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A PROJECT REPORT ON

Sign Language Recognition Using Python and OpenCV

SUBMITTED TO THE SAVITRIBAI PHULE PUNE UNIVERSITY,
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REQUIREMENTS FOR THE AWARD OF THE DEGREE
OF

BACHELOR OF ENGINEERING (COMPUTER ENGINEERING)

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Abstract

One of the nonverbal communication strategies is the hand gesture or sign. A sign language is formed by the collection of these hand gestures. Deaf-mute persons frequently utilize Sign Language to communicate with one another as well as with others. Normal people have always found it difficult to converse with deafmute people because they struggle to understand their gestures. As a result, the paper's main goal is to overcome the communication gap between hearing individuals and deafmutes. Although various sign language systems have been developed, they are neither versatile nor cost effective. As a result, this study offers an effective and user-friendly hand gesture detection system that enables deafmute people to easily converse with non-deaf people. Gesture Recognition and Pattern Recognition have been the focus of research in today's rapidly evolving technologies. Hand gestures are an important technique of nonverbal communication and play a major role in everyday life. Using the CNN algorithm, the suggested study presents a user-friendly method of communication.

Keywords: CNN, Sign Language, Gesture Recognition, OpenCV, ROI, Relu, Silhouette, Pooling, Histogram.

List of Abbreviations

The next list describes several abbreviations that will be later used within the body of the document

$2D$ **Two Dimension**

$3D$ **Three Dimensions**

CNN **Convolutional Neural Net**

ROI **Region Of Interest**

SLR **Sign Language Recognition**

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Chapter 1

INTRODUCTION

In recent years, Sign Language Recognition has been one of the popular topics of research in the emerging trend. Sign Language Recognition projects help to fill the communication gap between the specially-abled (deaf-mute) people and the normal people. Usually, deaf-mute people feel difficult to express their feelings to others as the normal feel tough to understand their gesture language. Hence, the opportunities for the deaf-mute people are low. This can be avoided by creating a platform that can communicate between the deafmute people and normal people by recognising the specially-abled people gesture and converting it to text/voice and vice versa. Hence, in this paper we aim to initialise this long term project by successfully completing until formation of words through the letters recognised out of the gestures of deaf-mute people. We were also successful in recognising certain words that have their own gestures.This proves to be a one big successful step for creation of the Sign Language Recognition platform. To make it effective economically and qualitatively, we have used simple technologies such as Python, Tensorflow, Keras and OpenCV that are available easily.

1.1 Overview

A gesture is a movement of any part of the body, such as the face or the hand. We use image processing and computer vision to recognise gestures here. Gesture recognition allows computers to understand human actions and serves as a translator between the two. This could allow humans to engage organically with computers without having to come into direct contact with the mechanical equipment. Deaf and dumb people use gestures to communicate in sign language. When transmitting voice was impossible, typing and writing were problematic, but vision was a possibility, this group used sign language to communicate. At the time,

sign language was the only option for individuals to communicate with one another. When people don't want to speak, they usually utilise sign language, but for the deaf and dumb community, it is their sole means of communication. The same meaning is conveyed through sign language as it is through spoken language. This is spoken by deaf and dumb people all throughout the world, but in regional dialects such as ISL and ASL. Hand gestures, either one or two hands, can be used to perform sign language.Isolated sign language and continuous sign language are the two types.Isolated sign language consists of a single gesture with a single word,whereas continuous ISL or Continuous Sign Language consists of multiple gestures with multiple words. A meaningful phrase is formed by a series of movements in sign language. We used an independent ASL gesture recognition algorithm in this work.

1.2 Motivation

The 2011 Indian census cites roughly 1.3 million people with "hearing impairment". In contrast to that numbers from India's National Association of the Deaf estimates that 18 million people –roughly 1 per cent of Indian population are deaf. These statistics formed the motivation for our project. As these speech impairment and deaf people need a proper channel to communicate with normal people there is a need for a system .Not all normal people can understand sign language of impaired people.

1.3 Problem Defintion and Objectives

To train Convolutional Neural Network (CNN) model for recognition of Sign Language gestures from video input and develop a UI which will work using Python and OpenCV.

Objectives are discussed below:

- **To provide an efficient and accurate way to convert sign language into text or voice.**
- **To generate dataset related to gestures for further synthesis.**
- **To train a pre-trained CNN model for gesture recognition.**
- **To develop proper and user friendly UI, for fluent user experience for getting desired result from the model.**

1.4 Project Scope and Limitations

Scope of this project are as follows:

- **It can be integrated with various search engines and texting application such as google, WhatsApp. So that even the illiterate people could be able to chat with other persons, or query something from web just with the help of gesture.**
- **This project is working on image currently, further development can lead to detecting the motion of video sequence and assigning it to a meaningful sentence with TTS assistance.**

Some basic limitations of the project can be seen as:

- **Laptop/Computer with camera is required.**
- **Basic knowledge of handling computer system is required.**

1.5 Methodologies of Problem solving

1. **Image Extraction: Image Extraction is the process by which gesture is extracted from the image. Text recognition system require training, where an image containing gesture is provided and the content of the image is extracted from the image.**
2. **Ontology: Ontology is a formal naming and definition of the types, properties and interrelationships of the entities in a particular domain. An ontology establishes relationships between the variables in a system. A good way to represent an ontology is a Graph, which we will be using for our use-case.**
3. **Gesture Recognition: Gesture recognition is the process by which gesture language can be converted to text by computers. Gesture recognition systems require training, where an individual inputs gesture data and their specific outputs into the system. The system analyzes the gesture and uses it to fine-tune the recognition of what that person's message.**

This concludes the first chapter of the report. All the initial details regarding the project were discussed. The idea and theme of the project is now clear and the further proceedings are scheduled successfully. The budgeting is done and the effort required to implement the project is known. In the next chapter, there will be a discussion about the literature survey and the related details of the project

Chapter 2

LITERATURE SURVEY

The previous chapter tells about the description of this project. The problem statement gives a brief idea about the project and the objectives gives a stepwise execution process of the project. In this chapter, some concrete basis supporting and extending the applicability of the project will be reviewed with the hope of providing better insights into the foundations of the project.

