VISVESVARAYA TECHNOLOGICAL UNIVERSITY

BELAGAVI – 590018, Karnataka

INTERNSHIP REPORT ON

"Virtual Assistant For Visually Impaired"

Submitted in partial fulfilment for the award of degree

BACHELOR OF ENGINEERING IN
Artificial Intelligence And Machine Learning

Submitted by:

Nithila .O

1BC22AI400

Conducted at
COMSOFT TECHNOLOGIES

BANGALORE COLLEGE OF
ENGINEERING AND TECHNOLOGY

BANGALORE COLLEGE OF ENGINEERING AND TECHNOLOGY

Department of Artificial Intelligence And Machine Learning

Accredited by NBA, New Delhi

Chandapura Bangalore

BANGALORE COLLEGE OF ENGINEERING AND TECHNOLOGY

Department of Artificial Intelligence And Machine Learning

Accredited by NBA, New Delhi

Chandapura Bangalore

CERTIFICATE

This is to certify that the Internship titled **"Virtual Assistant For Visually Impaired"** carried out by **Ms. Nithila.O,** a bonafide student of Bangalore College of Engineering and Technology, in partial fulfillment for the award of **Bachelor of Engineering**, in **AIML** branch under Visvesvaraya Technological University, Belagavi, during the year 2022-2023. It is certified that all corrections/suggestions indicated have been incorporated in the report.

The project report has been approved as it satisfies the academic requirements in respect of Internship prescribed for the course Internship / Professional Practice .

Signature of HOD **Signature of Principal**

D E C L A R A T I O N

I, Nithila.O, Third year student of AIML Branch, Bangalore College of Engineering And Technology - 560 099, declare that the Internship has been successfully completed, in **COMPSOFT TECHNOLOGY**. This report is submitted in partial fulfillment of the requirements for award of Bachelor Degree in Information Science and Engineering, during the academic year 2023-2024.

Place: Bangalore

USN :1BC22AI400

NAME : Nithila.O

COMPANY OFFER LETTER

Internship Offer Letter

Date: 24th October, 2023

Name: **Nithila.O**
USN: **1BC22AI400**
Placement ID: **23OCTMLBONE**

Dear Student,

We would like to congratulate you on being selected for the **Machine Learning with Python (Research Based)** Internship position with **Compsoft Technologies**, effective Start Date **24th October, 2023**, All of us are excited about this opportunity provided to you!

This internship is viewed as being an educational opportunity for you, rather than a part-time job. As such, your internship will include training/orientation and focus primarily on learning and developing new skills and gaining a deeper understanding of concepts of **Machine Learning with Python (Research Based)** through hands-on application of the knowledge you learn

A C K N O W L E D G E M E N T

This Internship is a result of accumulated guidance, direction and support of several important persons. We take this opportunity to express our gratitude to all who have helped us to complete the Internship.

We express our sincere thanks to our Principal, for providing us adequate facilities to undertake this Internship.

We would like to thank our Head of Dept – branch code, for providing us an opportunity to carry out Internship and for his valuable guidance and support.

We would like to thank our (Lab assistant name) Software Services for guiding us during the period of internship.

We express our deep and profound gratitude to our guide, Guide name, Assistant/Associate Prof, for her keen interest and encouragement at every step in completing the Internship.

We would like to thank all the faculty members of our department for the support extended during the course of Internship.

We would like to thank the non-teaching members of our dept, forhelping us during the Internship.

Last but not the least, we would like to thank our parents and friends without whose constant help, the completion of Internship would have not been possible.

NAME: NITHILA.O

USN : 1BC22AI400

ABSTRACT

This project aims to develop a Virtual Assistant tailored for individuals with visual impairments. Leveraging advancespeech recognition and natural language processing, the system will assist users in tasks like reading text, navigating environments, and accessing information.

Through a user-friendly interface and integration with assistive technologies, the Virtual Assistant aims to enhance independence and accessibility for visually impaired individuals in their daily lives.

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Virtual Assistant for Visually Impaired

CHAPTER 1

INTRODUCTION

Introduction to web design

"Virtual Assistant for visually impaired", the said project applies the concept of Deep learning i.e. Neural networks. The models employed for our project are - Face Detection and Object Detection. The system comprises a camera that acquires images and sends them to the application, where a powerful processor derives information from them and explains them to the user through a distinct audible message. The device will continuously detect all the faces in front of the person and verify them against all the faces of the people who have been previously taught to the device.

What is it all about?

In the system level, we could say that the novelty lies in the real-time web application. The already existing system comprises modules such as Image processing, Speech processing, etc, therefore the problems faced by blind people are often reduced to a particular extent. But neither are these modules enough nor are they implemented purposefully such that they assist the visually impaired. Taking these limitations into consideration, the system we have developed overcomes these drawbacks and helps build a system that assists the needful in a better and more appropriate manner.

Digital design is what runs internet and the marketing around it!

