MIT | Academy of Engineering

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

# A Minor Project Report on

*Submitted by,*


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*Guided by,*

**Mrs. Aarti Deshpande**

**A Report submitted to MIT Academy of Engineering, Alandi(D), Pune, An Autonomous Institute Affiliated to Savitribai Phule Pune University in partial fulfillment of the requirements of**

**SY BTECH.** in

**Computer Engineering**


## School of Computer Engineering

## MIT Academy of Engineering

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

**Alandi (D), Pune – 412105**


## (2022–2023)

MIT | Academy of Engineering

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

# CERTIFICATE

It is hereby certified that the work which is being presented in the SY BTECH Minor Project Report entitled "", in partial fulfillment of the requirements for the SY BTECH MInor project. in Computer Engineering and submitted to the **School of Computer Engineering** of **MIT Academy of Engineering, Alandi(D), Pune, Affiliated to Savitribai Phule Pune University (SPPU), Pune**, is an authentic record of work carried out during Academic Year **2022–2023**, under the supervision of **Mrs. Aarti Deshpande**, **School of Computer Engineering**

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# DECLARATION

We the undersigned solemnly declare that the Minor project report is based on our own work carried out during the course of our study under the supervision of **Mrs. Aarti Deshpande**.

We assert the statements made and conclusions drawn are an outcome of our project work. We further certify that

1. The work contained in the report is original and has been done by us under the general supervision of our supervisor.
2. The work has not been submitted to any other Institution for any other degree/diploma/certificate in this Institute/University or any other Institute/University of India or abroad.
3. We have followed the guidelines provided by the Institute in writing the report.
4. Whenever we have used materials (data, theoretical analysis, and text) from other sources, we have given due credit to them in the text of the report and giving their details in the references.

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# Abstract

Our project addresses the communication barrier between individuals who use sign language and those who do not understand it. We aim to provide a solution for voiceless individuals by developing a cost-effective mobile app. The main objective of our project is to create a system that can convert sign language into text through the scanning of hand gestures. By using this innovative mobile application, communication will no longer be a barrier between these two distinct communities. Our goal is to empower voiceless individuals and enable seamless communication with others.

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# Acknowledgment

We express our heartfelt gratitude to our mentors who have played a pivotal role in our journey. We extend our thanks to Mrs. Aarti Deshpande, Mrs. Ashwini Mane, Mrs. Shilpa Rudrawar, Mr. Jain, Dr. Dipti Sakhare - the dean of electrical and electronic engineering, and Dr. Rajeshwari Goudar - the dean of computer engineering. Their guidance and support have provided us with the opportunity to participate in the minor project course, which has not only enhanced our software knowledge but also fostered our interpersonal skills. We are truly grateful for their invaluable contribution to our growth and development.

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# Chapter 1

# Introduction

## 1.1 Background

Human beings possess the remarkable ability to express themselves by responding to their surrounding events. They perceive, listen, and articulate their reactions through speech. However, there are individuals who are unfortunate enough to lack this invaluable gift of communication. This creates a significant divide between those who can express themselves verbally and those who cannot.

To bridge this gap, an application has been developed to enable communication between these two groups. The application comprises two key modules: data collection and training/testing.

The data collection module is responsible for gathering relevant information. This may involve capturing images, recording actions, or any other suitable data that can be processed and analyzed.

Subsequently, the training and testing module comes into play. This module utilizes machine learning techniques, leveraging the OpenCV library in Python. Through training, the system learns to recognize specific images or actions, extracting meaningful information from the collected data. The testing phase verifies the system's accuracy and ensures its reliability in recognizing and interpreting the intended image or action.

The final objective is to convert the processed images into textual form. This involves the transformation of visual information into written text, enabling individuals who are unable to communicate verbally to express themselves by typing or displaying text-based messages.

By incorporating these modules and leveraging the capabilities of OpenCV in Python, this application seeks to empower individuals with limited communication abilities and facilitate meaningful interaction between them and those who possess typical verbal communication skills.

## 1.2 Project Idea

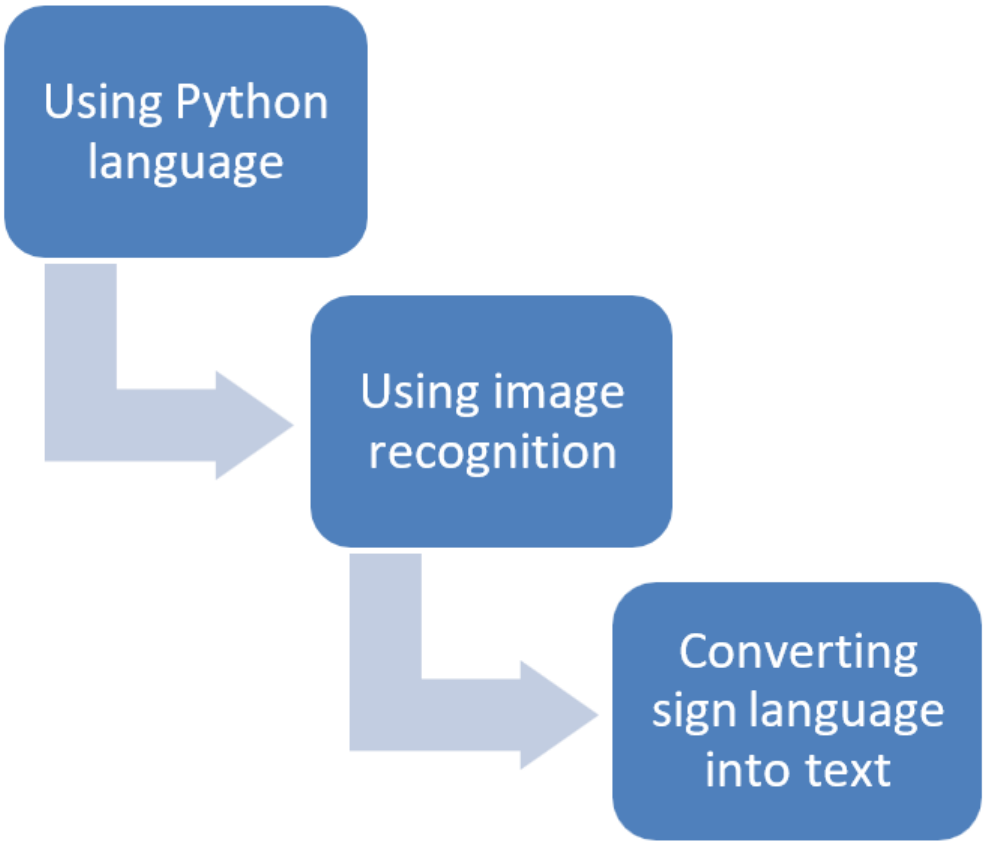


Figure 1.1: Flow chart of Project Idea

## 1.3 Motivation

The availability of articles and documents on Google and online platforms has been instrumental in enhancing our understanding of the challenges faced by individuals who are deaf or mute (commonly referred to as "deaf and dumb" in the past, but "deaf and mute" is a more appropriate and respectful term). Through these resources, we have gained insights into the daily obstacles they encounter when communicating with others who do not share their condition.

