.6 demonstrates the use of CNN to accurately identify facial expressions through the different stages of CNN. The input image is run through the convolutional feature extraction to identify the regions of interest such as eyes, mouth and using a gate unit that has been provided, each representation is given a weighted average based on how important and unobstructed it is and how much of it is present in the region. Finally the classification process provides the correct output of the type of emotion being displayed by the input image.

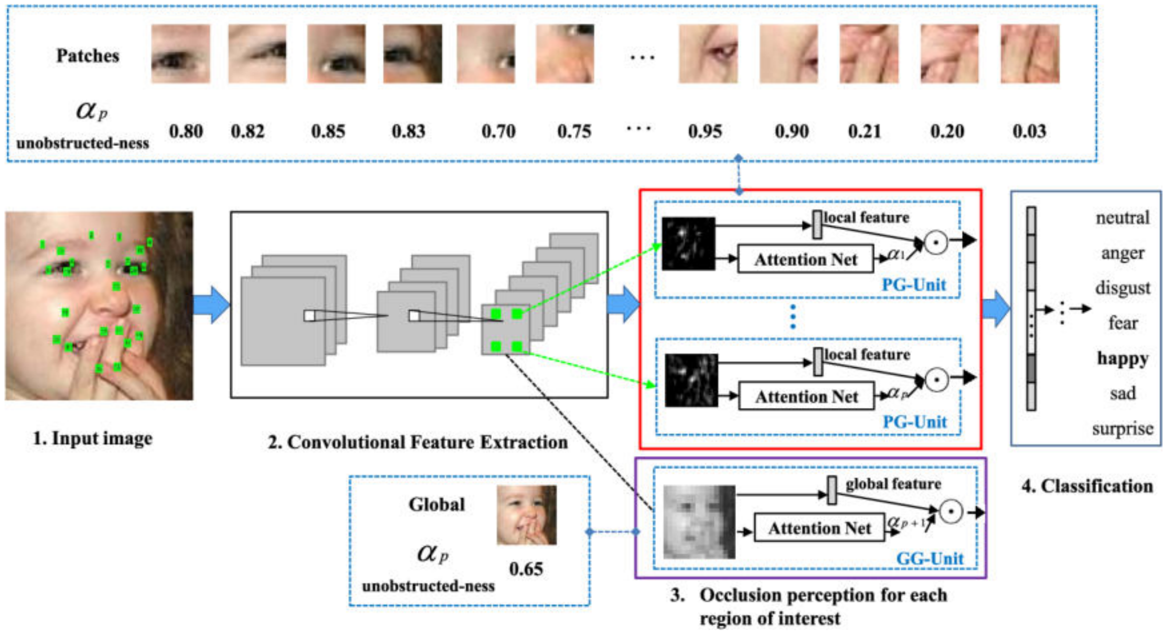


Figure 2.1.7 Facial expression detection using CNN

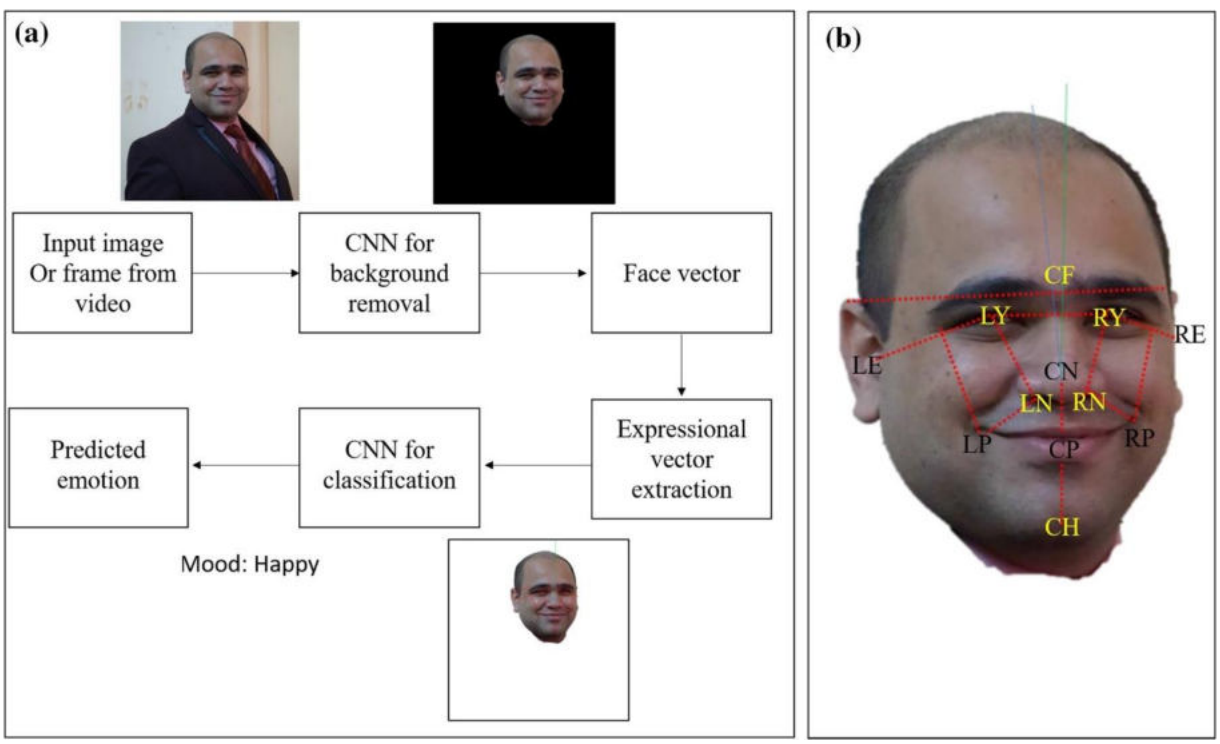


Figure 2.1.8 Emotion detection overview using CNN

Following the acquisition of the input picture, a skin tone detection technique is used to identify human body components in the image. The binary image that represents the skin tone-detected output is employed as the feature for the first layer of background removal by