Digital design is one of the most important parts of any internet business. A poorly designed website could turn away potential customers with low engagement, low trust, and low productreviews. On the other hand, a well-designed website could increase brand equity and loyalty.

Define What You Want to See

One of the first steps in designing a website is defining what you want to see. This can be donein a variety of ways.

You got a rough idea or… can you vision it in full?

For example, you may have a general idea of the types of products that you sell or services thatyou offer. Or, you may have a particular inspiration for what a certain type of website should look like.

Careful with your preliminary planning and structuring

You might be surprised in how many things you might find that you had not taken in consideration during your preliminary planning and structuring for your new website.

Sketch Before You Build

Once you have a clear picture of your website's content, graphics, and navigational elements, it's time to sketch. Sketching is a fundamental part of design, because it enables you to test theeffectiveness of your ideas. A sketch can be as simple as a drawing or as complex as a computerprogram that lets you test different layouts.

Increase the chances of finding problem before designing your site

You should sketch before you build because it will increase your chances of finding problemswith the site's design. For example, if you only build a website, you won't be able totest howwell the site looks. Sketching allows you to see how the design works before you have to dealwith the issues that come with building a site.

Choose a Framework

Once you have a design that you are satisfied with, you will have to create a code versionof your website. In other words, you will have to write the **HTML** and **CSS** code that drives yoursite.

There are many options when it comes to frameworks, but all of them serve a common purpose:they help developers create websites quickly and easily.

There are several good options for website frameworks. The most popular options are Bootstrap, Foundation, and Saffron.

You could also use WordPress

Obviously, there is also options for Content Management System such as WordPress that will allow you not to code your pages, however, a site entirely made by yourself HTML/CSS isnotonly unique (as you did not use a template available to the general public) but also much fasterand lighter in terms of **SEO** and Google page speed.

Web applications are similar to the traditional applications you'd install on your Information, such as Microsoft Office. They are able to perform the same kinds of tasks, they look the same and they feel the same but there is one key difference - the application itself is not installed on your phone or Information, but lives in the cloud. Web apps are not new, but itused to be that they were often unable to compete with more traditional applications for business critical functions or where rich user interaction was required. This is no longer the case. With the power of modern web technologies, we are able to design and build performing, secure, and feature rich applications that live in the cloud and bring with them a huge number of benefits.

1. **They are cost effective.**

- Web applications are cheaper to produce and maintain than traditional applications. No matter how many platforms your business uses (Mac, Linux, Windows) web application build can be used across them all.

2. **They can be accessed from anywhere.**

- Because web applications are built with web technologies and they run in a web browser Internet Explorer, Google Chrome, Mozilla Firefox – this allows them to be accessed from every web enabled tool. As long as you have an internet connection you can use them.
- It allows for remote working, it allows for rapid publishing of content, it allows for real time collaboration between teams. If you have web access, you have the ability to access your business tools.

3. **They benefit from more rapid update cycles.**

- A huge benefit of web applications is that when an update is released, all of your users are immediately using that version. This doesn't happen with installed applications, especially in large organizations with IT policies that restrict administrator access.

4. **They are secure.**

- Web developers have had to become experts in security – the web is a platform designed to share everything with everyone! As such, the types and levels of security included in web applications are often far greater than those seen in traditional applications.
- They also benefit from the ability to launch updates in real-time – the application on the servers is the application people are using. The applications on people's laptops however is the version last installed. And when those laptops get left on a train it's not a concern, as nothing is stored locally.

5. **They enable more computing with fewer Information.**

- Web applications push all of the hard work to the servers, and act as intermediaries between the user interface and the calculations happening behind the scenes. This means you can accomplish terrifyingly complex work on a tablet, or your phone.
- We've built web applications that allow people to understand the complex relationships between 250,000 pieces of art on their phones, and applications that run the business systems of one of the largest solar energy providers in the world. Often these products are not financially viable to build using traditional application processes.

- They also benefit from the ability to launch updates in real-time – the application on the servers is the application people are using. The applications on people's laptops however is the version last installed. And when those laptops get left on a train it's not a concern, as nothing is stored locally.

Problem Statement:

1. Design a Figma Model for the Assigned Project.
2. Design the Front-End Part of the website (Use HTML, CSS)[Mandatorytask].
3. Design a working backend database where user data is to be stored.
4. Design and Embed Functional features using JS or add conditional features to the site using JS.
5. Design a subscribe to email updates feature, and a place where the email addresses are to be stored.

CHAPTER 2

SYSTEM ANALYSIS

A. Text-to-Speech

This module comprises text and speech processing. The main purpose of this module is to take into consideration all the text provided and convert these into the appropriate audio output using speech processing. We have implemented a dynamic system that makes use of Google API (Gttx) for the conversion of Text to Speech dynamically provided that good internet connectivity is present.

B. Object Recognition

Object Recognition is a process in which Real-world objects are identified using Image processing. It is an important operation that will aid visually impaired to locate their frequently used day to day objects. The system that we have developed provides support in visual aid by assisting to dynamically locate and identify the objects in an image and providing the text output for the same.