Communication for individuals who are deaf and mute differs significantly from that of individuals who can hear and speak. They often rely on alternative means of communication, such as sign language, gestures, facial expressions, and written notes. These forms of communication require both parties to be familiar with the specific sign language or gestures being used, creating a barrier between individuals who are deaf and mute and those who do not understand these alternative communication methods.

Fortunately, these articles also shed light on various solutions that have been explored to overcome these communication barriers. These solutions aim to provide inclusive and effective communication tools for individuals who are deaf and mute, fostering better interaction with the general population.

Drawing from the ideas and information gathered from these articles, we have developed a novel approach that distinguishes itself from previous solutions. Our project incorporates unique features not found in other existing initiatives. These features are designed to be cost-effective and user-friendly, ensuring accessibility for a wider range of users.

By leveraging the knowledge and insights gained from the articles, we have been able to create a solution that addresses the specific communication needs of individuals who are deaf and mute. Our goal is to bridge the communication gap between these individuals and the rest of society, empowering them to engage in meaningful interactions with ease and confidence.

## 1.4 Project Challenges

1. In the past, obtaining online data related to sign language was challenging, and the available resources often lacked comprehensive coverage. The existing resources were limited in terms of the number of signs covered or lacked the necessary details.

2. Training models using large data sets of sign language can indeed be a complex task, and during the coding process, we encountered numerous errors.

## 1.5 Proposed Solution

We have conceived the idea of developing a mobile application that aims to bridge the communication barrier between individuals who are mute and the general population. This application will serve as a real-time translator, converting the actions and gestures of mute individuals into understandable communication for others.

By leveraging the capabilities of modern smartphones, our application will utilize the device's camera to capture and analyze the actions and gestures of individuals who are mute. Through the integration of advanced image processing and machine learning algorithms, the application will be able to recognize and interpret these actions accurately.

Once the actions are identified, the application will generate corresponding text or visual representations that convey the intended message. This can be achieved through on-screen text display, voice output, depending on the user's preferences and the context of the communication.The application will also incorporate a user-friendly interface, making it easy for both individuals who are mute and those who can hear and speak to interact effectively.

By reducing the communication barrier between individuals who are mute and the general community, our mobile application strives to foster inclusivity, understanding, and improved social interaction. It will provide a valuable tool for enabling effective communication and building bridges of connection between these two communities.

# Chapter 2

# Literature Review

## 2.1 Related work And State of the Art (Latest work)

There is system which aims right now only on American sign language and converts them to text and help the deaf and mute to carry out their daily transactions without relying on an interpreter [1]. Some projects were simple demonstration of how CNN can be used to solve computer vision problems with an extremely high degree of accuracy [2] and other included both static and dynamic gesture using multiclass support vector machine (SVM) [3]. There is some app like fingerspelling which teaches the correct hand positions in real time on web browsers. This app uses people's webcams to track their hand movements while an algorithm checks their accuracy [4]. There are also some projects which can translate video of sign language, and then smart algorithms translate it into speech. It is as quick as the person speaks it translate it next second [5].

## 2.2 Limitation of State of the Art techniques

The systems made to date are only applicable to American Sign Language [4]. Some systems use histograms for image recognition, and as a result, they were only limited to images whose histogram was previously saved [1]. Various systems are inaccurate, if the posture in which the user is doing the gesture is wrong then it will not give

a correct prediction [2]. Some system models required gloves to detect the sign [2]. Many of the systems were not affordable [5] and they could not recognize signs that involved moving hands [6].

## 2.3 Discussion and future direction

In our project, we will curate our own data set consisting of various categories such as alphabets, numbers, common phrases, idioms, and more. To train our model, we will utilize Google Teachable Machine, a user-friendly platform for training machine learning models. By collecting a wide range of images for each specific sign, we aim to increase the accuracy and robustness of our model.

An important advantage of our system is that it does not rely on users wearing gloves for successful image recognition. This eliminates the need for specialized equipment or accessories, enhancing convenience and ease of use for individuals who are mute.

By addressing the limitations of existing systems, particularly in terms of accuracy and usability, our project strives to provide a more comprehensive and accessible solution for communication between individuals who are mute and others. Through our innovative approach and meticulous attention to accuracy, we aim to overcome barriers and develop a system that delivers reliable and precise image recognition results without requiring additional accessories or compromising the user experience.

## 2.4 Concluding Remarks

Our project focuses on bridging the communication gap for individuals who are deaf or hearing impaired by introducing a cost-effective mobile application. This app aims to automate the process of capturing, recognizing, and translating sign language into speech, benefiting the deaf community. Conversely, it also analyzes hand gestures and converts them into text displayed on the screen for the benefit of the hearing impaired.

The mobile app will leverage the capabilities of modern smartphones, utilizing their

camera to capture and analyze sign language gestures in real-time. Through advanced image processing and machine learning algorithms, the app will accurately recognize and interpret these gestures. The recognized gestures will then be translated into spoken language, allowing deaf individuals to understand and participate in conversations more easily.

Conversely, for individuals who are hearing impaired, the app will analyze spoken language input and convert it into text displayed on the screen. This facilitates effective communication with others, even in situations where verbal communication may be challenging or impossible.

Our goal is to provide an accessible and affordable solution that empowers individuals who are deaf or hearing impaired to engage in seamless communication with the broader community. By leveraging mobile technology and advanced algorithms, we aim to enhance inclusivity, break down communication barriers, and foster understanding and connection between individuals with different hearing abilities.