In Literature, We went through additional comparable studies that are performed in the domain of the sign language recognition. The following are summaries of each of the project's works:

2.1 Literature Review

2.1.1 A. Literature survey on Methods of Hand-Gesture Recognition in Sign Language Recognition :-

Given paper focused on methods used in the prior Sign Language Recognition systems. Based on our review, HMM-based approaches have been extensively explored in prior research, including its modifications. Deep Learning, such as Convolutional Neural Networks, has been popular in the past five years. Hybrid CNN-HMM and completely deep learning systems have yielded encouraging results and provide avenues for additional research. Clustering and high computational needs, however, continue to stymie their adoption. We believe that the research's future focus should be on developing a simplified network that can reach high performance while requiring little CPU resources, and that embeds the feature learner within the classification in a multi layered neural network approach

2.1.2 Literature survey on Normal People and Deaf-Dumb People Communication:-

The overall purpose project is facilitate the interaction between deaf and dumb people and normal people to makes the communication between normal people and dumb people easier, by translate the sign language to voice or text with high accuracy. The dumb and deaf communicate via sign language, which is hard to decipher for those who are not familiar with it. As a result, it is necessary to develop a device that can translate gestures into speech and text. This will be a significant step in allowing deaf and dumb people to communicate with the broader population.

2.1.3 Literature survey on A System for Recognition of Indian Sign Language for Deaf People using Otsu's Algorithm

In proposed paper, some methods for making sign recognition easier for people while communicating and the result of those symbol signs will be converted into the text. In this project, we are capturing hand gestures through a webcam and converting this image into a grayscale image. The segmentation of the grayscale image of a hand gesture is performed using the Otsu thresholding algorithm. . The whole picture level is split into two categories: hand and backdrop. The best threshold value is calculated by computing the proportion between total class variance and class variance. The Canny edge detection technique is used to locate the border of a hand gesture in a picture. We employed edge-based segmentation and threshold-based segmentation in Canny edge detection. Then Otsu's algorithm is used because of its simplified calculations and stability. This algorithm fails when the global distribution of the target and background varies widely

2.1.4 Literature survey on Image Processing for Intelligent Sign Language Recognition:-

HMMs are suited for full sign recognition of ASL, because to their inherent time-varying nature. Because a series of several of the 36 basic hand shapes may be used to gesture most ASL signs. The continuous indications can be split, with the fundamental hand shapes retrieved as the input to the HMM processor. The fundamental hand shapes may then be identified and chained as ASL words' output. With the approaches presented in this work,

the system may be expanded to a full-sign recognition system

2.1.5 Literature survey on Sign Language Interpreter using Machine Learning and Image Processing:-

Pham Microsoft Kinect is used by the Hai to interpret Vietnamese Sign Language. The user must align himself with Kinect's field of view and then conduct sign language movements in the suggested system. Using multiclass Support Vector Machine, it can distinguish both dynamic and static gestures. The gesture features are retrieved, filtered out and normalize on Euclidean distance during recognition.

2.1.6 Literature survey on Hand-Gesture recognition by using Digital Image Processing using MATLAB :-

The introduction of modern techniques significantly expands the possibilities of traditional microscopic procedures in the forensic field, allowing for the acquisition of necessary quantitative data in forensic analysis of pedological phases, mineral phase discrimination, or the option of organic phase analysis straight forwadly in the SEM chamber.

Chapter 3

SOFTWARE REQUIREMENTS SPECIFICATION

In the last chapter, the basis of implementing this project were discussed. Following that, in this chapter Software Requirement Specification document will be elaborated. In the subsequent sections, there will be a discussion regarding the technical requirements, methodology to be used in SDLC, etc.

3.1 Assumptions and Dependencies

- **User must have basic knowledge of computer.**
- **User follows instruction as shown by the application.**
- **Maintenance and updates will be provided by Administrators.**
- **Must be familiar basic with the Software and their knowledge of basic functions of python.**
- **The organization device should be a laptop or computer.**

3.2 Functional Requirements

3.2.1 System Feature 1

User-friendly based GUI built using industrial standard PyQT5.

3.2.2 System Feature 2

Real time American standard character detection based on gesture made by user. Also, forming a stream of sentences based on the gesture made after a

certain interval of time

3.2.3 System Feature 3

Customized gesture generation. Allowing the users to customize any specific gesture according to their needs and requirements.

3.3 External Interface Requirements

3.3.1 User Interfaces

Simple user-friendly interface allows anyone not from technical background to easily use the application. The frameworks used will help to make the interface responsive and support the functioning on a computer device.

3.3.2 Hardware Interfaces

The hardware interface will include a computer to run the software and a webcam to capture real-time hand gestures of the user.

3.3.3 Software Interfaces

The GUI is built using industrial standard PyQT5. Which is also quite easy to understand and learn for a person who recently have entered in technology field.

3.3.4 Communication Interfaces

The application software will be showing the output in the form of text on your computer screen in real-time with negligible delay to recognize the given hand-gesture.

3.4 Nonfunctional Requirements

These requirements specify the criteria that can be used to judge operation of system, rather than specific behaviour.