C. Face recognition

Some face recognition algorithms identify countenance by extracting landmarks, or features, from a picture of the subject's face that includes the features shape of the jaw, nose, cheek, facial hair and other such characteristics. The features of the image in consideration are then compared with other images having similar features. The algorithm normalizes a dataset of face embeddings then compresses these embeddings, only saving the information within the image that's useful for face recognition. Eventually what we will be obtaining is a bounding box surrounding the face in the live monitoring having the name of the person and the confidence attached to the bounding box.

CHAPTER 3

REQUIREMENT ANALYSIS

Hardware Requirement Specification

- VISUAL STUDIO
- NODE JS
- Notepad++ Editor
- Processor: Intel core i5 processer
- Memory: 15.6 GB
- Hard Disk: 40 GB

Software Requirement Specification

A]Functional Requirements

- Figma
- Frontend (HTML &CSS)
- Database
- JavaScript
- Backend

B]Non-Functional Requirements

- **Availability**

The online registration system shall permit backing up of the registration database while other registration actives are going on.

- **Accessibility**

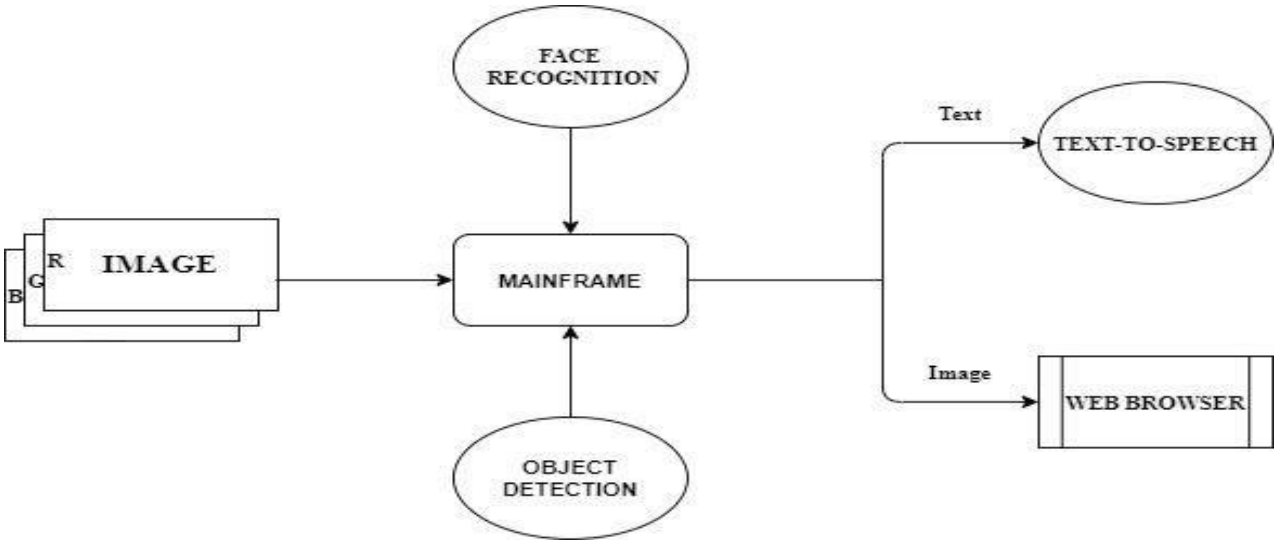
The system shall be accessible by people with specific vision needs to the extent that a user shall be able to display whole user interface in a larger font without truncating displayed text or other values.

- **Security**

The access permissions for system data may only be change by the systems data administrator passwords shall never be viewable at the point of entry or any other time.

CHAPTER 4

DESIGN ANALYSIS



CHAPTER 5

IMPLEMENTATION

The system developed is deployed on the web as a website. The website is built on the backbone of flask, which serves the purpose of providing connectivity between the python code and the HTML. When the website is loaded, the object detection module starts its processing and the objects detected by this module are displayed on the page as well as delivered to the user via an earpiece/speaker. Along with this, we also have two buttons ('Switch to Face' and 'Stop') on the landing page that are well separated to be easily accessible. Clicking on 'Stop' results in pausing the Livestream until the 'Start' button is clicked. The 'Switch to Face' button on click will switch to the page where the Face Recognition processing begins. We have also included the buffer which can only contain a maximum of five entities (objects/people) at a time. Each entity will be converted to speech in every 20 seconds if it still exists in the frame.

The 'Face Detection' module is implemented similarly as the 'Object Detection' module using the same layout for the buttons. Here, the clicking of the 'Stop' button will have the same function as mentioned above whereas a click on the 'Add Face'button will capture the current frame and prompt the user to speak out the name of the person whose face is being added. The name is spoken into the microphone by the user and the speech-to-text model converts this audio into the text and stores the text with the captured frame into the database. All the processing is carried out in the python engine and is displayed using HTML tothe user. Thus implementing all these, we obtain a system that is more relevant and more assistive to the user.