CNN. The type of input photograph affects how the skin tone is detected. The YCbCr color threshold may be utilized if the picture is a colored image. The Y-value should be larger than 80, the Cb range should be between 85 and 140, and the Cr range should be between 135 and 200 for skin tome. The numbers shown in the previous paragraph were selected through a process of trial and error and were effective for practically every one of the skin tones accessible. We discovered that the skin tone identification technique has very poor accuracy when the input image is grayscale.

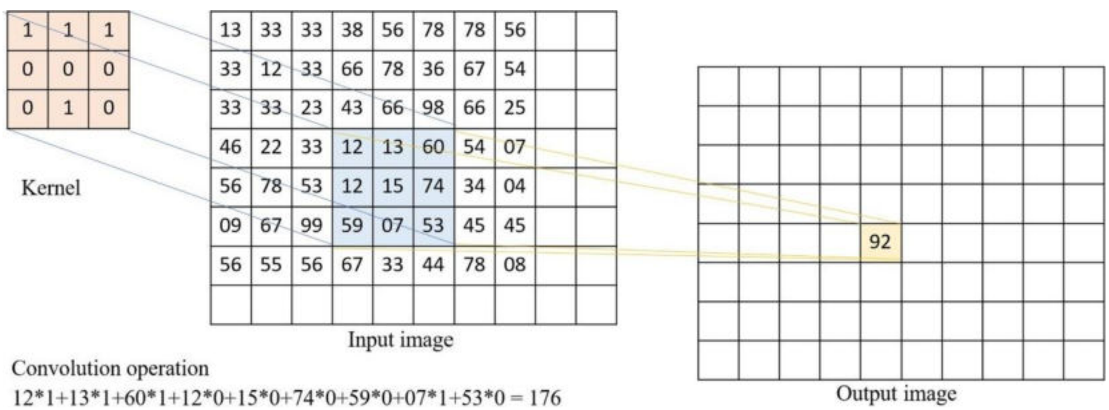


Figure 2.1.9 Convolutional filter operation with the 3x3 kernel

CNN also use the circles-in-circles filter to increase accuracy during background removal. Hough transform values are used in this filter operation to identify each circle. Hough transform served as the backdrop removal CNN's second input feature in order to preserve consistency regardless of the type of input picture.