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# Chapter 3

# Problem Definition and Scope

## 3.1 Problem statement

App Development for Specially abled (Deaf) People

## 3.2 Goals and Objectives

1. To enhance communication accessibility for individuals with disabilities by bridging the gap between the disabled and able-bodied individuals.
2. To develop advanced language interpretation technology that can accurately convert spoken language into written text, enabling effective communication for people with hearing impairments or those who prefer written communication.
3. To create intuitive and user-friendly tools or applications that facilitate learning and understanding of sign language for beginners. This can include interactive tutorials, visual aids, and feedback mechanisms to make the learning process more engaging and efficient.
4. To prioritize affordability and reliability in the development of the application, ensuring that it is accessible to a wide range of users, regardless of their financial capabilities. This can be achieved through partnerships with organizations, offering subsidized pricing, or exploring sustainable funding models to keep the

app affordable while maintaining its reliability and quality.

## 3.3 Scope and Major Constraints

Main Users: Common people

## 3.4 Hardware and Software Requirements

1. Operating System: Windows
2. Programming Language: Python
3. Computer Vision Libraries: OpenCV is required for image processing, feature extraction, and object detection.
4. Machine Learning Framework: TensorFlow, Keras are used for training and inference tasks.
5. Neural Network Architectures: Convolutional neural networks (CNNs) is used for image processing.
6. Development Environment: Jupyter Notebook.

## 3.5 Expected Outcomes

1. Accurate Sign Language Recognition: The system should be capable of accurately detecting and recognizing sign language gestures and movements performed by users. It should have a high degree of accuracy in identifying and understanding different signs and their meanings.
2. Real-Time Translation: The system should provide real-time translation of sign language into spoken or written language. It should be able to process sign language gestures swiftly and produce corresponding translations in a timely manner, enabling seamless communication between sign language users and non-sign language users.

3. Continuous Improvement: The project should have mechanisms in place for continuous improvement and refinement of the sign language translator system. This can involve collecting user feedback, updating the system with new sign language patterns or gestures, and incorporating machine learning techniques to enhance accuracy over time.

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# Chapter 4

# System Requirement Specification

## 4.1 Overall Description

### 4.1.1 Product Perspective

1. Python libraries
2. Python compiler
3. Google teachable machine
4. Kaggle

## 4.2 Specific Requirements

### 4.2.1 User Requirements

1) Internet

2) Mobile

### 4.2.2 External Interface Requirements

1) Webcam

2) Proper lighting

### 4.2.3 Functional Requirements

Table 4.1: Functional Requirements

| Functional Requirement | Function Name | Functional Requirement Description |
|---|---|---|
| 1 | Choose Hand | The user needs to choose hand so that camera can focus on that part and scan actions |
| 2 | Turn On Webcam | User need to give access to camera for further process |
| 3 | Stay In Camera Region | For proper scanning of actions user needs to be them in-camera region |
| 4 | Display Text | Actions done by user will be compared with previously saved images and then text will be displayed |
| 5 | Convert Into Voice | Actions done by user will be compared with previously images and will convert text into voice |

# Chapter 5

# Methodology

## 5.1 System Architecture

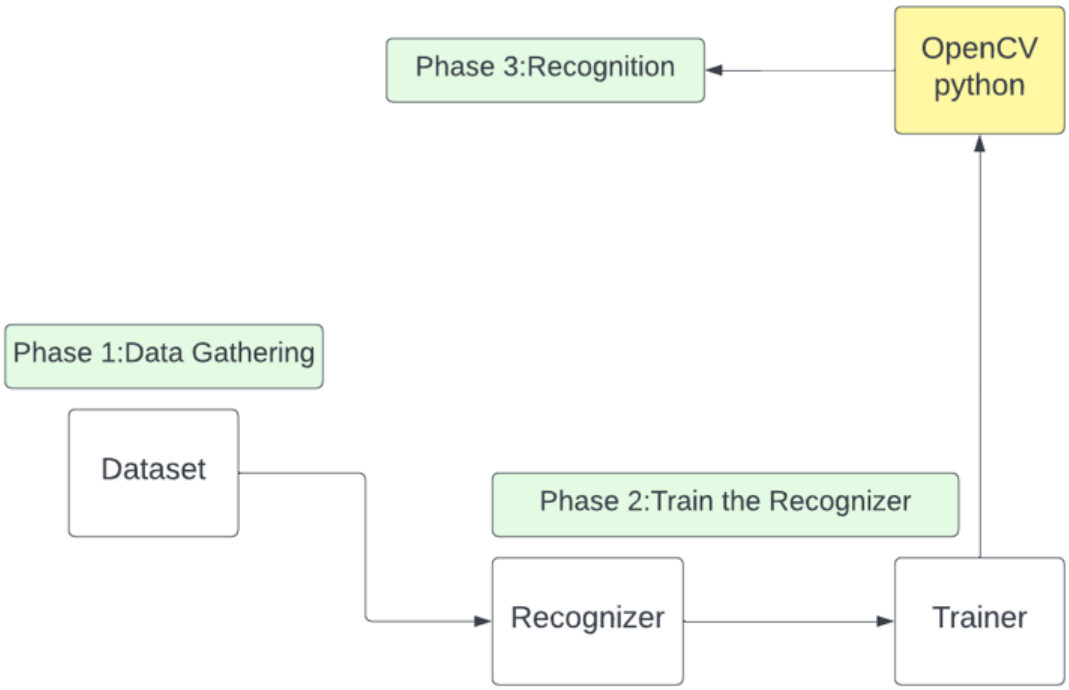


Figure 5.1: Block Diagram of Project Implementation

## 5.2 Mathematical Modeling

### 5.2.1 Convolution Neural Networks (CNN):

Computer vision is a field of Artificial Intelligence that focuses on problems related to images and videos. CNN combined with Computer vision is capable of performing complex problems.