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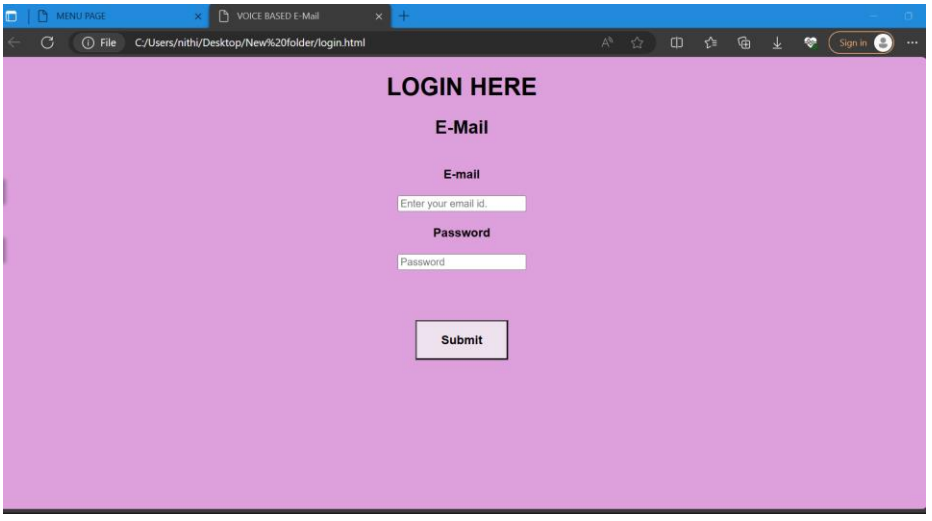
CHAPTER 6
CODING FOR VIRTUAL ASSISTANT FOR VISUALLY IMPAIRED

LOGIN PAGE.HTML

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>VOICE BASED E-Mail</title>
  <link rel="stylesheet" href="instyles.css">
</head>

<style>
  body {
    background:plum;
  }
  </style>
<body>

    <h1><center>LOGIN HERE</center></h1>
    <form>


      <label><center><b>E-mail</b></center></label>
      <center><input id="E-mail" name="E-Mail" placeholder="Enter your email
id."></center>

      <label><center><b>Password</b></center></label>
      <center><input id="password" name="password" placeholder="Password"></center>
    </form>
    <br>
    <br>
    <br>

    <center><b><button onclick="Submit">Submit</b></button></center>

      </body>
      </html>
```

INSTYLES.CSS

```css
body {
    font-family: Arial, sans-serif;
    margin: 0;
    padding: 0;
  }
  button {
    background-color: rgb(239, 226, 239) ;
    color: black;
    padding: 15px 32px;
    text-align: center;
    text-decoration:dotted;
    display: table-cell;
    font-size: 16px;
    margin-top: 10px;
    cursor: pointer;
  }

 form{
  display: contents;
  flex-direction: column-reverse;
  margin-top: 3rem;
 }

 label{
  margin-bottom: 1rem;
  padding: 0.5rem;
  border: none;
  border-radius: 3px;
  box-shadow: 5px 5px 5px rgba(0, 0, 0, 0.3)
 }
```



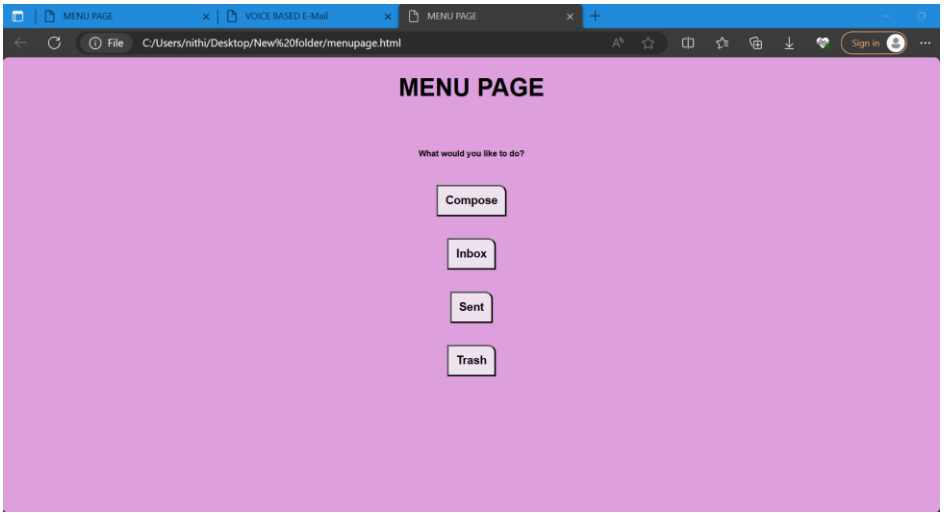
MENUPAGE.HTML

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>MENU PAGE</title>
  <link rel="stylesheet" href="pagestyles.css">
</head>

<style>
  body {
    background:plum;
  }
  </style>
<body>

    <h1><center>MENU PAGE</center><br>
   <h6><p><center>What would you like to do?</center></p></h6></h1></center>

    <center><b><button onclick="compose">Compose</b></button></center><br>
    <center><b><button onclick="inbox">Inbox</b></button></center><br>
    <center><b><button onclick="sent">Sent</b></button></center><br>
    <center><b><button onclick="trash">Trash</b></button></center><br>

      </body>
      </html>
```