3.4.1 Performance Requirements

These requirements give the performance aspects required from the project. This is part of the general capacity planning process. The performance requirements are as follows.

1. **The UI will be user friendly.**
2. **It will show results in real-time.**

3.4.2 Safety Requirements

Safety requirements specify the needs that can help a system to keep intact after any problem takes place. The requirements are as follows.

1. **A backup of the database is stored.**
2. **There is no need of user login and hence the authentication is not required which saves us from auth safety procedures.**

3.4.3 Security Requirements

Security requirements are needed to prevent any malicious attack that can take place on the project. These requirements are as follows.

1. **The website will have login and sign-up options.**
2. **only signed user can login.**
3. **user can upload answer-sheet on the website.**
4. **The website is user friendly, and prevented from malicious attack**

3.4.4 Software Quality Attributes

1. **Security: This is achieved by send the essay via POST method and neglecting the need of login.**
2. **Efficiency: System fulfillment its purpose with utilization of all necessary resources.**
3. **Portability: The ease with which a system can be adapted to run on computers.**
4. **Testability: Suitability for allowing to follow program execution.**
5. **Readability: Form of representation is understandable.**

6. **Maintainability: The separation of the modules allows easy maintainability.**

7. **Resource Utilization: The resource requirements are similar to a standard website as most of the work is done at the backend.**

3.5 System Requirements

System requirements give us the components that are needed to make the project possible.

3.5.1 Database Requirements

a. Logical Database Requirements: A logical database can stretch over multiple physical hard disks and information files. The data storage unit is still a single database for information retrieval purposes. To have a logical database, all given hard disks and information files must be accessible from a single source.
b. Physical Database Requirements: A physical database is technically a smaller unit of storage referred to as a company, field, record or table, depending on how much information the physical storage device contains. A field is the smallest unit of storage housing only a single file.

3.5.2 Software Requirements (Platform choice)

- **Microsoft Windows XP or later / Ubuntu 12.0 LTS or later /MAC OS 10.1 or later. Python Interpreter (3.6).**

1. **Language – Python**

2. **Libraries**

   (a) **Numpy**

   (b) **Pandas**

   (c) **OpenCV**

   (d) **Matplotlib**

   (e) **Scikit Learn**

   (f) **Mahotas**

   (g) **Keras**

   (h) **Tensorflow**

It is recommended to use Anaconda Python 3.6 distribution and using a Jupyter Notebook.

3.5.3 Hardware Requirements

- **Processor: Intel Core i3 3 rd gen processor or later**
- **Hard Disk: 512 MB disk space**
- **RAM: 512 MB**
- **Camera :(300ppi or 150lpi) 4-megapixel cameras and up**

3.6 Analysis Models: SDLC Model to be applied

SDLC is a step by step procedure or systematic approach to develop software. It consists of various phases which tells us how to design, develop, enhance and maintain particular software. It consists of various phases like requirement, feasibility study, design, coding, testing, installation and maintenance.

3.6.1 Waterfall Model

Waterfall approach was first SDLC Model to be used widely in Software Engineering to ensure success of the project and we have also used this Model for the development of the website. Waterfall Model is also referred to as a linear-sequential life cycle model. In The Waterfall Model, the whole process of software development is divided into separate phases where the outcome of one phase acts as the input for the next phase sequentially. The following Figure ?? is a representation of the different phases of the Waterfall Model.

- **Requirements Analysis and Documentation: The specifications of the input and output or the final product are studied and documentation is done with IEEE papers.**
- **Design: The requirement specifications are studied here and system design is prepared.**
- **Implementation: In this stage system is developed according to module wise.**
- **Testing: This stage all developed software are installed and they are tested with different way against system requirements.**

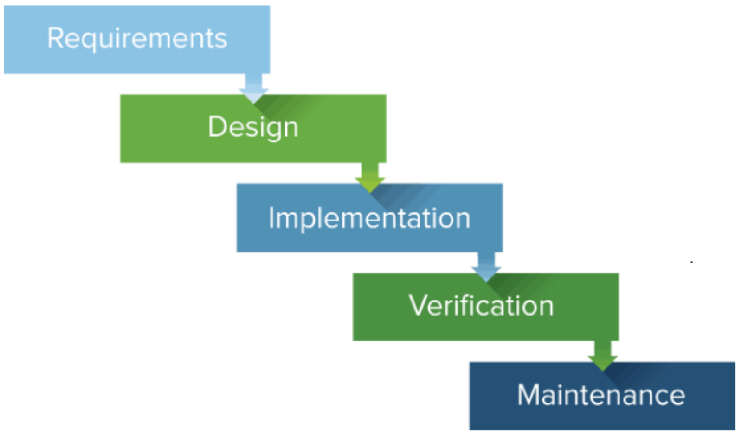

Figure 3.1: Waterfall Model

- **Deployment: Once the testing is done the website will be deployed on Web Services.**
- **Maintenance: According to software's new version and there use them need to update.**

According to software's new version and there use them need to update.

Chapter 4

SYSTEM DESIGN

The third chapter described the study of Software requirement specification. It included functional requirements, non-functional requirements, hardware and software requirements, external requirements, system requirements. This SRS needed to be represented into pictorial form for better understanding. This chapter is about system design. The system design consists of architecture and the system implementation flow. It includes diagrams like system architecture, data flow diagram, use case diagram, activity diagram, class diagram. These diagrams help in understanding the functioning of the system.