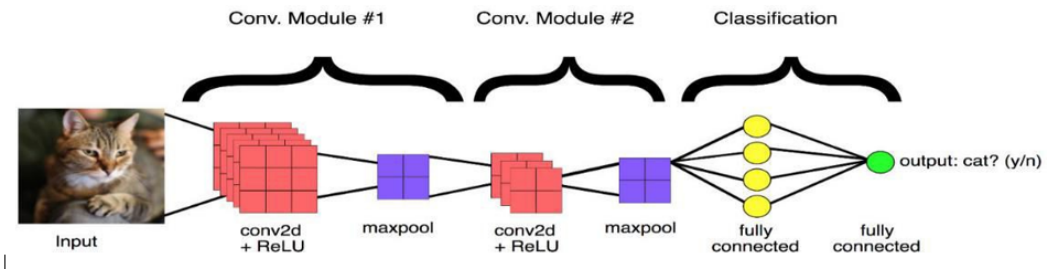


Figure 5.2: Working of CNN

The Convolution Neural Networks has two main phases namely feature extraction and classification. A series of convolution and pooling operations are performed to extract the features of the image. The size of the output matrix decreases as we keep on applying the filters. Size of new matrix = (Size of old matrix — filter size) +1 A fully connected layer in the convolution neural networks will serve as a classifier. In the last layer, the probability of the class will be predicted. The main steps involved in convolution neural networks are:

1.Convolution

2. Pooling

3. Flatten

4. Full connection

**1. Convolution**

Convolution is nothing but a filter applied to an image to extract the features from it. We will use different filters to extract features like edges, highlighted patterns in an image. The filters will be randomly generated. What this convolution does

is, creates a filter of some size says 3x3 which is the default size. After creating the filter, it starts performing the element-wise multiplication starting from the top left corner of the image to the bottom right of the image. The obtained results will be extracted feature.

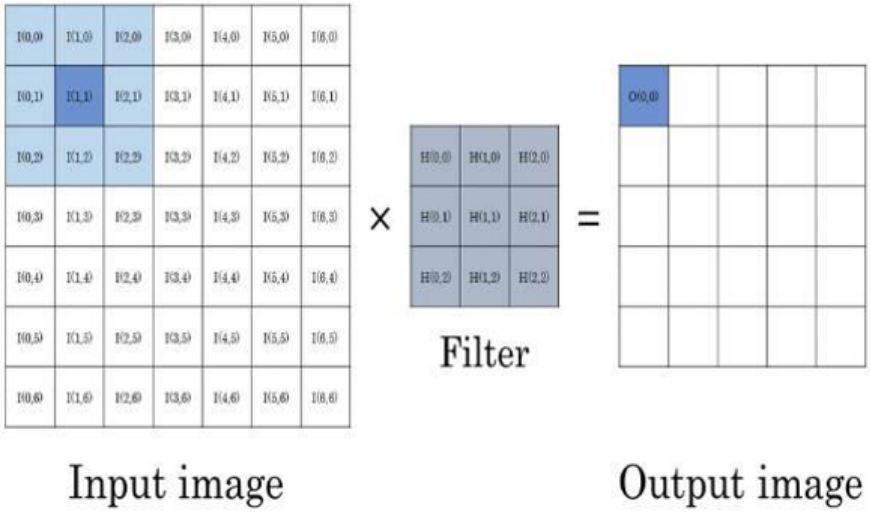


Figure 5.3: Convolution

## 2. Pooling

After the convolution operation, the pooling layer will be applied. The pooling layer is used to reduce the size of the image. There are two types of pooling: A. Max Pooling B. Average Pooling

### A. Max Pooling

Max pooling is nothing but selecting the maximum pixel value from the matrix. This method is helpful to extract the features with high importance or which are highlighted in the image.

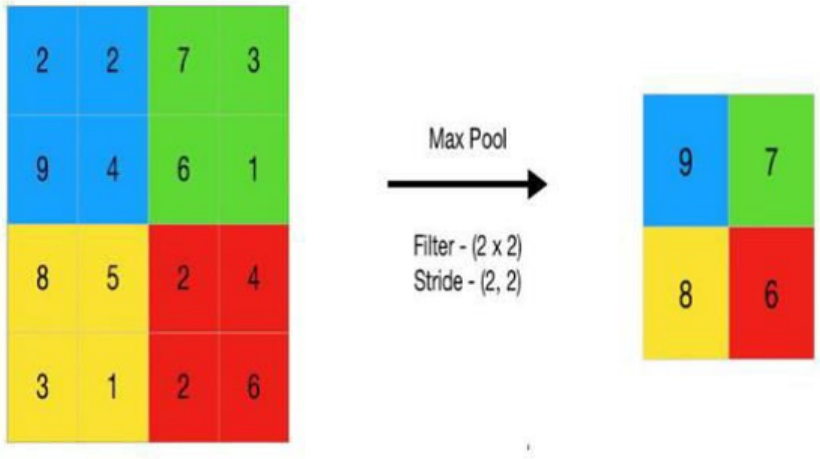


Figure 5.4: Max Pooling

**B. Average Pooling**

Unlike Max pooling, the average pooling will take average values of the pixel. In most cases, max pooling is used because its performance is much better than average pooling.

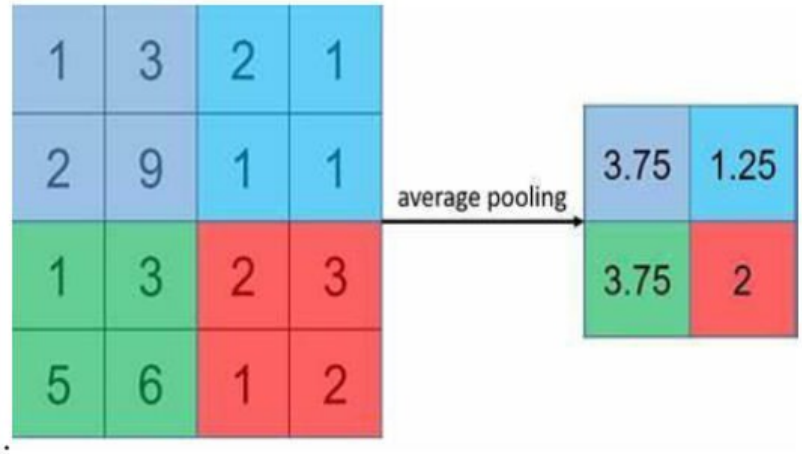


Figure 5.5: Average Pooling

### 3. Flatten

The obtained resultant matrix will be in multi-dimension. Flattening is converting the data into a 1- dimensional array for inputting the layer to the next layer. We flatten the convolution layers to create a single feature vector.

