Hand Gesture Recognition System

A Minor Project Report Submitted To

Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal

Towards Partial Fulfilment for the Award Of

Bachelor of Technology

In

COMPUTER SCIENCE AND ENGINEERING

Submitted By

Vandana Solanki (0863CS201176)

Sonam Yadav (0863CS201158)

Somya Rai (0863CS201157)

Tanu Kumari (0863CS201168)

Under the Supervision of

Asst. Prof. Rupali Pathak

Session: 2022-2023

Department of Computer Science and Engineering,

Prestige Institute of Engineering, Management and Research, Indore (M.P.)

[An Institution Approved By AICTE, New Delhi & Affiliated To RGPV, Bhopal]

PRESTIGE INSTITUTE OF ENGINEERING MANAGEMENTAND RESEARCH

INDORE (M.P.)

DECLARATION

We **Vandana Solanki, Sonam Yadav, Somya Rai and Tanu Kumari** hereby declare that the project entitled "**Hand Gesture Recognition System**", which is submitted by us for the partial fulfilment of the requirement for the award of Bachelor of Technology in Computer Science & Engineering to the Prestige Institute of Engineering, Management and Research, Indore (M.P.). Rajiv Gandhi Proudhyogiki Vishwavidyalaya, Bhopal, comprises my own work and due acknowledgement has been made in text to all other material used**.**

Signature of Students:

Vandana Solanki

Sonam Yadav

Somya Rai

Tanu Kumari

Date:

Place: PIEMR, Indore

PRESTIGE INSTITUTE OF ENGINEERING MANAGEMENTAND RESEARCH

INDORE (M.P.)

DISSERTATION APPROVAL SHEET

This is to certify that the dissertation entitled **"Hand Gesture Recognition System"** submitted by **Vandana Solanki (0863CS201176), Sonam Yadav (0863CS201158), Somya Rai (0863CS201157), and Tanu Kumari (0863CS201168)** to the Prestige Institute of Engineering, Management and Research, Indore (M.P.) is approved as fulfilment for the award of the degree of "Bachelor of Technology in Computer Science & Engineering" by Rajiv Gandhi Proudhyogiki Vishwavidyalaya, Bhopal, (M.P.).

Internal Examiner **External Examiner**

Dr. Aradhana Negi

Date: Date:

HOD, CSE

Dr. Piyush Choudhary

PIEMR, INDORE

PRESTIGE INSTITUTE OF ENGINEERING MANAGEMENTAND RESEARCH

INDORE (M.P.)

CERTIFICATE

This is certified that project entitled "**Hand Gesture Recognition System**" submitted by **Vandana Solanki, Sonam Yadav, Somya Rai and Tanu Kumari** is a satisfactory account of the bona fide work done under our supervision and is recommended towards partial fulfilment for the award of the degree Bachelor of Technology in Computer Science & Engineering to Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal (M.P.) .

Date:

Enclosed by:

Asst.Prof. Rupali Pathak	Dr. Aradhana Negi	Dr. Piyush Choudhary
Project Guide	**Project Coordinator**	**Professor & Head, CSE**

Dr. Manojkumar Deshpande

Director

PIEMR, Indore

PRESTIGE INSTITUTE OF ENGINEERING MANAGEMENTAND RESEARCH

INDORE (M.P.)

ACKNOWLEDGEMENT

After the completion of Minor project work, words are not enough to express our feelings about all these who helped us to reach our goal; feeling above this is our indebtedness to the almighty for providing us this moment in life.

First and foremost, we take this opportunity to express our deep regards and heartfelt gratitude to our project guide **Asst. Prof. Rupali Pathak** and Project Coordinator **Dr. Aradhana Negi, Department of Computer Science and Engineering, PIEMR, Indore** for their inspiring guidance and timely suggestions in carrying out our project successfully. They are also the constant source of inspiration for us. Working under their guidance has been an opportunity for us to learn more and more.

We are extremely thankful to **Dr. Piyush Choudhary, (HOD, CSE)** for his co-operation and motivation during the project. We extend our deepest gratitude to **Dr. Manojkumar Deshpande, Director, PIEMR, and Indore** for providing all the necessary facilities and true encouraging environment to bring out the best of our endeavour's.

We would like to thank all the teachers of our department for providing invaluable support and motivation. We remain indebted to all the non-teaching staff of our Institute who has helped us immensely throughout the project.

We are also grateful to our friends and colleagues for their help and co-operation throughout this work. Last but not least; we thank our family for their support, patience, blessings and understanding while completing our project.

Name of Students:

Vandana Solanki (0863CS201176)

Sonam Yadav (0863CS201158)

Somya Rai (0863CS201157)

Tanu Kumari (0863CS201168)

INDEX

Declaration	**I**
Dissertation Approval Sheet	**III**
Certificate	**IIV**
Acknowledgement	**V**
Table of Contents	**VII**
List of Tables	**IX**
List of Figures	**X**

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION

1.1 Introduction……..…….……1

1.2 Motivation…….....1

1.3 Objective……...2

1.4 Analysis …….....2

1.4.1 Functional Requirements …….....2

1.4.2 Non-functional Requirements ……..…..…3

1.4.3 Use Case Diagram…….4

CHAPTER 2 BACKGROUND AND RELATED WORK

2.1 Problem Statement ……..…....6

2.2 Background and Related Work…….…….....6

2.2.1 Background Work ……...6

2.2.2 Literature survey ……..….....6

CHAPTER 3 DESIGN (UML AND DATA MODELING)