4.1 System Architecture

System architecture is the conceptual model that defines the structure, behavior, and more views of a system. System architecture of our project is System design defines the system architecture. It also describes the modules and interfaces. As shown in fig 4.1 explains the architecture of our system. The system architecture provides an insight of how the flow of process will be. Entire process of how the system will move forward that will generate the end-result is depicted.There are mainly two parts in system Architecture: In first part, based on the object detected in front of the camera its binary images is being populated. Meaning the object will be filled with solid white and background will be filled with solid black. Based on the pixel's regions, their numerical value in range of either 0 or 1 is being given to next process for modules. In second part, A gesture scanner will be available in front of the end user where the user will have to do a hand gesture. Based on Pre-Processed module output, a user shall be able to see associated label assigned for each hand gestures, based on the predefined American Sign Language (ASL) standard inside the output window screen. 4.1

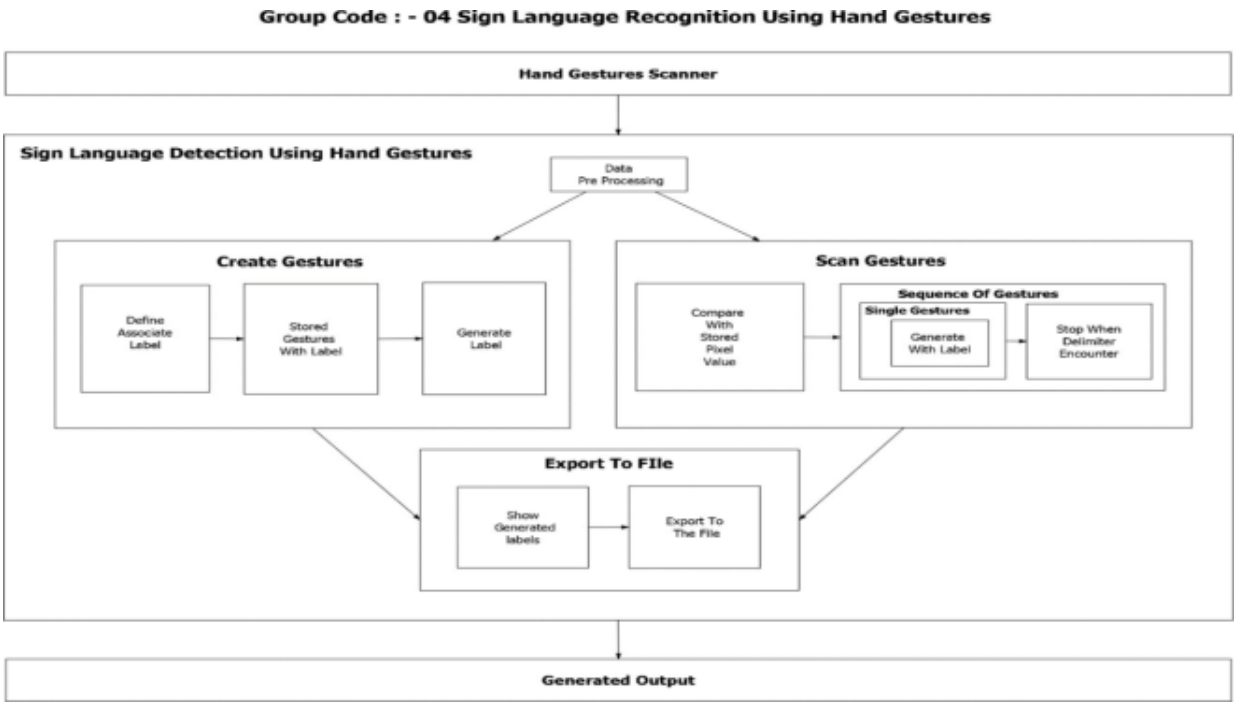

Figure 4.1: System Architecture

4.2 Mathematical Model

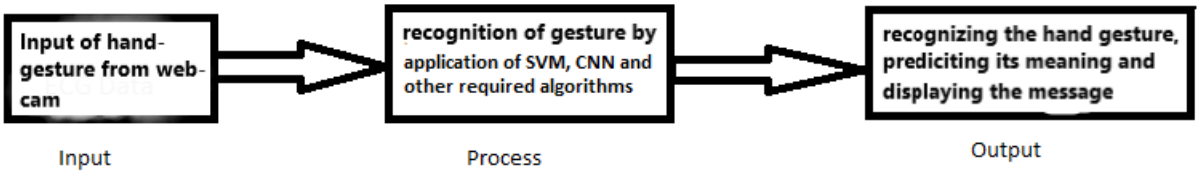

Figure 4.2: Mathamatical Model

- **Set Theory:**

S = s, I, O, F, e, V
Where
s = Start of program
I = I1, I2
I1 = Recorded video of User,
I2 = Live video if required
O= O1, O2
O1= Detection of Hand Gesture.
O2= Recognizing the meaning of the sign/gesture.
F= F1

F1= Gesture/sign detection
E=end of program
V = Failures and success conditions.
Success if:

- **Gesture/Sign detected accurately.**
- **It's recognition done accurately.**
- **Accurate message displayed as output.**

Failure if:

- **More time consumption by the system.**
- **Hardware failure.**
- **Software failure.**
- **Improper network connection.**

Space Complexity:
The space complexity depends on slide-summary and desired-shot .More the hashed data means more is the space complexity.

Time Complexity:
If system has n records then, the time complexity of checking the records is O(1) in best case and O(n) in worst case.
E=end of program
T = Failures and success conditions.