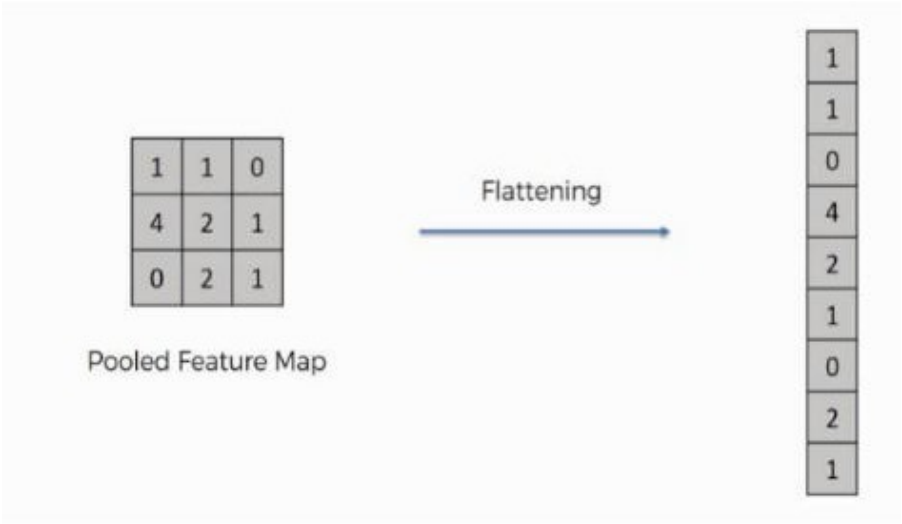


Figure 5.6: Flatten

**4. Fully Connection**

A fully connected layer is simply a feed-forward neural network. All the operations will be performed and prediction is obtained. Based on the ground truth the loss will be calculated and weights are updated using gradient descent back propagation algorithm

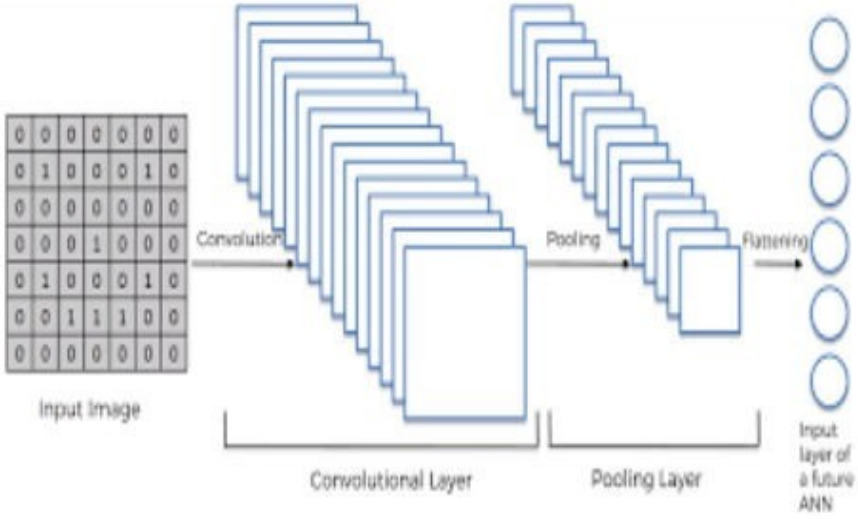


Figure 5.7: Full Connection

## 5.3 Approach/Algorithms

**CODE 1:**

Step 1: Cap = cv2.videocapture library will give access to open the webcam.

Step 2: One window will display on screen.

Step 3: Detector = HandDetector will detect the hand.

Step 4: Clicking on G button one can capture to many images.

Step 5: Train the data on google teachable machine.

**CODE 2**:

Step 1: Cap = cv2.videocapture library will give access to open the webcam.

Step 2: detector = HandDetector library for hand detection.

Step 3: classifier will provide a path where we have stored the files.

Step 4: Label the images with text with matching images.

Step 5: while img = cap.read is true ,the massage will display with particular word.