3.1 UML Modeling…….11

3.1.1 Class Diagram…..…….……..11

3.1.2 Block Diagram …….....……...12

3.1.3 Flowchart Diagram…….....13

CHAPTER 4 IMPLEMENTATION

4.1 Tools Used……..15

4.2 Technology……....15

CHAPTER 5 PROJECT PLAN

5.1 Work Breakdown Structure…….....19

CHAPTER 6 Project Screenshot

6.1 Snapshot…….…….....21

CHAPTER 7 CONCLUSION/ FUTURE SCOPE

7.1 Conclusion…….…….....24

7.2 Future Scope……..…24

References…….….25

LIST OF TABLES

Table 5.1.1 Work Breakdown Structure Table……..……..…..19

LIST OF FIGURES

Fig 1.4.1 Use Case Diagram…….....4

Fig 2.2.1 System Implementation……6

Fig 3.1.1 Class Diagram…….....11

Fig 3.1.2 Block Diagram…….....12

Fig 3.1.3 Flowchart Diagram…….....13

Fig 6.1.1 Project Screenshot-I……21

Fig 6.1.2 Project Screenshot-II……..22

CHAPTER 1
INTRODUCTION

1.1 Introduction

Recent developments in computer software and related hardware technology have provided a value added service to the users. In everyday life, physical gestures are a powerful means of communication. They can economically convey a rich set of facts and feelings. For example, waving one's hand from side to side can mean anything from a "happy goodbye" to "caution". Use of the full potential of physical gesture is also something that most human computer dialogues lack.

The task of hand gesture recognition is one the important and elemental problem in computer vision. With recent advances in information technology and media, automated human interactions systems are build which involve hand processing task like hand detection, hand recognition and hand tracking.

This prompted my interest so I planned to make a software system that could recognize human gestures through computer vision, which is a sub field of artificial intelligence. The purpose of my software through computer vision was to program a computer to "understand" a scene or features in an image.

A first step in any hand processing system is to detect and localize hand in an image. The hand detection task was however challenging because of variability in the pose, orientation, location and scale. Also different lighting conditions add further variability.

1.2 Motivation

Biometric technologies make use of various physical and behavioral characteristics of human such as fingerprints, expression, face, hand gestures and movement. These features are then processed using sophisticated machines for detection and recognition and hence used for security purposes. Unlike common security measures such as passwords, security cards that can easily be lost, copied or stolen; these biometric features are unique to individuals and there is little possibility that these pictures can be replaced or altered.

Among the biometric sector hand gesture recognition are gaining more and more attention because of their demand regarding security for law enforcement agency as well as in private sectors such as surveillance systems.

In video conferencing system, there is a need to automatically control the camera in such a way that the current speaker always has the focus. One simple approach to this is to guide the camera based on sound or simple cues such as motion and skin color.

Hand gestures are important to intelligent human and computer interaction to build fully automated systems that analyze information contained in images, fast and efficient hand gesture recognition algorithms are required.

1.3 Objective

First objective of this project is to create a complete system to detect, recognize and interpret the hand gestures through computer vision

Second objective of the project is therefore to provide a new low-cost, high speed and color image acquisition system.

1.4 Analysis

1.4.1 Functional Requirement

Functional requirements specify the main technical functionalities and specifications that the system should incorporate.

1. MediaPipe Hand: The MediaPipe Hand Landmarker task lets you detect the landmarks of the hands in an image. These instructions show you how to use the Hand Landmarker with Python.

2. OpenCV-Python: OpenCV-Python is a library of Python bindings designed to solve computer vision problems. OpenCV-Python makes use of Numpy, which is a highly optimized library for numerical operations with a MATLAB-style syntax. All the OpenCV array structures are converted to and from Numpy arrays.

3. TensorFlow is a free and open-source software library for machine learning and artificial intelligence. It can be used across a range of tasks but has a particular focus on training and inference of deep neural networks.

1.4.2 Non-Functional Requirement

Non-functional requirements specify the criteria in the operation and the architecture of the system.

1 Efficiency in Computation: This software shall minimize the use of Central Processing Unit (CPU) and memory resources on the operating system. When HGR is executing, the software shall utilize less than 80% of the system's CPU resource and less than 100 megabytes of system memory.

2 Extensibility: The software shall be extensible to support future developments and add-ons to the HGR software. The gesture control module of HGR shall be at least 50% extensible to allow new gesture recognition features to be added to the system.

3 Portability: The HGR software shall be 100% portable to all operating platforms that support Python Runtime Environment. Therefore, this software should not depend on the different operating systems.