4.3 Data Flow Diagrams

The use case diagram as shown in figure 4.3

4.4 Entity Relationship Diagrams

The Entity Relationship Diagram as shown in figure 4.3

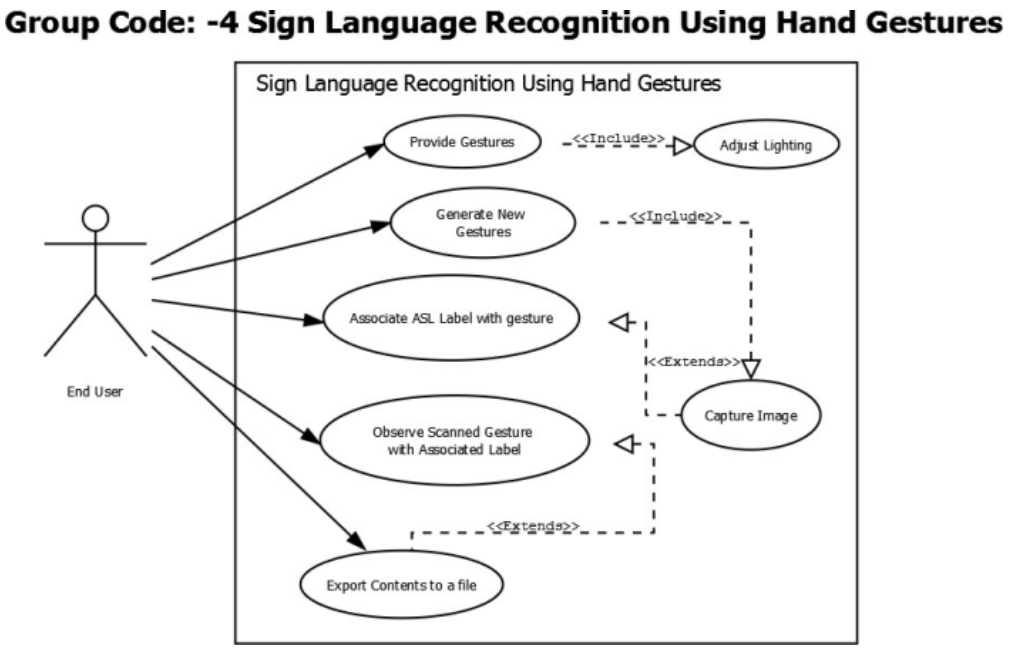

Figure 4.3: Use case Diagram

4.5 UML Diagrams

4.5.1 Use Case Diagram

The use case diagram as shown in figure 4.7

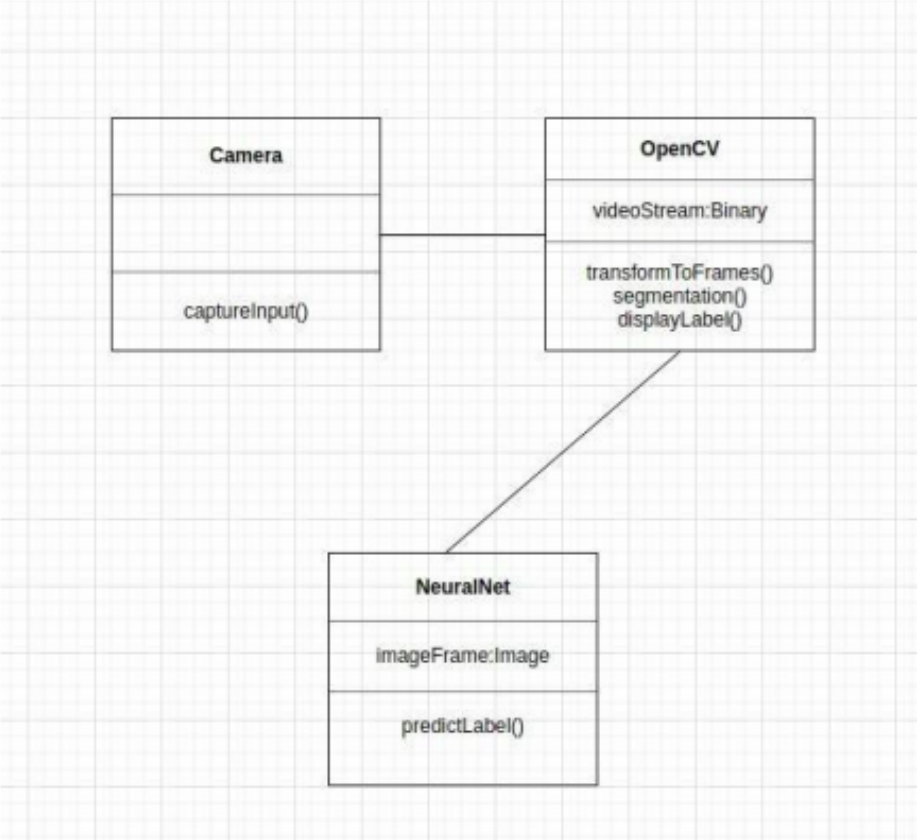

Figure 4.4: Entity Relationship Diagram 2

4.5.2 Sequence Diagram

A sequence diagram shown in fig. 4.8 is a type of interaction diagram because it describes how and in what order a group of objects works together. These diagrams are used by software developers and business professionals to understand requirements for a new system or to document an existing process. Sequence diagrams are sometimes known as event diagrams or event scenarios. User uploads an image and then according to his request a result is displayed.