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# Chapter 6

# Implementation

## 6.1 Analysis

### 6.1.1 Activity Diagram

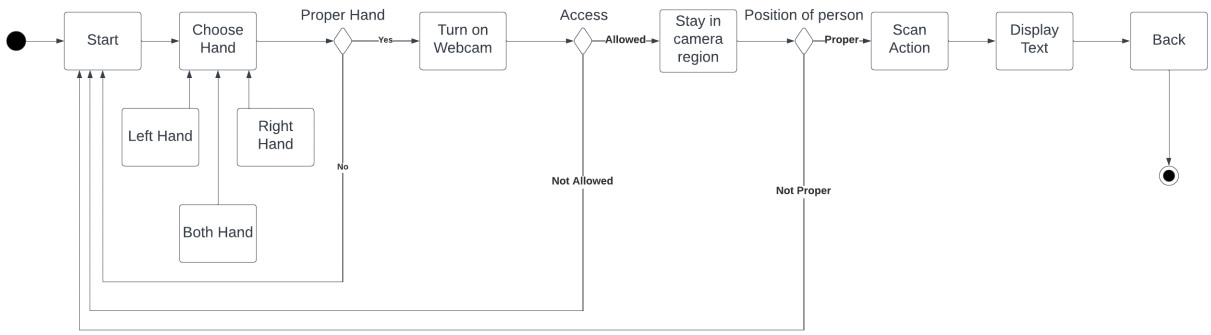


Figure 6.1: Activity Diagram

### 6.1.2 Use Case Diagram

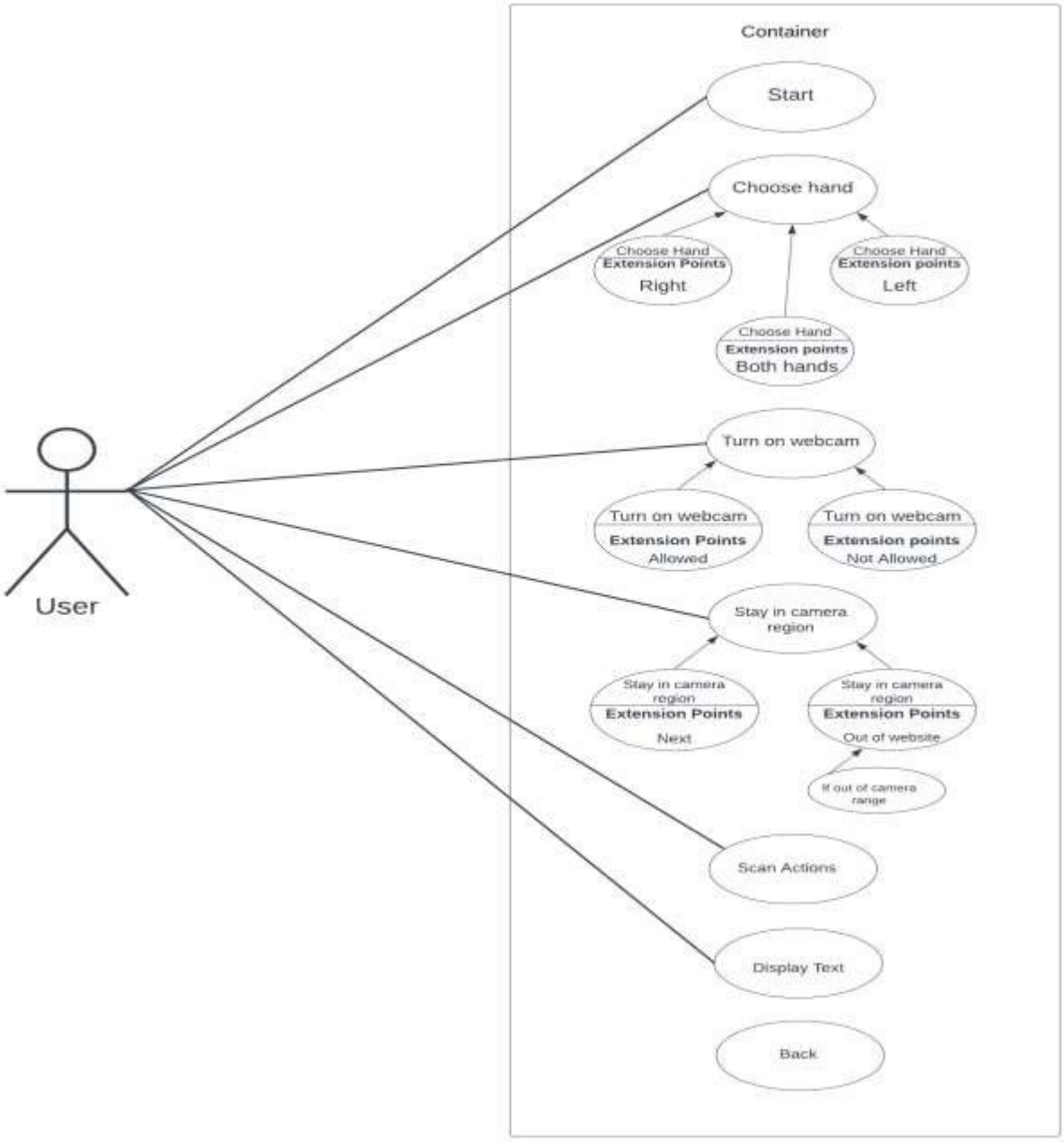


Figure 6.2: Use Case Diagram

### 6.1.3 Sequence Diagram

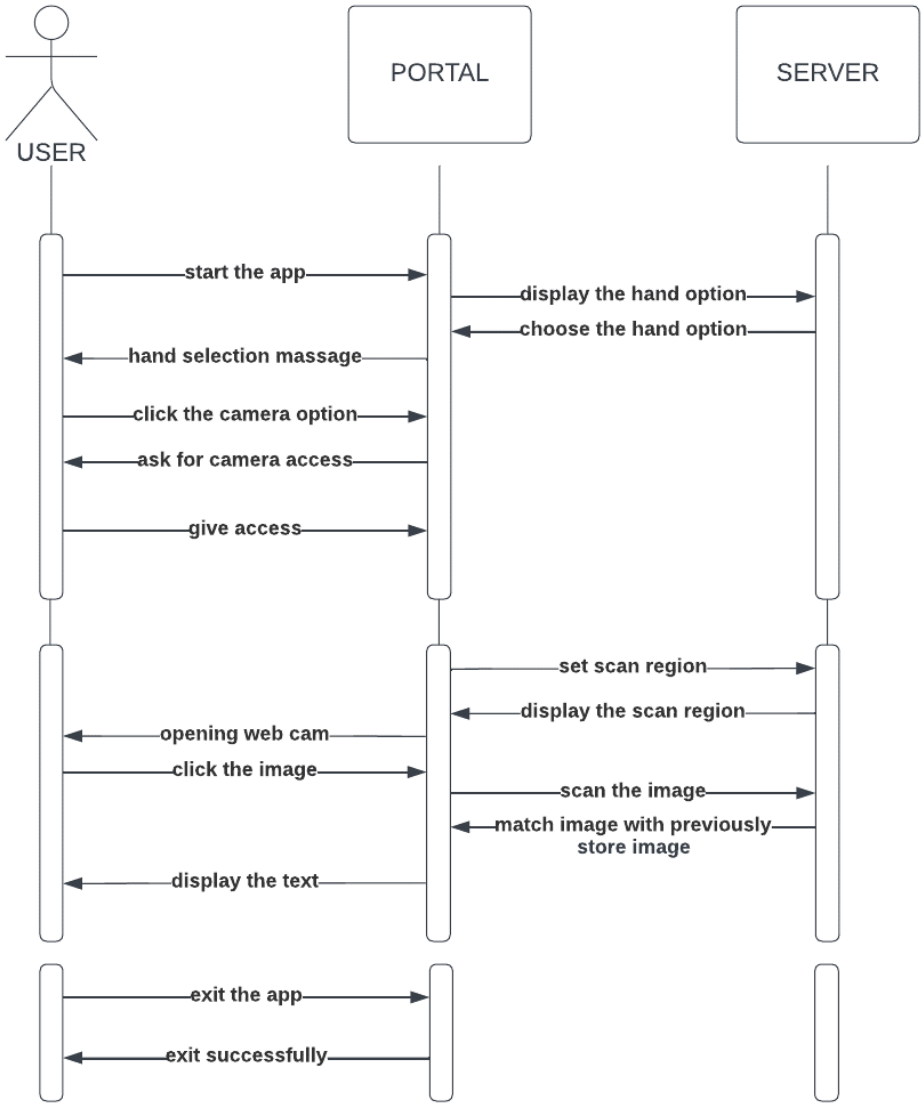


Figure 6.3: Sequence Diagram

## 6.2 Output

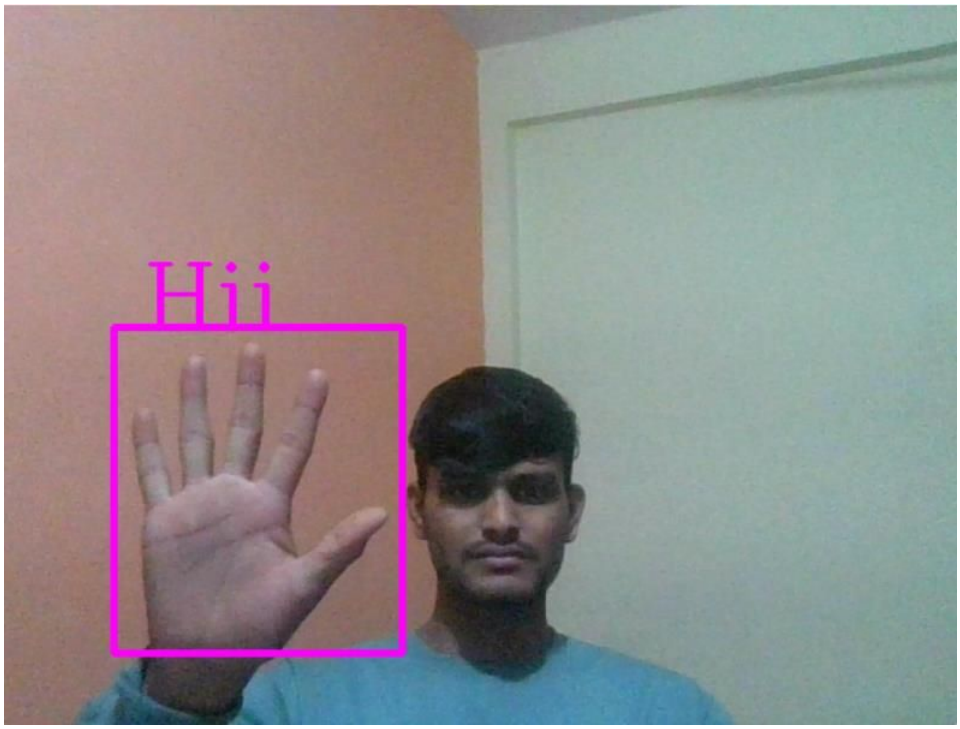


Figure 6.4: Display of text 'Hii'


Figure 6.5: Display of text 'Dhawal'

# Chapter 7

# Result Analysis/Performance Evaluation

## 7.1 Result Analysis of Objective 1

By leveraging the power of modern technology, such as mobile camera-based translators, we can foster better understanding and communication between individuals with different abilities. These advanced translators offer the following improvements:

1. Seamless Language Translation: With the help of mobile camera-based translators, normal individuals and people with disabilities can overcome language barriers effortlessly. By scanning the actions or gestures of someone using sign language, the translator rapidly processes the visual information and converts it into spoken or written language. This allows individuals to understand each other's messages in a matter of seconds.

2. Accessibility and Inclusivity: These translators promote accessibility and inclusivity by enabling effective communication between people with diverse abilities. Normal individuals can use the translator to understand sign language, bridging the communication gap with those who rely on sign language as their primary means of communication. This empowers everyone to interact, share ideas, and build meaningful connections without constraints.

3. Real-Time Translation: Mobile camera-based translators offer real-time translation capabilities. This means that as the camera captures the sign language gestures, the translator instantly converts them into spoken or written language. This real-time aspect eliminates delays in communication and allows for smooth, dynamic conversations between individuals, fostering natural and engaging interactions.

4. User-Friendly Interface: The translators are designed with a user-friendly interface, making them accessible to a wide range of people. The mobile app interface is intuitive, with clear instructions and visual cues to guide users through the translation process. The goal is to ensure that individuals of all ages and technological backgrounds can easily navigate and utilize the translator with minimal effort.

5. Accuracy and Reliability: Mobile camera-based translators are built using advanced computer vision algorithms and machine learning models, which continually improve their accuracy over time. The translators are trained on vast datasets of sign language gestures, allowing them to recognize a wide array of signs and gestures accurately. This enhances the reliability and precision of the translation, ensuring that the intended message is correctly conveyed.