1.4.3 Use Case Diagram

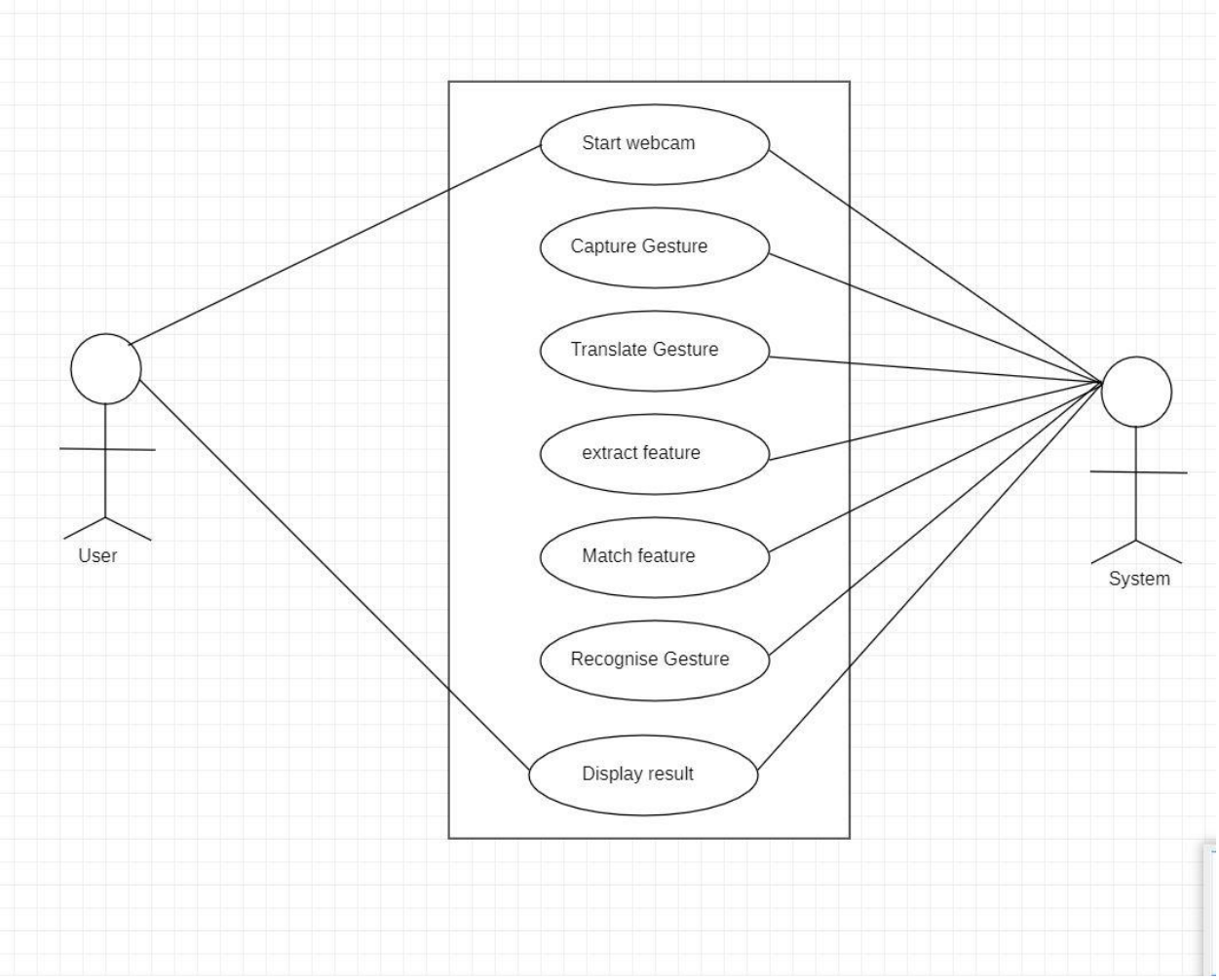

Fig 1.4.1 Use Case Diagram

CHAPTER 2

BACKGROUND AND RELATED WORK

2.1 Problem Statement

Gesture recognition is the process by which gestures made by the user are used to convey the information or for device control. A primary goal of Gesture recognition research is to create a system which can identify specific human gestures and use them to convey information or for device control**.**

2.2 Background and Related Work

2.2.1 Background Work

Hand gesture recognition system can be divided into following modules:

- Preprocessing
- Feature extraction of the processed image
- Real time classification

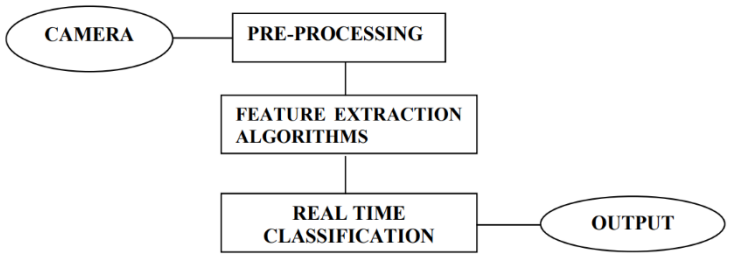

Figure 2.2.1 System Implementation

2.2.2 LITERATURE SURVEY

Deaf Mute Communication Interpreter- A Review [1] : This paper aims to cover the various prevailing methods of deaf-mute communication interpreter system. The two broad classification of the communication methodologies used by the deaf –mute people are - Wearable Communication Device and Online Learning System. Under Wearable communication method, there are Glove based system, Keypad method and Handicom Touch-screen. All the above

mentioned three sub-divided methods make use of various sensors, accelerometer, a suitable micro-controller, a text to speech conversion module, a keypad and a touch-screen. The need for an external device to interpret the message between a deaf –mute and non-deaf-mute people can be overcome by the second method i.e online learning system. The Online Learning System has different methods. The five subdivided methods are- SLIM module, TESSA, Wi-See Technology, SWI_PELE System and Web-Sign Technology.

An Efficient Framework for Indian Sign Language Recognition Using Wavelet Transform [2]:The proposed ISLR system is considered as a pattern recognition technique that has two important modules: feature extraction and classification. The joint use of Discrete Wavelet Transform (DWT) based feature extraction and nearest neighbour classifier is used to recognize the sign language. The experimental results show that the proposed hand gesture recognition system achieves maximum 99.23% classification accuracy while using cosine distance classifier.

Hand Gesture Recognition Using PCA in [3]: In this paper authors presented a scheme using a databasedriven hand gesture recognition based upon skin color model approach and thresholding approach along with an effective template matching with can be effectively used for human robotics applications and similar other applications.. Initially, hand region is segmented by applying skin color model in YCbCr color space. In the next stage thresholding is applied to separate foreground and background. Finally, template based matching technique is developed using Principal Component Analysis (PCA) for recognition.