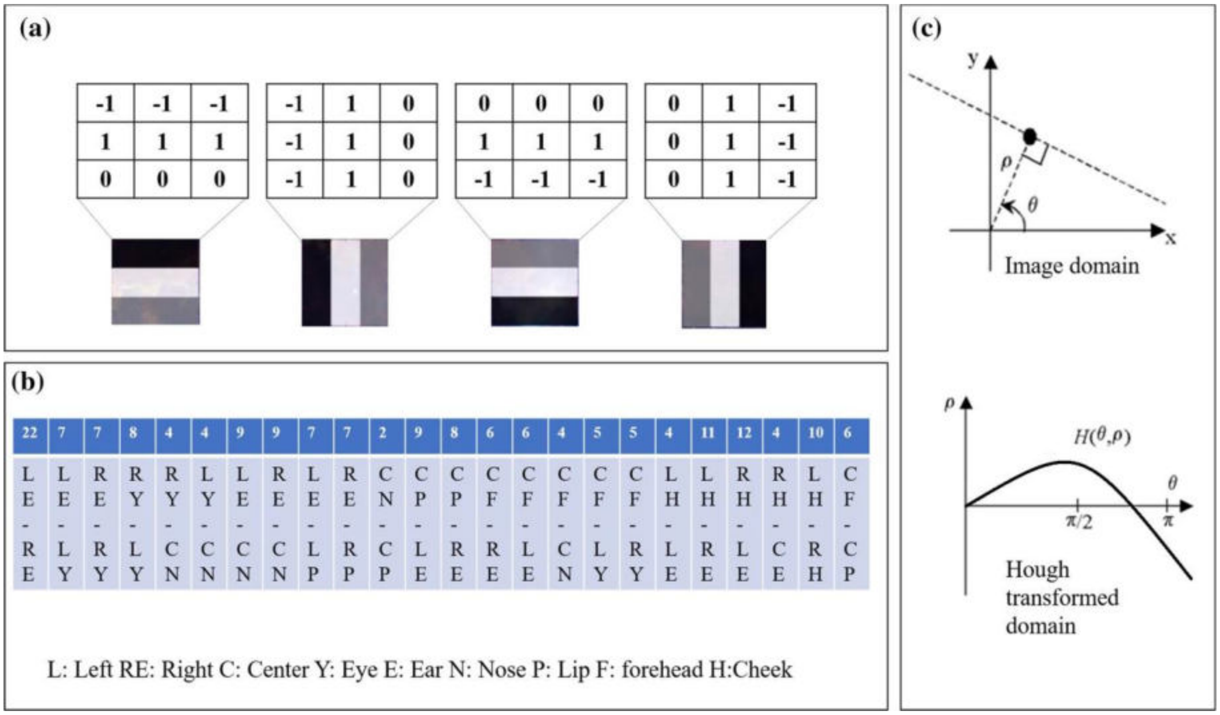


Figure 2.1.10 Vertical and horizontal edge detector filter matrix

2.1.3. System Overview

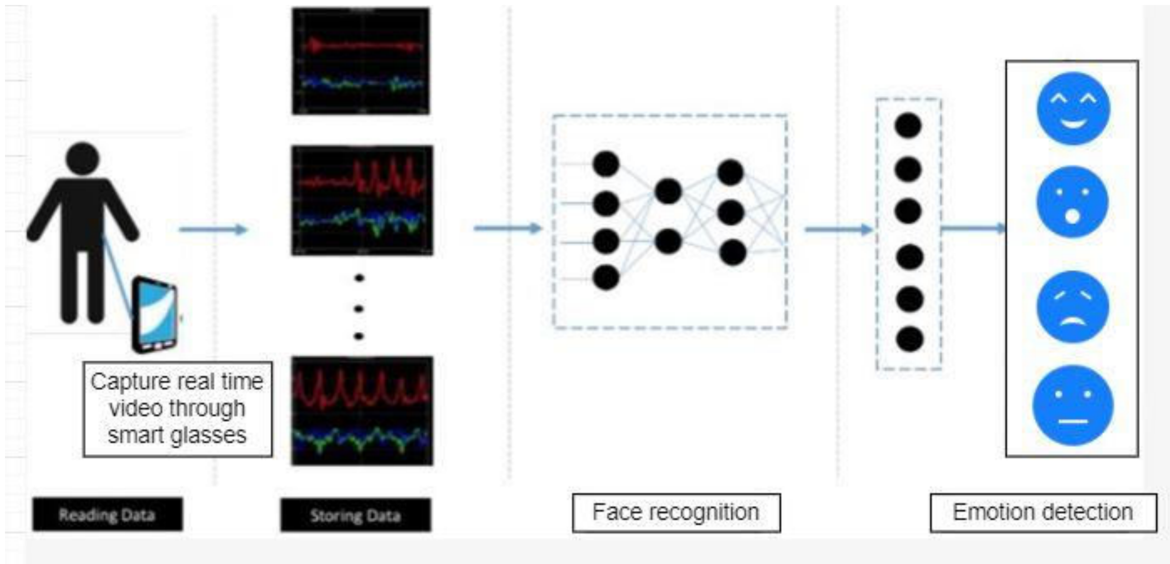


Figure 2.1.11 General overview diagram of component

Figure 2.1.8 demonstrates the general overview of the facial recognition and emotion detection system.

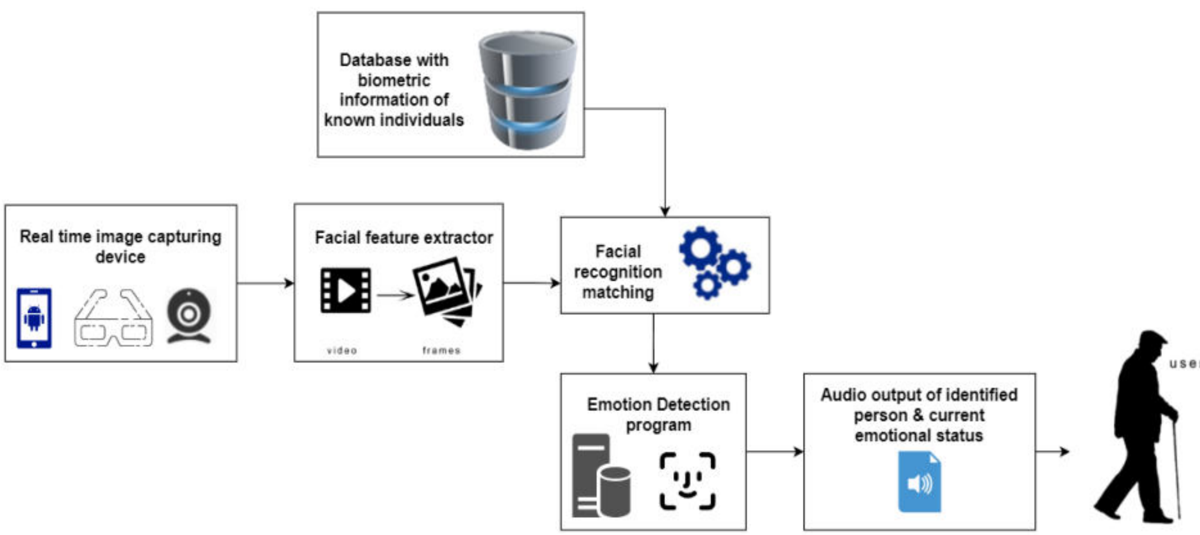


Figure 2.1.12 System diagram of component

A system diagram is a graphic representation of the system's parts and interactions with supporting materials. Figure 2.1.9 demonstrates the detailed function on how real time data is captured through the smart glasses and raw data is fed to the facial feature extractor to be split into frames and run through the facial recognition program with the given database and identify any known individuals in the environment. Emotion detection program is run after a person is successfully identified and relay audio output to the user of the identified person and emotional status on real time.

2.1.4. Development Process

2.1.5. Feasibility study

The technological resources required for the project should be identified and considered during the feasibility assessment. The creation of this study project requires the use of technologies like raspberry pi and image processing. Image processing has associated algorithms. This research topic is therefore virtually technically possible.

The following tools and technologies are used to develop this system.