6. Portability and Convenience: By utilizing mobile devices, these translators offer the advantage of portability and convenience. Users can have the translator app readily available on their smartphones or tablets, allowing them to communicate effectively in various settings, whether it's during social interactions, educational activities, or professional engagements. The portability of the technology empowers individuals to communicate on their own terms, without the need for additional equipment or specialized devices.

   In summary, mobile camera-based translators facilitate understanding and communication between normal individuals and those with disabilities. They offer seamless language translation, accessibility, real-time capabilities, user-friendly interfaces, accuracy, reliability, and the convenience of portability. These advancements contribute to a more inclusive society, fostering mutual understanding and enabling individuals with different abilities to interact and connect

effortlessly.

## 7.2 Result Analysis of Objective 2

Our innovative app aims to fill the gap in the current landscape by offering a comprehensive solution that encompasses all three sign languages, facilitates direct and real-time translation, enhances the learning experience, features a user-friendly interface, receives regular updates, and encourages community engagement.

## 7.3 Result Analysis of Objective 3

According to a study conducted in 2018, traditional methods of learning sign language often involve repetitive reading and writing techniques, which can lead to exhaustion and reduced motivation. In response to this challenge, our app revolutionizes the learning experience by making it enjoyable, engaging, and easy to understand.

## 7.4 Result Analysis of Objective 4

Our app is designed with a strong commitment to accessibility and affordability. We believe that language translation should be accessible to all individuals, regardless of their financial circumstances. Therefore, we have made the decision to provide our translation services completely free of charge. There are no limitations on the number of times users can access and utilize the app in a day, ensuring that individuals can rely on it whenever they need it without any restrictions or additional costs.

By offering our app for free and without usage limits, we aim to eliminate any barriers that may prevent financially unstable individuals from accessing and benefiting from our translation services. We understand the importance of communication and believe that everyone should have equal opportunities to engage and connect with others, irrespective of their financial capabilities.

In addition to making the app freely available, we are actively exploring sustainable funding models and partnerships with organizations that share our vision of promoting accessibility. This approach allows us to cover the costs of app development, maintenance, and server resources, while keeping the app accessible to those who need it the most.

Our commitment to providing free and unlimited access to the app is rooted in the belief that language translation should not be a privilege reserved for the few, but a fundamental right for all individuals. We strive to create an inclusive environment where individuals, regardless of their financial stability, can use our app without any barriers or limitations, enabling them to communicate effectively and participate fully in society.