Hand Gesture Recognition System For Dumb People [4]: Authors presented the static hand gesture recognition system using digital image processing. For hand gesture feature vector SIFT algorithm is used. The SIFT features have been computed at the edges which are invariant to scaling, rotation, addition of noise.

An Automated System for Indian Sign Language Recognition in [5]: In this paper a method for automatic recognition of signs on the basis of shape based features is presented. For segmentation of hand region from the images, Otsu's thresholding algorithm is used, that chooses an optimal threshold to minimize the within-class variance of thresholded black and white pixels. Features of segmented hand region are calculated using Hu's invariant moments that are fed to Artificial

Neural Network for classification. Performance of the system is evaluated on the basis of Accuracy ,Sensitivity and Specificity.

Hand Gesture Recognition for Sign Language Recognition: A Review in [6]: Authors presented various method of hand gesture and sign language recognition proposed in the past by various researchers. For deaf and dumb people, Sign language is the only way of communication. With the help of sign language, these physical impaired people express their emotions and thoughts to other person.

Design Issue and Proposed Implementation of Communication Aid for Deaf & Dumb People in [7]: In this paper author proposed a system to aid communication of deaf and dumb people communication using Indian sign language (ISL) with normal people where hand gestures will be converted into appropriate text message. Main objective is to design an algorithm to convert dynamic gesture to text at real time. Finally after testing is done the system will be implemented on android platform and will be available as an application for smart phone and tablet pc.

Real Time Detection And Recognition Of Indian And American Sign Language Using Sift In [8]: Author proposed a real time vision based system for hand gesture recognition for human computer interaction in many applications. The system can recognize 35 different hand gestures given by Indian and American Sign Language or ISL and ASL at faster rate with virtuous accuracy. RGB-to-GRAY segmentation technique was used to minimize the chances of false detection. Authors proposed a method of improvised Scale Invariant Feature Transform (SIFT) and same was used to extract features. The system is model using MATLAB. To design and efficient user friendly hand gesture recognition system, a GUI model has been implemented.

A Review on Feature Extraction for Indian and American Sign Language in [9]: Paper presented the recent research and development of sign language based on manual communication and body language. Sign language recognition system typically elaborate three steps pre processing, feature extraction and classification.Classification methods used for recognition are Neural Network(NN), Support Vector Machine(SVM), Hidden Markov Models(HMM), Scale Invariant Feature Transform(SIFT),etc.

SignPro-An Application Suite for Deaf and Dumb . in [10]: Author presented application that helps the deaf and dumb person to communicate with the rest of the world using sign language.

The key feature in this system is the real time gesture to text conversion. The processing steps include: gesture extraction, gesture matching and conversion to speech. Gesture extraction involves use of various image processing techniques such as histogram matching, bounding box computation, skin colour segmentation and region growing. Techniques applicable for Gesture matching include feature point matching and correlation based matching. The other features in the application include voicing out of text and text to gesture conversion.

Offline Signature Verification Using Surf Feature Extraction and Neural Networks Approach [11]: In this paper, off-line signature recognition & verification using neural network is proposed, where the signature is captured and presented to the user in an image format.

CHAPTER 3

DESIGN (UML AND DATA MODELING)

3.1 UML Modeling

3.1.1 Class Diagram

Class diagram describes the attributes and operations of a class and also the constraints imposed on the system. The class diagrams are widely used in the modeling of object oriented systems because they are the only UML diagrams, which can be mapped directly with object-oriented languages.