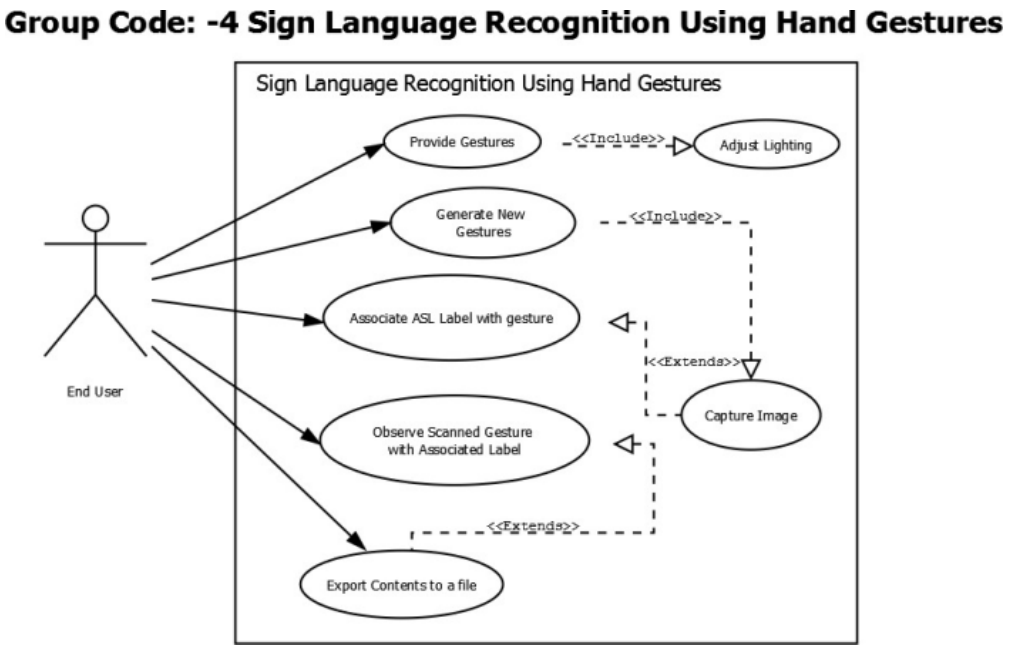

Figure 4.5: Use case Diagram

4.5.3 Activity Diagram

Activity diagram fig. 4.9 is basically a flowchart to represent the flow from one activity to another activity. The activity can be described as an operation of the system. The control flow is drawn from one operation to another. Firstly, the application will be started. The user can select the architectural plans according to their wish.