PAGESTYLES.CSS

```
body {
    font-family: Arial, sans-serif;
    margin: 0;
    padding: 0;
  }
  button {
    background-color: rgb(239, 226, 239) ;
    color: black;
    border-top-right-radius: 10px;
    text-decoration: solid;
    font-size: 15px;
    margin-top: 10px;
    padding: 10px 10px;
    cursor: pointer;
  }

 label{
  margin-bottom: 1rem;
  padding: 0.5rem;
```

```
  border: none;
  border-radius: 3px;
  box-shadow: 5px 5px 5px rgba(0, 0, 0, 0.3)
 }
```

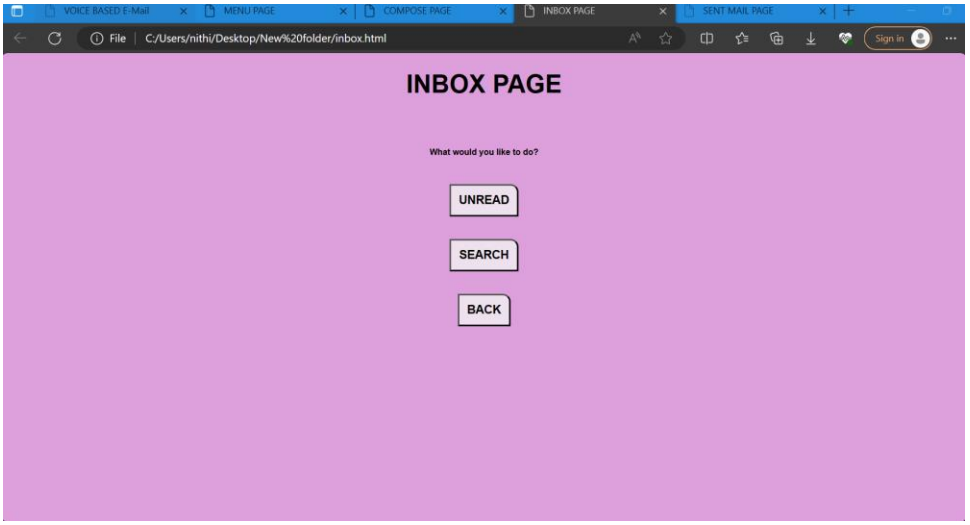


INBOX.HTML

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>INBOX PAGE</title>
  <link rel="stylesheet" href="boxstyles.css">
</head>

<style>
  body {
    background:plum;
  }
  </style>
<body>

    <h1><center>INBOX PAGE</center><br>
   <h6><p><center>What would you like to do?</center></p></h6></h1></center>

    <center><b><button onclick="unread">UNREAD</b></button></center><br>
    <center><b><button onclick="search">SEARCH</b></button></center><br>
    <center><b><button onclick="back">BACK</b></button></center><br>

      </body>
      </html>
```

INSTYLES.CSS

```css
body {
    font-family: Arial, sans-serif;
    margin: 0;
    padding: 0;
  }
  button {
    background-color: rgb(239, 226, 239) ;
    color: black;
    padding: 15px 32px;
    text-align: center;
    text-decoration:dotted;
    display: table-cell;
    font-size: 16px;
    margin-top: 10px;
    cursor: pointer;
  }

 form{
  display: contents;
  flex-direction: column-reverse;
  margin-top: 3rem;
 }