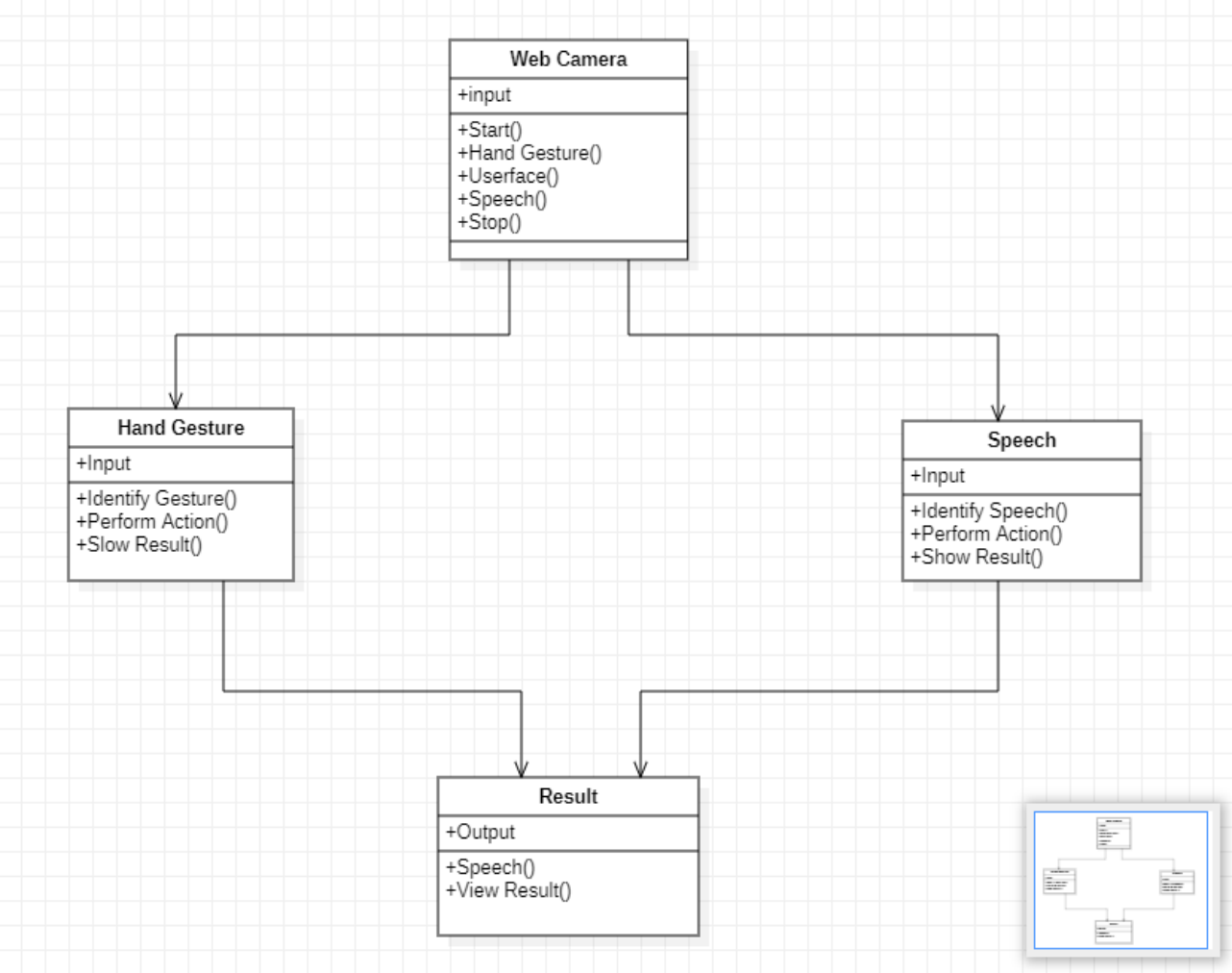

Fig. 3.1.1 Class Diagram

3.1.2 Block Diagram

A block diagram is a diagram of a system in which the principal parts or functions are represented by blocks connected by lines that show the relationships of the blocks.

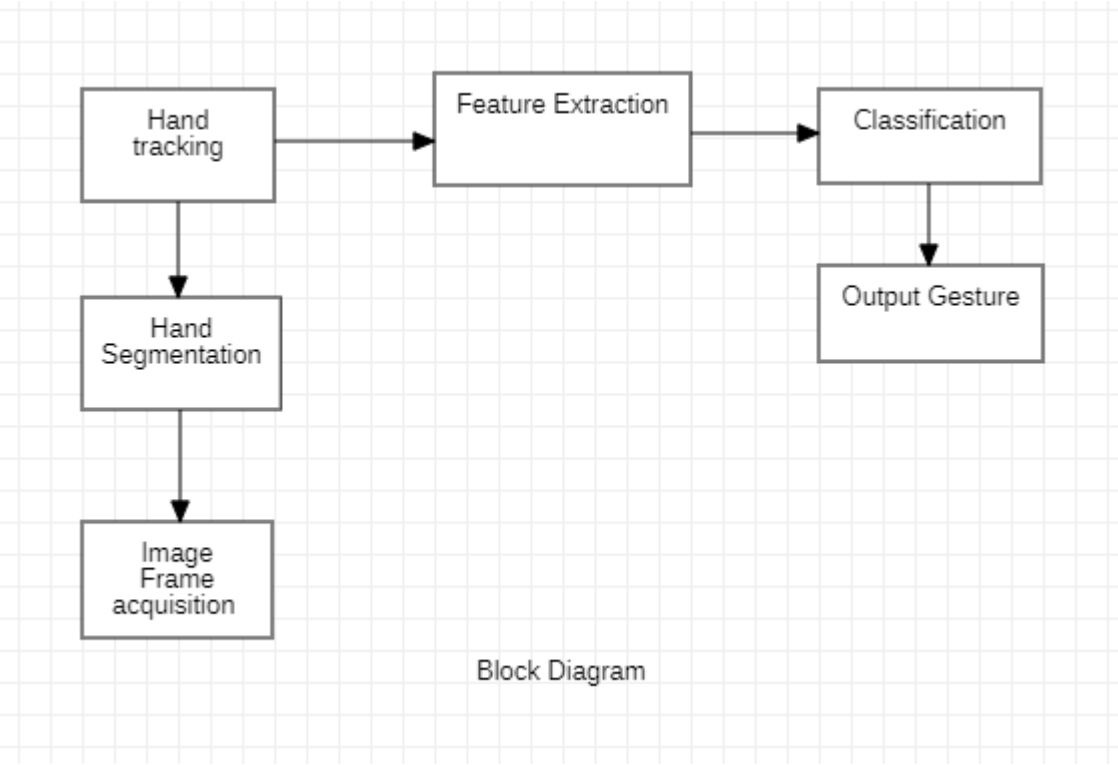

Fig. 3.1.2 Block Diagram

3.1.3 Flowchart Diagram

A flowchart is a type of diagram that represents a workflow or process. A flowchart can also be defined as a diagrammatic representation of an algorithm, a step-by-step approach to solving a task. The flowchart shows the steps as boxes of various kinds, and their order by connecting the boxes with arrows.