- Pycharm
- Anaconda
- TensorFlow
- Keras
- Firebase, Google cloud
- OpenCV
- GIT
- Raspberry Pi
- Android studio

2.1.6. Requirement Gathering

One of the crucial actions that must be taken before to the implementation of any system is this phase. The needs for the projects are determined through requirement gathering, which also aids in determining the system's functional and non-functional requirements. To understand what kind of implementations should be made, which technologies were used in the prior research works, accuracy and effectiveness of those systems, and what are the research gaps in those previous works, it is necessary to analyze and conduct proper research related to this project.

The boundaries and problems with the system are discussed in research publications together with information about earlier systems. It will be easier to discover a new solution without those issues if you understand them. The greatest places to find the criteria are in prior research papers and systems that are already in place. Additionally, Google Scholar, Google, relevant users of similar systems, and feedback provided to current systems are used to compile the criteria.

2.1.7. Resources used

- **Hardware resources**
  - Smartphone
  - Smart-glasses
  - Cloud data storage for pictures of known individuals
  - RAM- 16GB.
  - Processor speed – 1.0GHz minimum.
  - Server machine with higher processing power.
  - Raspberry PI
  - Camera sensors
  - Headphone
  - Required raspberry pi modules headphones

- **Software resources**
    - Pycharm

      PyCharm is a dedicated Python Integrated Development Environment (IDE) providing a wide range of essential tools for Python developers, tightly integrated to create a convenient environment for productive Python, web, and data science development.

    - Anaconda

      Designed to make package management and deployment easier, Anaconda is a distribution of the Python and R computer languages for scientific computing. For Windows, Linux, and macOS, the release provides data-science packages.

    - TensorFlow

      A free and open-source software library for artificial intelligence and machine learning is called TensorFlow. Although it may be used to many different tasks, deep neural network training and inference are given special attention.

    - Gitlab

      A Git repository is provided for the continuous integration created using GitLab Inc. by the web-based DevOps lifecycle tool. This project uses it for version control as well as to integrate the project.

    - Google colab

      Colab is particularly well suited to machine learning, data analysis, and teaching. It enables anybody to create and execute arbitrary Python code through the browser.

    - Google cloud

      The Google Cloud Platform is a collection of cloud computing services that Google offers. It employs the same internal architecture that Google does for its consumer products, including Google Search, Gmail, Drive, and YouTube.

2.2. Commercialization aspects of the product

Real-time smart navigation system provides a perfect solution for visually impaired people of all age groups. Main program is run without user interface to suit the needs of the community except for the face identification system where a non-participant must upload the pictures of known individuals of the user through the given API, however this process is done before the activation of the system so as to not to affect the user's experience.

We have implemented a successful smart navigation system with high accuracy level. The system will successfully identify known individuals of the user in multiple environments and capable of identifying multiple individuals at the same time. The emotion detection system is set to function only after correctly identifying the individual and a timer is set to relay the emotions being displayed the identified individual within a given time interval.

In future we are decided to commercialize the product by providing demonstrations to eye doctors and patients in hospitals as well as the Ceylon School for the Deaf and Blind. We are also planning to consult the more interviews with doctors and users to identify new challenges in their lifestyle and provide solutions by integrating helpful features to the existing system.

2.3. Implementation & Testing

2.3.1. Implementation

All the procedures for face and emotion detection were implemented in this stage. The Prediction Model was trained as the initial step, and Python was used for implementation. Training was done with CNN. TensorFlow and Keras were employed to manage the CNN.

To store the pictures of known individuals of the user, an API was developed where a non-participant must upload the pictures of known individuals of the user through the given API, however this process is done before the activation of the system to not to affect the user's experience. Another reason for pre-uploading the pictures is the fundamental idea behind the system to run the system without a user interface. The images of the known individuals are saved under their respective name which will be used by the audio output mechanism to relay the name of the individual to the user when he/she is correctly identified by the system.

The emotion detection system is setup in a manner that it is only set to function when an individual is identified by the system and is run on a timer so that the system relays real time information regarding the emotions being displayed by the identified individual at periodic time intervals.