 label{
  margin-bottom: 1rem;
  padding: 0.5rem;
  border: none;
  border-radius: 3px;
  box-shadow: 5px 5px 5px rgba(0, 0, 0, 0.3)
 }
```

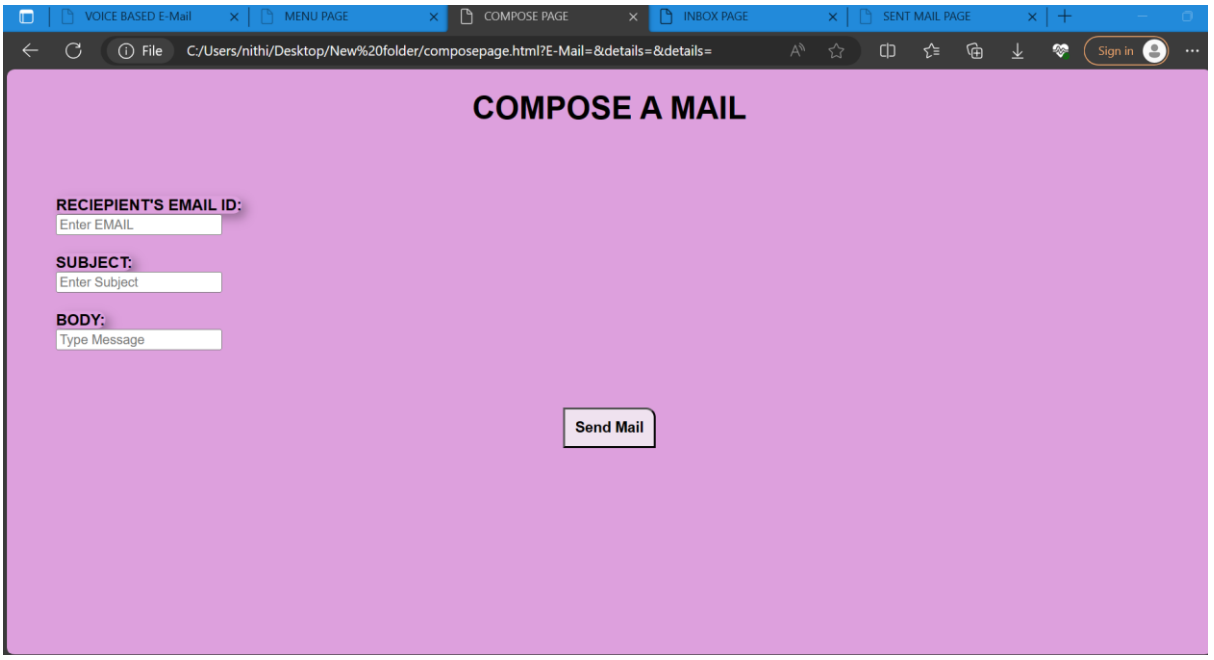


COMPOSEPAGE.HTML

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>COMPOSE PAGE</title>
  <link rel="stylesheet" href="composestyles.css">
</head>

<style>
  body {
    background:plum;
  }
.div{
  width: 300px;
  height: 100px;
  padding: 50px;
}
  </style>
<body>

    <h1><center>COMPOSE A MAIL</center></h1>
    <form>
<div class="div">
      <label><b>RECIEPIENT'S EMAIL ID:</label><br>
      <input id="E-mail" name="E-Mail" placeholder="Enter EMAIL"><br><br>

      <label><b>SUBJECT:</b></label><br>
      <input id="subject" name="details" placeholder="Enter Subject"><br><br>

      <label><b>BODY:</b></label><br>
      <input id="subject" name="details" placeholder="Type Message">
    </div>

    </form>
    <br>
    <br>
    <br>

    <center><b><button onclick="Sendmail">Send Mail</b></button></center>

      </body>
      </html>
```

COMPOSESTYLES.CSS

```css
body {
    font-family: Arial, sans-serif;
    margin: 0;
    padding: 0;
 }
 button {
    background-color: rgb(239, 226, 239) ;
    color: black;
    border-top-right-radius: 10px;
    text-decoration: solid;
    font-size: 15px;
    margin-top: 10px;
    padding: 10px 10px;
 }

form{
 display: contents;
 flex-direction: column-reverse;
 margin-top: 3rem;
 box-shadow: 5px 5px 10px ;

}

label{
 margin-bottom: 50rem;
 padding: 0.5 rem;
 border:none;
 border-radius: 50px;
 box-shadow: 5px 5px 10px rgba(0, 0, 0, 0.3)

}
button {
    background-color: rgb(239, 226, 239) ;
    color: black;
    border-top-right-radius: 10px;
    text-decoration: solid;
    font-size: 15px;
    margin-top: 10px;
    padding: 10px 10px;
    cursor: pointer;
}
```