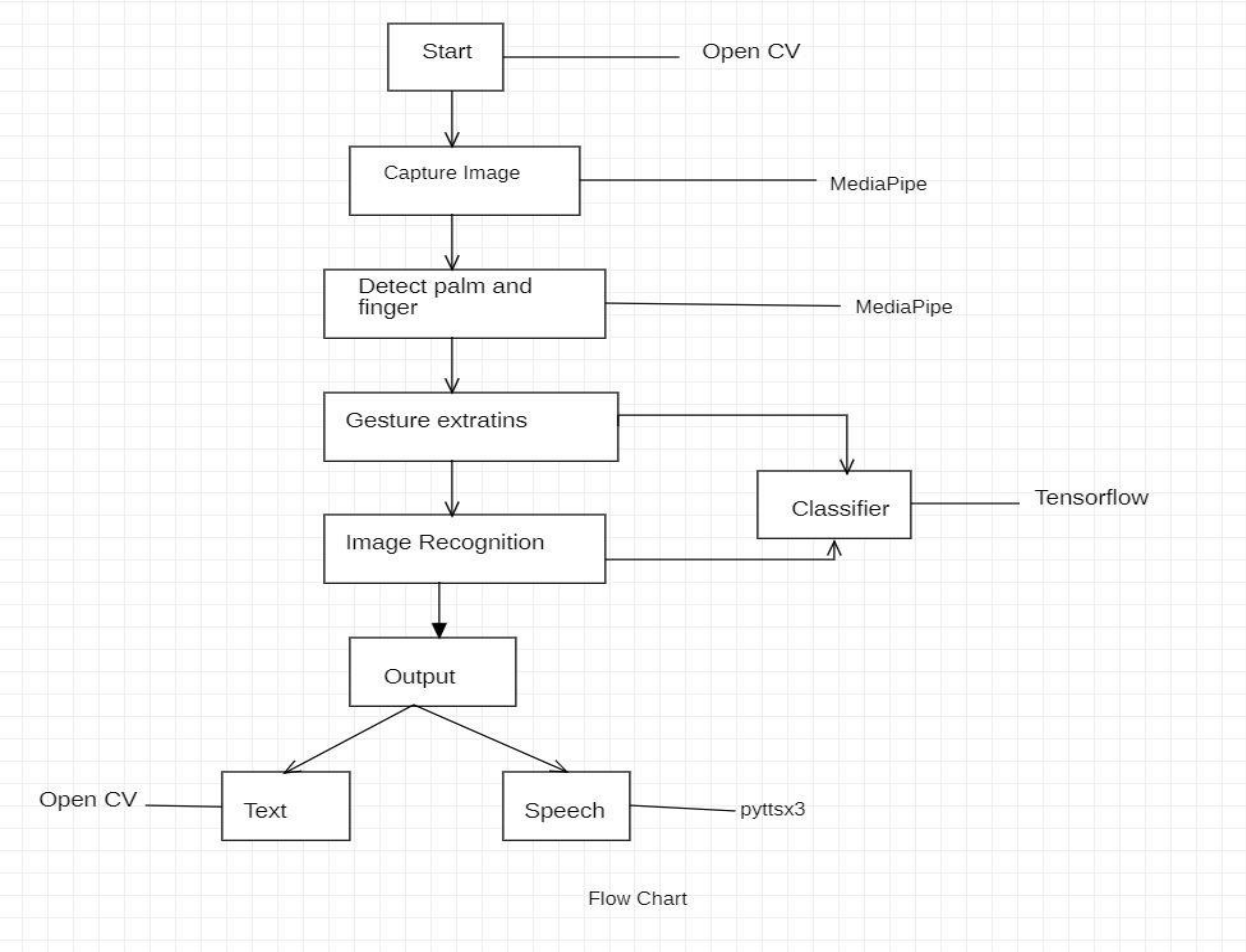

Fig. 3.1.3 Flowchart Diagram

CHAPTER 4

IMPLEMENTATION

4.1 Tools Used

4.1.1 Jupyter Notebook

Jupyter notebooks basically provides an interactive computational environment for developing Python based Data Science applications. They are formerly known as ipython notebooks. The following are some of the features of Jupyter notebooks that makes it one of the best components of Python ML ecosystem −

- Jupyter notebooks can illustrate the analysis process step by step by arranging the stuff like code, images, text, output etc. in a step by step manner.
- It helps a data scientist to document the thought process while developing the analysis process.
- One can also capture the result as the part of the notebook.
- With the help of jupyter notebooks, we can share our work with a peer also.

4.1.1 Pycharm

PyCharm is an integrated development environment (IDE) used for programming in Python. It provides code analysis, a graphical debugger, an integrated unit tester, integration with version control systems, and supports web development with Django. PyCharm is developed by the Czech company JetBrains.

4.2 Technology Used:

- Numpy

  NumPy is the fundamental package for scientific computing in Python. It is a Python library that provides a multidimensional array object, various derived objects (such as masked arrays and matrices), and an assortment of routines for fast operations on arrays, including mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms, basic linear algebra, basic statistical operations, random simulation and much more.

- MediaPipe

  MediaPipe is a cross-platform pipeline framework to build custom machine learning solutions for live and streaming media. MediaPipe is an open-source framework for building pipelines to perform computer vision inference over arbitrary sensory data such as video or audio. Using MediaPipe, such a perception pipeline can be built as a graph of modular components. The MediaPipe framework is mainly used for rapid prototyping of perception pipelines with AI models for inferencing and other reusable components. It also facilitates the deployment of computer vision applications into demos and applications on different hardware platforms. The configuration language and evaluation tools enable teams to incrementally improve computer vision pipelines.

- TensorFlow

  TensorFlow is an open-source library for fast numerical computing.

  It was created and is maintained by Google and was released under the Apache 2.0 open source license. The API is nominally for the Python programming language, although there is access to the underlying C++ API.

  Unlike other numerical libraries intended for use in Deep Learning like Theano, TensorFlow was designed for use both in research and development and in production systems, not least of which is RankBrain in Google search and the fun DeepDream project.

  It can run on single CPU systems and GPUs, as well as mobile devices and large-scale distributed systems of hundreds of machines.