2.3.2. Testing

Starting from the requirement gathering and analysis phases has been arisen throughout the application development by the testing phase. According to the development methodology, the crucial to effective testing is, comprehensive all testing concepts and test framework design before the implementation phase is over. To ensure that the implementation is always in line with the requirements specification testing has been performed, as mentioned in the implementation phase. Unit testing, Module testing, Integration testing, and System testing has been done**.**

A. Unit Testing

Unit testing is a testing technique and singular units of source code are decided whether the units are suitable to use. A unit is the slightest testable part of an application. Unit testing is done by every part exclusively. The units are done by the individuals except the engineer of that unit. Such that way, the units are completed by every individuals of the unit.

B. Module Testing

Each class, record, module or part is tested in Module testing. The module test was completed by a collection area that is not the owner of that module.

C. Integration Testing

The original software testing method is known as integration testing, in which several software components are merged and tested as a whole. Prior to validation testing, it occurs during module testing. When doing integration testing, modules that have undergone unit testing are used as input. After grouping the modules into bigger aggregates, tests written for integration testing are then applied to the aggregates. Additionally, each member of the cluster carried out integration testing independently.

D. System Testing

Software and hardware systems are tested as a whole, integrated system to see whether they meet their specified requirements. Black box testing encompasses system testing, which is independent of the logic or code's internal structure. The integrated system was tested collectively and modified if any units had issues.

The user tests each and every component of the system independently. This is to establish that it doesn't appear that the issues have spread to the next section. Afterward, separate modules are combined to form a system. The system is then put to the test as a whole to find any faults and make sure that all of the different components are correctly integrated and functioning as a whole. All members may perform this since they will all need to assess how their particular component functions both independently and in relation to the rest of the system.

E. Test Cases

Table 1: Test Case 1

Test Case	Test Case 001
Test case description	Diagnose the image which is captured by the smart glasses as identify individual as 'Father' and emotion as 'Angry'
Pre-condition	Wear smart glasses and associated gadget
Test procedure	1. Activate smart glasses 2. Activate real time smart navigation system
Test input	
Expected Result	System should identify the individual as 'Father' and display emotion as 'Angry'
Actual result	System displayed as 'Father – Angry'
Test Result	Pass

Table 2: Test Case 2

Test Case	**Test Case 002**
Test case description	Diagnose the image which is captured by the smart glasses as identify individual as 'Brother' and emotion as 'Happy'
Pre-condition	Wear smart glasses and associated gadget
Test procedure	1. Activate smart glasses 2. Activate real time smart navigation system
Test input	
Expected Result	System should identify the individual as 'Father' and display emotion as 'Angry'
Actual result	System displayed as 'Brother – Happy'
Test Result	Pass

Table 3: Test Case 3

Test Case	Test Case 003
Test case description	Diagnose the image which is captured by the smart glasses as identify individual as 'Cousin' and emotion as 'Sad'
Pre-condition	Wear smart glasses and associated gadget
Test procedure	1. Activate smart glasses 2. Activate real time smart navigation system
Test input	
Expected Result	System should identify the individual as 'Cousin' and display emotion as 'Sad'
Actual result	System displayed as 'Cousin – Sad'
Test Result	Pass

Table 4: Test Case 4

Test Case	**Test Case 004**
Test case description	Diagnose the image which is captured by the smart glasses as identify individual as ‘Sister’ and emotion as ‘Surprise’
Pre-condition	Wear smart glasses and associated gadget
Test procedure	1. Activate smart glasses 2. Activate real time smart navigation system
Test input	
Expected Result	System should identify the individual as ‘Sister’ and display emotion as ‘Surprise’
Actual result	System displayed as ‘Sister - Surprise’
Test Result	Pass

Table 5: Test Case 5

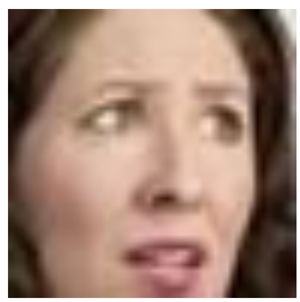
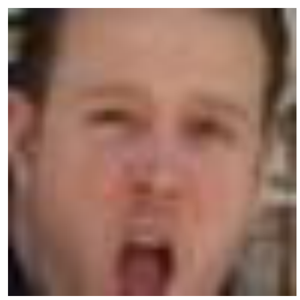
Test Case	**Test Case 005**
Test case description	Diagnose the image which is captured by the smart glasses as identify individual as 'Mother' and emotion as 'Fear'
Pre-condition	Wear smart glasses and associated gadget
Test procedure	1. Activate smart glasses 2. Activate real time smart navigation system
Test input	
Expected Result	System should identify the individual as 'Mother' and display emotion as 'Fear'
Actual result	System displayed as 'Sister – Surprise'
Test Result	Pass