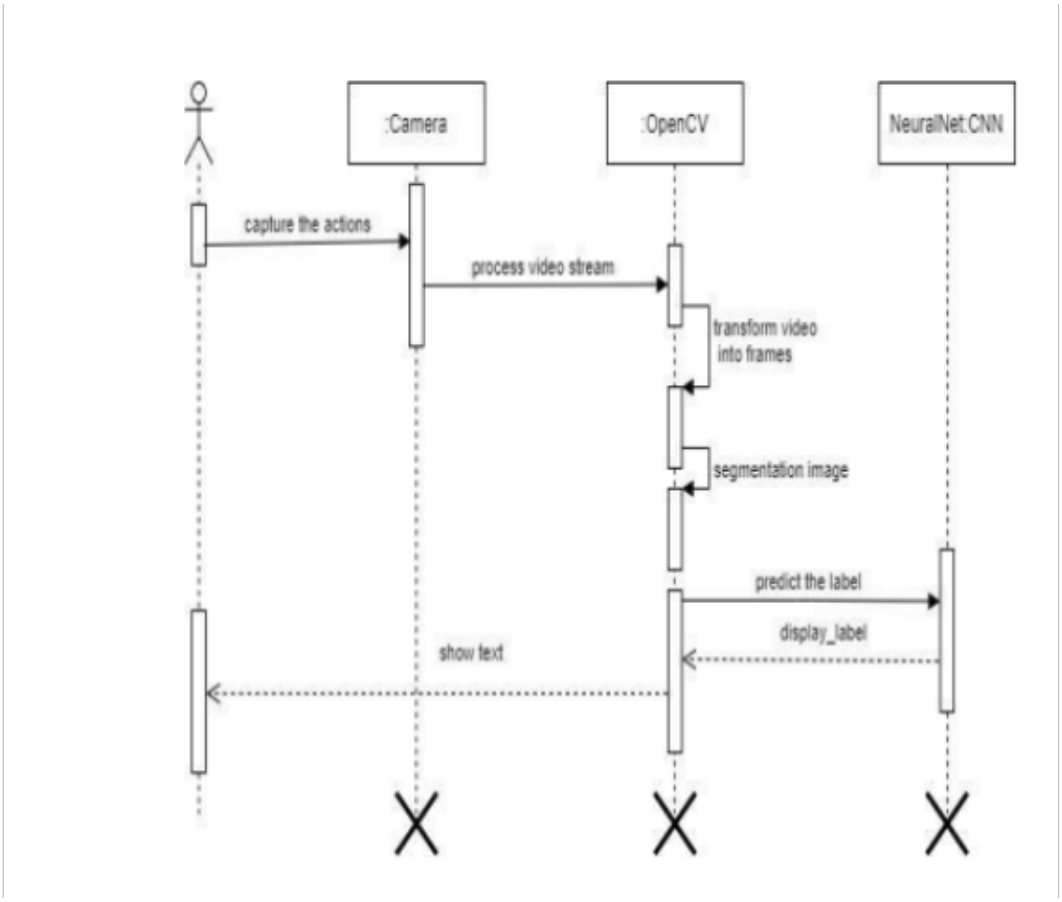

Figure 4.6: Sequence Diagram

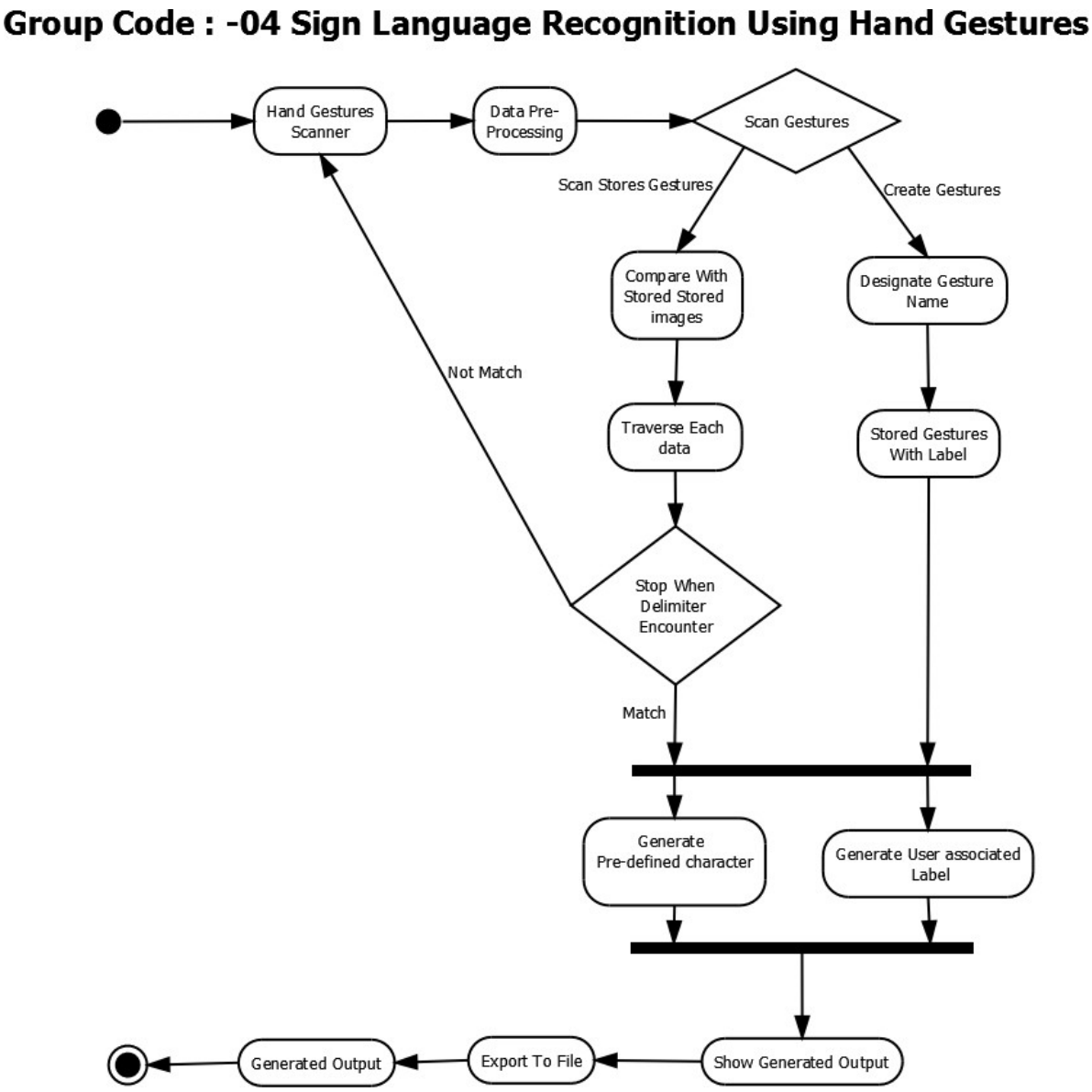

Figure 4.7: Activity Diagram

Chapter 5

PROJECT PLAN

A project plan is a formal document designed to guide the control and execution of a project. A project plan is the key to a successful project and is the most important document that needs to be created when starting any business project. The following chapter contains necessary points to be considered for the project plan.

5.1 Project Estimate

The project estimate is prior calculation of the cost, resources and other needs. This is done after the requirements of the project are finalized between both the parties. The estimated cost include the cost of hosting the servers which can be range from INR 2000 - INR 5,000 based on the providers and the type of service used.

5.1.1 Reconciled Estimates

The budget of a project is calculation or estimation of all the efforts and costs required to implement the project. For this project, the budget has been calculated by using CoCoMo model. The basic CoCoMo model was used in Organic mode as the project is small and doesn't have too many complex budgeting factors. The basic CoCoMo equations are:-

$$E = a_b(KLOC)^{(b_b)} \tag{5.1}$$

$$D = c_b(E)^{(d_b)} \tag{5.2}$$

$$SS = \frac{E}{D} \tag{5.3}$$

Estimated size of the project = 5 KLOC
So, using equations 5.1 5.2, we get
E = 2.4(5)$^{1.05} = 13.01PM$
D = 2.5(13.01)$^{0.38} = 6.63M$
SS = 13.01/6.63 = 1.96P

Here, E is Effort (measured in Person Months),
D is Deployment Time (measured in Months)
SS is Staff Size (units is Persons)
Hence, Total Effort required is 13 person months(approx.) yielding a Development Time of 6.63 months and a Staff Size of 2 persons.
As, the team size is 4 persons, the development time of 6.63 months can be speeded up and calculated as follows:

Person	D
2	1/6.63
4	1/x

So, x = 2 6.63/4 = 3.3
Hence, the project will require 3 month (approx.) to complete (theoretically).

5.2 Risk Management

Risk management is defined as the process of identifying, assessing and controlling threats to a project. Risk management is a process that seeks to reduce the uncertainties of an action taken through planning, organizing and controlling of both human and financial capital.It is the responsibility of project manager to go through potential threats. The project manager can identify the risks and accordingly control them with the help of other stake holders.

5.2.1 Risk Identification

The risks identified in the project are very few because of high cohesiveness and low coupling involved. Also, open-source technologies are used throughout and no external APIs are used which makes the project self-dependent and hence the probability of error is less.