- Open CV

  OpenCV is a huge open-source library for computer vision, machine learning, and image processing. OpenCV supports a wide variety of programming languages like Python, C++, Java, etc. It can process images and videos to identify objects, faces, or even the handwriting of a human. When it is integrated with various libraries, such as Numpy which is a highly optimized library for numerical operations, then the number

of weapons increases in your Arsenal i.e whatever operations one can do in Numpy can be combined with OpenCV.

- Pyttsx3

  pyttsx3 is a text-to-speech conversion library in Python. Unlike alternative libraries, it works offline and is compatible with both Python 2 and 3. An application invokes the pyttsx3.init() factory function to get a reference to a pyttsx3. Engine instance. it is a very easy to use tool which converts the entered text into speech. The pyttsx3 module supports two voices first is female and the second is male which is provided by “sapi5” for windows. It supports three TTS engines :

  - sapi5 – SAPI5 on Windows
  - nsss – NSSpeechSynthesizer on Mac OS X
  - espeak – eSpeak on every other platform

CHAPTER 5

PROJECT PLAN

5.1 Work Breakdown Stucture

Project Management	Analysis	Design	Development	Testing and Production
Project planning	Discussion	Prototype design	Data capturing structure	Test configuration
Scope statement	Requirement specification	Architecture design	Data conversion	Reviewing project
Scheduling	Use cases	Improving project performance	Building model Training Data	Deploy
Risk planning	Reporting needs		Classifiers generation	
Plan changes			Classification	