In summary, our app is offered free of charge without any usage limits, ensuring that individuals who are not financially stable can also access and utilize it without any problems. We are dedicated to promoting accessibility and equal opportunities for all, recognizing the importance of communication in creating a more inclusive and connected world.

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# Chapter 8

# Conclusion

## 8.1 Conclusion

In conclusion, our team has achieved significant progress in the implementation of the App Development for Specially abled (Deaf) people, with an estimated completion rate of 90-100 percentage . Throughout the duration of our course, we gained practical experience working with various tools and technologies, including Python, Google Teachable Machine, Kaggle, and more. These tools have played a crucial role in enhancing the design and functionality of our project, allowing us to meet the specific requirements of our target users.

By utilizing Python and other relevant technologies, we were able to develop a robust and user-friendly application that facilitates communication and understanding for individuals with hearing impairments. We leveraged the capabilities of Google Teachable Machine and other machine learning models to improve the accuracy and efficiency of our app's translation features, enabling seamless conversion of sign language into written or spoken language.

The hands-on experience we gained during the project provided us with valuable insights into the challenges faced by individuals with hearing impairments and the potential solutions that technology can offer. It broadened our understanding of accessibility and inclusive design, emphasizing the importance of creating tools and applications that cater to the diverse needs of different user groups.

As a result of our efforts, we have gained a clear perspective on the requirements and considerations involved in developing a product for the deaf community. We have also acquired valuable technical skills and knowledge that can be applied to future projects in the field of accessibility and assistive technology.

In conclusion, our team has successfully completed the implementation of the App Development for Specially abled (Deaf) people, incorporating our learning's and experiences with Python, Google Teachable Machine, Kaggle, and other relevant tools. We are proud of the progress we have made and believe that our application has the potential to make a meaningful impact in improving communication accessibility for individuals with hearing impairments.

## 8.2 Future Scope

According to the World Health Organization (WHO), there is a significant and growing population worldwide that requires rehabilitation to address their "disabling" hearing loss. The statistics reveal that currently, over 5 percent of the global population, which accounts for approximately 430 million individuals (including 432 million adults and 34 million children), are in need of support for their hearing impairment. Shockingly, these numbers are projected to rise in the future, with an estimated 700 million people, or one in every ten individuals, expected to experience disabling hearing loss by the year 2050.

Considering these statistics, it becomes evident that our product's impact extends far beyond the present. By addressing the communication barriers faced by individuals with hearing impairments, our product plays a crucial role in improving their quality of life and fostering inclusivity. Moreover, as the prevalence of hearing loss continues to increase, the need for effective communication solutions will only become more critical.

By providing a user-friendly and accessible platform that facilitates communication between individuals with hearing impairments and the general population, our product not only addresses the immediate challenges faced by millions of people today

but also prepares for the future. As the number of individuals with hearing loss rises, our product will remain relevant and valuable in reducing communication barriers and promoting effective interaction.

Additionally, the versatility and adaptability of our product allow for further enhancements and customization in response to evolving user needs. As technology advances and new developments in assistive technologies emerge, our product can integrate and leverage these advancements to provide even more comprehensive and efficient support to individuals with hearing impairments.

By recognizing the long-term impact of disabling hearing loss and designing our product to be future-proof, we aim to contribute to a world where communication barriers are minimized, inclusivity is fostered, and individuals with hearing impairments can fully participate in society. We strive to be at the forefront of the assistive technology landscape, continuously improving and expanding our product to meet the needs of an ever-growing population facing hearing loss challenges.

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# Appendices

# Appendix A

# OpenCV

OpenCV is the huge open-source library for the computer vision, machine learning, and image processing and now it plays a major role in real-time operation which is very important in today's systems. By using it, one can process images and videos to identify objects, faces, or even handwriting of a human. When it integrated with various libraries, such as NumPy, python is capable of processing the OpenCV array structure for analysis. To Identify image pattern and its various features we use vector space and perform mathematical operations on these features.

GETTING STARTED (HOW TO READ IMAGES)

1. Open Jupyter Notebook.
2. Import cv2.
3. Paste a test image in the directory.
4. Create variable to store image using imread() function.
5. Display the image using imshow() function.
6. Add a delay using a waitkey() function.

- import cv2
- LOAD AN IMAGE USING 'IMREAD'

- img = cv2.imread("Resources/lena.png")
- DISPLAY
- cv2.imshow("Lena Soderberg", img)
- cv2.waitKey(0)

ACCESSING LIVE FEED FROM WEBCAM

1. Open Jupyter Notebook. Import cv2.
2. Create variable to store video using VideoCapture() function.
3. Pass parameter 0 in VideoCapture(0) to access webcam.
4. Create an infinite while loop to display each frame of the webcam's video continuously.
5. Display the live feed using imshow() function.
6. Add a delay of infinity using waitKey(0).

- import cv2
- Width = 640
- Height = 480
- cap.set(3, frameWidth)
- cap.set(4, frameHeight) 7. cap.set(10, 150)
- while True:
- success, img = cap.read()
- cv2.imshow("Result", img)

# References

*An ai app that converts sign language into text, speech.* (n.d.). The Economics Time. Retrieved from https://economictimes.indiatimes.com/magazines/panache/meet-the-new-google-translator-an-ai-app-that-converts-sign-language-into-text-speech/articleshow/66379450.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

Ankit Ojha, S. M. A. T. D. D. P., Ayush Pandey. (n.d.). Sign language to text and speech translation in real time using convolutional neural network. Retrieved from https://www.ijert.org/sign-language-to-text-and-speech-translation-in-real-time-using-convolutional-neural-network

Arora, D. S., & roy, A. (n.d.). Recognition of sign language using image processing. Retrieved from https://www.researchgate.net/publication/322186019_Recognition_of_sign_language_using_image_processing

(n.d.). Retrieved from https://www.goodnet.org/articles/this-app-makes-easy-for-people-to-learn-sign-language

Omkar Vedak, A. T. M. P., Prasad Zavre. (n.d.). Sign language interpreter using image processing and machine learning. , 1-3. Retrieved from https://www.irjet.net/archives/V6/i4/IRJET-V6I4413.pdf

Prof. Chhaya Narvekar, A. P. M. M., Sayukta Mungekar. (n.d.). Sign language to speech conversion using image processing and machine learning. Retrieved from 2020071224.pdf(ijtre.com)