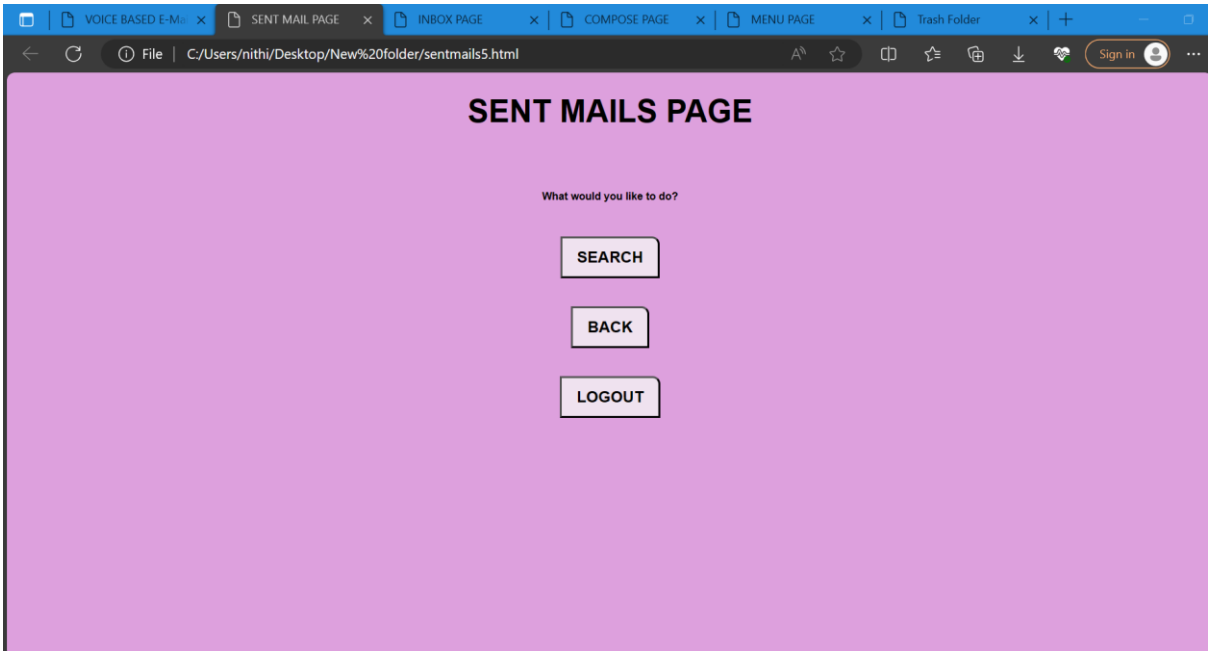


SENTMAILS.HTML

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>SENT MAIL PAGE</title>
  <link rel="stylesheet" href="sent.css">
</head>

<style>
  body {
    background:plum;
  }
  </style>
<body>

    <h1><center>SENT MAILS PAGE</center><br>
   <h6><p><center>What would you like to do?</center></p></h6></h1></center>

    <center><b><button onclick="search">SEARCH</b></button></center><br>
    <center><b><button onclick="back">BACK</b></button></center><br>
    <center><b><button onclick="logout">LOGOUT</b></button></center><br>

      </body>
      </html>
```

SENT.CSS

```css
body {
    font-family: Arial, sans-serif;
    margin: 0;
    padding: 0;
  }
  button {
    background-color: rgb(239, 226, 239) ;
    color: black;
    padding: 10px 15px;
    text-align: center;
    text-decoration:dotted;
    display: table-cell;
    font-size: 16px;
    margin-top: 10px;
    cursor: pointer;
    border-top-right-radius: 0.5rem;
  }

 label{
  margin-bottom: 1rem;
  padding: 0.5rem;
  border: none;
  border-radius: 3px;
  box-shadow: 5px 5px 5px rgba(0, 0, 0, 0.3)
 }
```



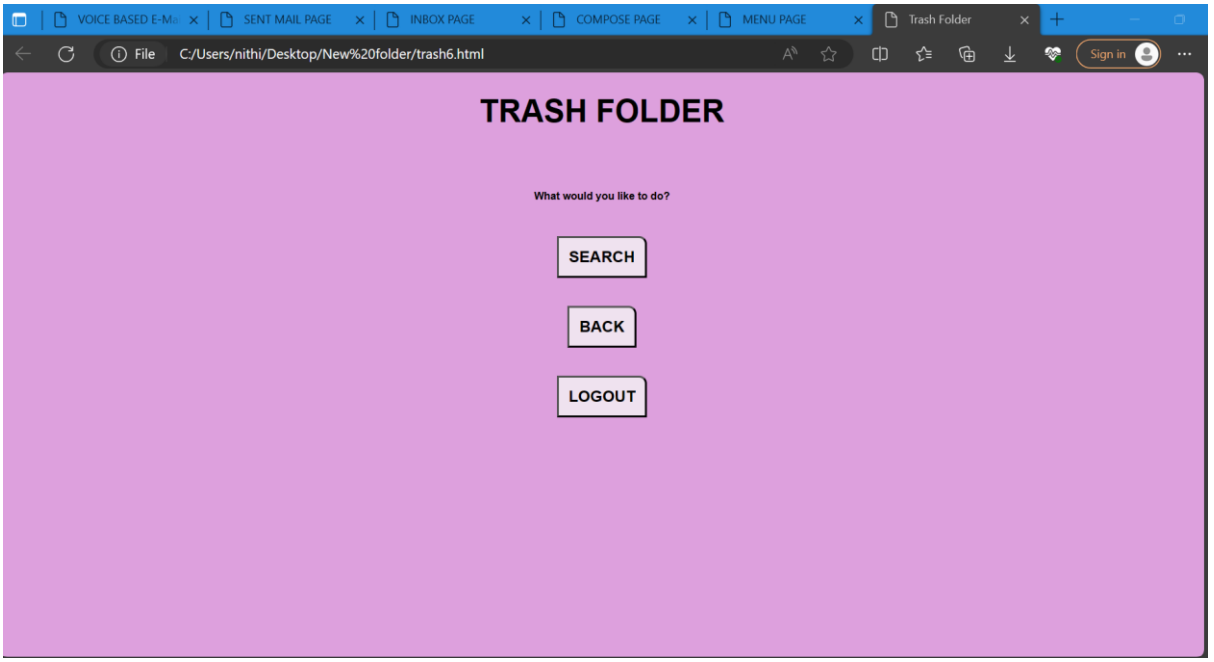
TRASH.HTML