Table 6: Test Case 6

Test Case	Test Case 006
Test case description	Diagnose the image which is captured by the smart glasses for unidentified individual.
Pre-condition	Wear smart glasses and associated gadget
Test procedure	1. Activate smart glasses 2. Activate real time smart navigation system
Test input	
Expected Result	Detect the image as 'Unidentified'
Actual result	The image was displayed as 'Unidentified'
Test Result	Pass

3. RESULTS & DISCUSSION

3.1. Results

It is evident from the results of each step that a variety of factors affect the system's accuracy. They are algorithm, training data set, and testing data set. The system should, in accordance with the specifications, be a tool that helps the user when utilizing a smart glass and wired headphones with a battery backup.

The device contains the following features as follows,

- No User Interface (UI)

  The system doesn't contain a user interface so as to suit the needs of the visually impaired person and is activated when the user triggers the system using the activation button.

- Simple and user friendly

  Simply put on the eyewear, and the gadget may be attached to a belt, bag strap, or pocket. The gadget is attached to a headset or earphone to provide audio output of the system findings.

- Quick response

  The system processes real-time data captured from the smart glasses and outputs are relayed with a quick response time.

There are some shortcomings in the system, and they are described as follows,

- Partial delay in face identification for distances due to the average camera quality being relayed to the system.
- Accuracy is in the percentages between 75% - 85% but can be further increased with a high-resolution video capturing device.

3.2. Research Findings

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Considering the various obstacles and challenges faced by the visually impaired community, we developed the real-time smart navigation system to help overcome some of the challenges in order to overcome their shortcomings. The main goal of this research is to create a smart gadget for visually impaired people to help them navigate around the outside world.

One on one interviews were carried out with people from the visually impaired community to gain an understanding of the problems they face and also while doing further research into this topic, we were able to find easier methods to implement the system such as capturing real-time data through smart glasses.

One of the main problems faced during the process is the acquisition of a high-resolution camera to capture high quality video streaming to extend the functionality of the system. Due to the pandemic situation, many of outlets were closed and out of stock and therefore it was a challenging task to acquire the required hardware.

3.3. Discussion

The facial recognition and emotion detection components for the Real-time Smart Navigation system was designed and implemented according to the requirements. The participation of a non-user to upload the pictures for the facial recognition component was discussed and implemented as such so as to not to affect the quality of the photographs being uploaded to the system and therefore will result in a high accuracy when running the component. The obtained results indicate that this application offers a reasonable level of accuracy when compared to the majority of the prior investigations.

One of the most important problems globally faced by the visually impaired person is the inability to identify a known person and be aware of the emotions being displayed by the other person. The proposed system provides a suitable solution to overcome this problem while allowing the user to become more active and aware of the emotions during social interactions.

4. CONCLUSION

The Smart Navigation system has been primarily developed using the concept of Image Processing and also uses the concept of IoT for the smart cane implementation. The application has been developed with a user-friendly interface to effectively aid the visually impaired community. Due to multiple features such as face recognition coupled with emotion detection, walk-lane detection, road sign detection, obstacle detection, and pothole detection using the smart cane, the current system presents a unique opportunity for blind people to become more active in a cost-effective manner. The features detected through the camera and its image processing results are converted into audio/vocal commands and relayed to the user. Compared to the other systems in the market, this system consists of several unique features that cater to the multiple needs of blind people and encourage them to lead a more active social life. However, there are several shortcomings in the application. Therefore, overcoming these shortcomings and making this application more usable for the blind community is essential.

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6. APPENDICES

Appendix A : Use case Diagram

Appendix B : Activity Diagram

Appendix C : System Diagram