Table 5.1.1 Work Breakdown Structure Table

CHAPTER 6

PROJECT SCREENSHOT

6.1 Project Screenshot

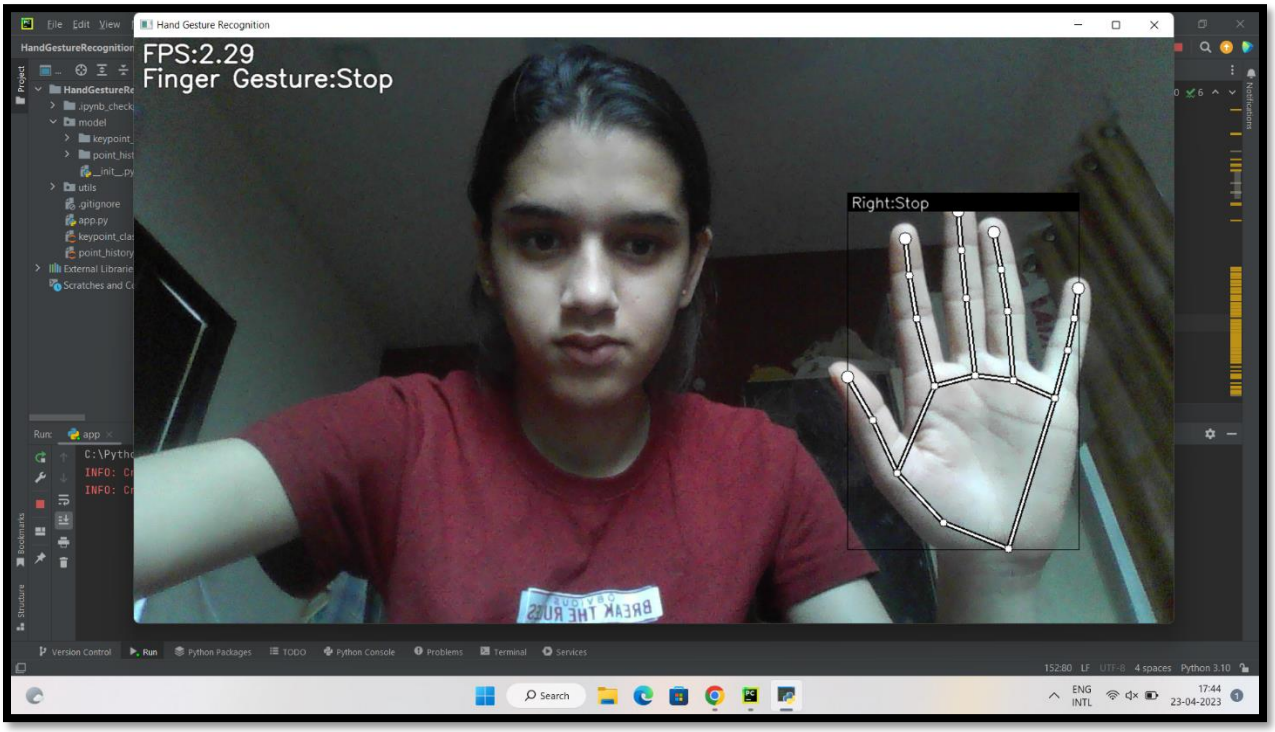

Fig 6.1.1 Project Screenshot- I

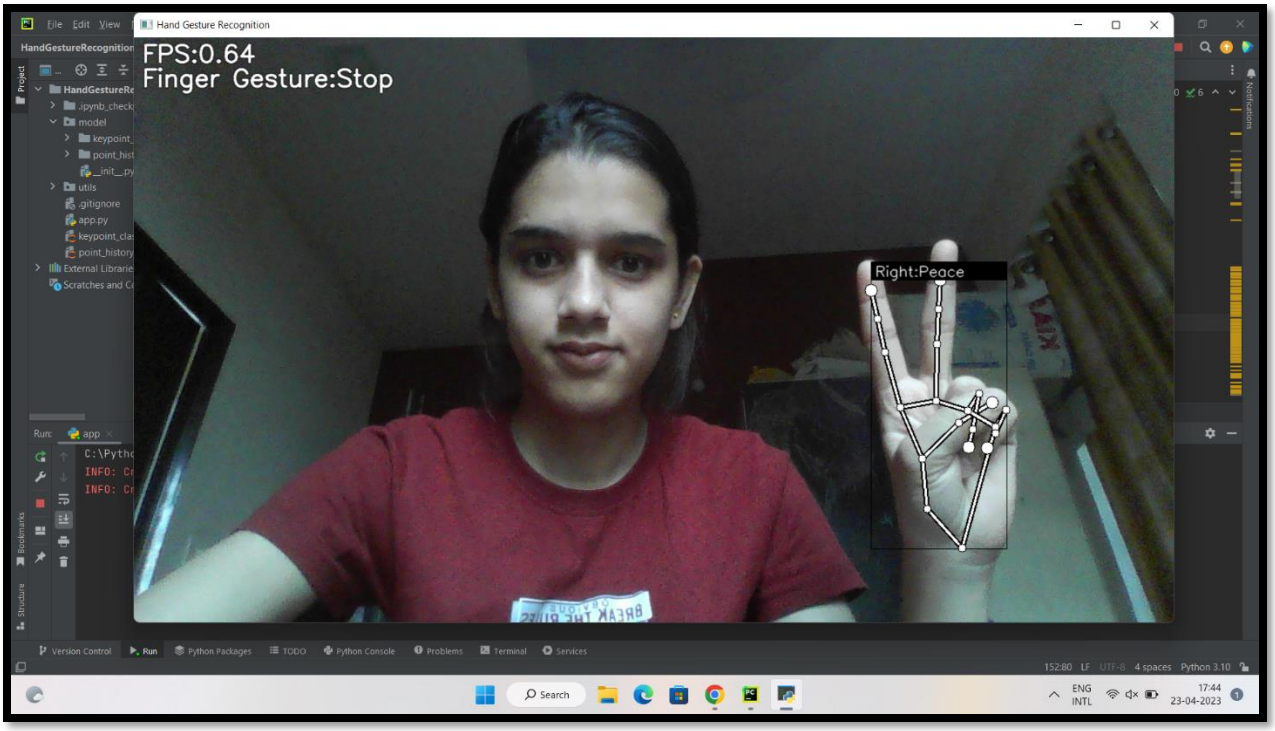

Fig 6.1.2 Project Screenshot-II

CHAPTER 7

CONCLUSION

7.1 Conclusion

Sign language is the medium for deaf and dumb people to share their feelings or thoughts with others. But their communication is restricted to other disabled persons as normal who cannot understand what they wants to say.The vision-based solutions can overcome some of their difficulties and disadvantages, they appear to be the best choice for raw data collection. Here, designed a system for the purpose of recognition of numbers and alphabets in the Sign Language. This system converts the sign language into voice and displayed on LCD which is easily understandable by disabled and normal people. Also it provides a cheap, portable and efficient solution.

7.2 Future Scope

The system could also be made smart to be trained for only one or two gestures rather than all and then made ready for testing. This will require only a few changes in the current interface code, which were not performed due to the shortage of time.

One time training constraint for real time system can be removed if the system is made efficient to work with both hand jointly and with motion gestures which seems very difficult by now altogether.

References

[1] Sunitha K. A, Anitha Saraswathi.P, Aarthi.M, Jayapriya. K, Lingam Sunny, "Deaf Mute Communication Interpreter- A Review", International Journal of Applied Engineering Research ,Volume 11, pp 290-296 , 2016.

[2] Mathavan Suresh Anand, Nagarajan Mohan Kumar, Angappan Kumaresan, " An Efficient Framework for Indian SignLanguage Recognition Using Wavelet Transform" Circuits and Systems, Volume 7, pp 1874- 1883, 2016.

[3] Mandeep Kaur Ahuja, Amardeep Singh, "Hand Gesture Recognition Using PCA", International Journal of Computer Science Engineering and Technology (IJCSET), Volume 5, Issue 7, pp. 267-27, July 2015.

[4] Sagar P.More, Prof. Abdul Sattar, "Hand gesture recognition system for dumb people", International Journal of Science and Research (IJSR)

[5] Chandandeep Kaur, Nivit Gill, "An Automated System for Indian Sign Language Recognition", International Journal of Advanced Research in Computer Science and Software Engineering.

[6] Pratibha Pandey, Vinay Jain, "Hand Gesture Recognition for Sign Language Recognition: A Review", International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 3, March 2015 .

[7] Nakul Nagpal,Dr. Arun Mitra.,Dr. Pankaj Agrawal, "Design Issue and Proposed Implementation of Communication Aid for Deaf & Dumb People", International Journal on Recent and Innovation Trends in Computing and Communication ,Volume: 3 Issue: 5,pp- 147 – 149.

[8] Neelam K. Gilorkar, Manisha M. Ingle, "Real Time Detection And Recognition Of Indian And American Sign Language Using Sift", International Journal of Electronics and Communication Engineering & Technology (IJECET), Volume 5, Issue 5, pp. 11-18 , May 2014

[9] Neelam K. Gilorkar, Manisha M. Ingle, "A Review on Feature Extraction for Indian and American Sign Language", International Journal of Computer Science and Information Technologies, Volume 5 (1) , pp314-318, 2014.

[10] Ashish Sethi, Hemanth ,Kuldeep Kumar,Bhaskara Rao ,Krishnan R, “Sign Pro-An Application Suite for Deaf and Dumb”, IJCSET , Volume 2, Issue 5, pp-1203-1206, May 2012.

[11] Priyanka Sharma,“Offline Signature Verification Using Surf Feature Extraction and Neural Networks Approach”, International Journal of Computer Science and Information Technologies, Volume 5 (3) , pp 3539-3541, 2014.