```
<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>Trash Folder</title>
  <link rel="stylesheet" href="trash.css">
</head>

<style>
  body {
    background:plum;
  }
  </style>
<body>

    <h1><center>TRASH FOLDER</center><br>
   <h6><p><center>What would you like to do?</center></p></h6></h1></center>

    <center><b><button onclick="search">SEARCH</b></button></center><br>
    <center><b><button onclick="back">BACK</b></button></center><br>
    <center><b><button onclick="logout">LOGOUT</b></button></center><br>

      </body>
      </html>
```

TRASH.CSS

```
body {
    font-family: Arial, sans-serif;
    margin: 0;
    padding: 0;
  }
  button {
    background-color: rgb(239, 226, 239) ;
    color: black;
    padding: 10px 10px;
    text-align: center;
    text-decoration:dotted;
    display: table-cell;
    font-size: 16px;
    margin-top: 10px;
    cursor: pointer;
    border-top-right-radius: 0.5rem;
  }

 label{
  margin-bottom: 1rem;
```

```
  padding: 0.5rem;
  border: none;
  border-radius: 3px;
  box-shadow: 5px 5px 5px rgba(0, 0, 0, 0.3)
}
```



CHAPTER 7

CONCLUSION

In this paper, various techniques to implement the aforementioned system are analyzed and summarized. Different systems have different ways of implementation along with some limitations and restrictions. These types of systems are very critical for multiple reasons and the occurrence of an error in such a system/device may cause catastrophic damage and loss. The system we are achieving overcomes the limitations of the already implemented systems. Our system consists of a basic UI on a web-based application and comprises several Deep learning models; some of them are object detection, face recognition, speechrecognition and so on. These modules will work together and assist in vital activities like object detection as well as face detection and recognition for the visually impaired.

CHAPTER 8

FUTURE SCOPE

A. **Alerting the visually impaired person about the Obstacle Position**

We would implement the device in such a way that the sensors will be mounted on a spectacle and this would help the person wearing the spectacle detect the obstacle position in front of their vision in the walking path.

B. **Voice Command and Emergency Voice Call Establishment**

We would include the facility to save an emergency number in the application so that the visually impaired person can establish a voice call to the predefined number by using his/her voice command. When the visually impaired person wants to give a voice command, he/she need not touch the phone and just pressing the lock button thrice on the phone will lead to prompt command and by uttering “HELP” this voice command will connect through a voice call to a predefined number.

C. **Text Reader**

This system will help a visually impaired person to listen to the text which is written in any literature or any book. The system will take a pic and it will recognize the text written on it using image processing. This recognized text is then converted to speech using a text-to-speech model.

CHAPTER 9

REFERENCES

1. Marcos Barata, Afan Galih Salman, Ikhtiar Faahakhododo, Bayu Kanigoro,"Android based voice assistant for blind people", Library Hi Tech News, Vol. 35 Issue: 6, pp.9-11 (2018).
2. Md. Siddiqur Rahman Tanveer, M.M.A. Hashem and Md. Kowsar Hossain , " Android Assistant EyeMate for Blind and Blind Tracker" (2018).
3. Joseph Redmon, Ali Farhadi, "An Incremental Improvement", Pjreddie (2018).
4. Vincent Gaudissart, Silvio Ferreira, Céline Thillou, Bernard Gosselin,"Mobile Reading Assistant for Blind People" (2018).
5. DR. Kavitha C, MR. Nithin V Gopal, MS. Nidhi Amarnath, MR. Prajwal G, MS. Supreetha R.R., "VIRTUALASSISTANT FOR BLIND PEOPLE" (2018).
6. Prof. Priya U. Thakare, Kote Shubham, Pawale Ankit, Rajguru Ajinkya, Shelke Om, "Smart Assistance System for the Visually Impaired" International Journal of Scientific and Research Publications, Volume 7, Issue 12, December 2017 378 ISSN 2250-3153 (2017).
7. Faizan Ahmad ,Aaima Najamand Zeeshan Ahmed, " Image-based Face Detection and Recognition" ,Arxiv (2015).
8. R. Velázquez, Wearable Assistive Devices for the Blind. Chapter 17 in A. Lay-Ekuakille & S.C. Mukhopadhyay (Eds.), Wearable and Autonomous Biomedical Devices and Systems for Smart Environment: Issues and Characterization, LNEE 75, Springer, pp 331-349 (2010).

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