5.2.2 Risk Analysis

Risk analysis is handling the system response in the risk conditions which are identified. If the system response is incorrect then the developers work on it and try fixing out the identified risks. Risk analysis can affect on project objectives which can work incorrectly in the risk cases. The risk analysis assigns the severity to the risks and developers start working accordingly.

1. **High severity: Catastrophic**
2. **Medium severity: Critical**
3. **Low severity: Marginal**

5.2.3 Overview of Risk Mitigation, Monitoring, Management

There are few risks which were encountered while developing the project, these risk have low probability but high impact. The most important thing is their probability. These errors are not catastrophic as they do not occur regularly. The risks are described in the tables 5.1 and 5.2 and are self-explanatory.

Table 5.1: Risk 1

Risk ID	1
Risk Description	application Crash
Category	Technical
Source	code
Probability	Low
Impact	High
Strategy	Wait for a while
Risk status	Not Occured

5.3 Project Schedule

The project schedule is a set of activities which covers the development of all functionalities in the project. It comes with the start and end date of each and every activity. The project schedule includes every single detail of the project, such as who will be completing each task, the deliverables that will be produced, the goals and objectives the project will achieve and the amount of time it will take to complete the project.

Table 5.2: Risk 2

Risk ID	2
Risk Description	Inappropriate key-point
Category	Technical
Source	dataset
Probability	Low
Impact	High
Strategy	Re-evaluation of Model
Risk status	Occured

5.3.1 Project Task Set

1. **To provide an efficient and accurate way to convert sign language into text or voice.**
   (a) **To take video as input from the user's camera.**
   (b) **To process the input video.**
2. **To generate dataset related to gestures for further synthesis.**
   (a) **To create a database for the newly generated outputs.**
   (b) **To store the text/voice message generated from the given input video to the database.**
3. **To train a pre-trained CNN model for gesture recognition.**
   (a) **To train Stage-I and Stage-II CNN for generation of text or voice message about gestures from input video.**
   (b) **Training Stage-I CNN will recognize the gesture in the given input video.**
   (c) **Stage-II CNN will predict given gesture and display output text or voice message.**
4. **To develop proper and user friendly UI, for fluent user experience for getting desired result from the model.**
   (a) **To develop a UI for user to give video input and convert sign language into text or voice.**
   (b) **To learn and Understand Client Side scripting.**

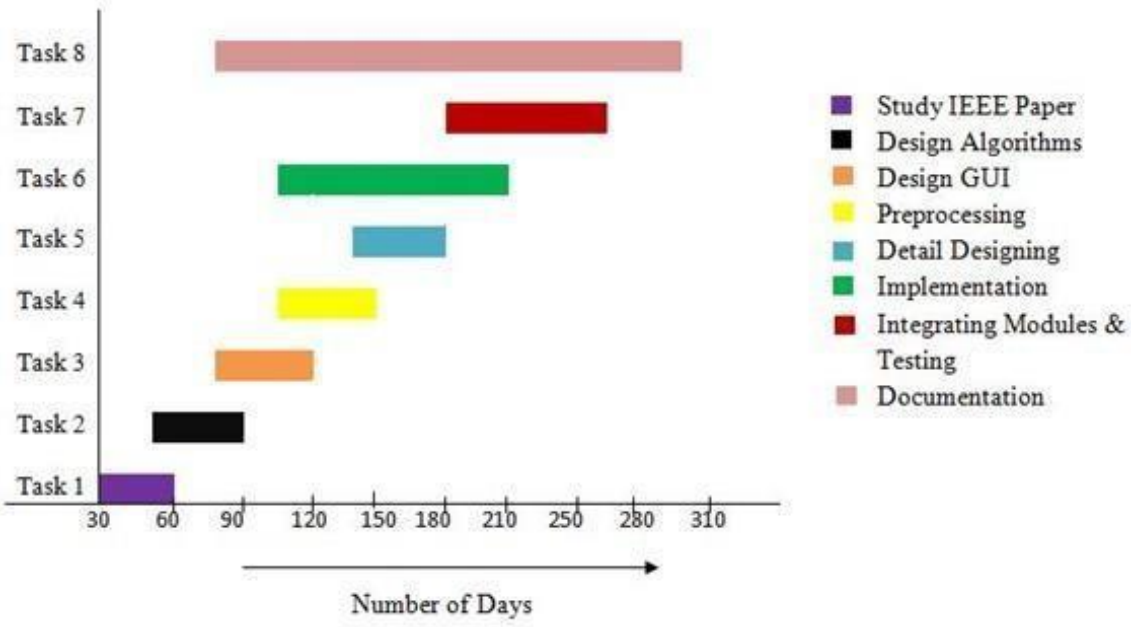

Figure 5.1: Schedule of Project Work

5.3.2 Timeline Chart

The schedule is shown is shown in Fig. 5.1.

5.4 Team Organization

According to Savitribai Phule Pune University rules, the team was supposed to be of 3 students from Final year of Computer Engineering. The team was formed in June 2021.

5.4.1 Team Structure

- **Project Guide : Prof. Ms. S. B. Borhade**
- **Project Preparation and Planning :Mr. Suraj Adsul, Mr. Amit Dighe, Mr. Saurabh Wankhede**
- **Front-End : Mr. Suraj Adsul, Mr. Amit Dighe, Mr. Saurabh Wankhede**
- **Back-End : Mr. Suraj Adsul, Mr. Amit Dighe, Mr. Saurabh Wankhede**

All the members contributed equally in the project and all the tasks received appropriate attention from all the members starting from designing, implementation and testing.

In this chapter, we took a glance at the project plan including project estimates along with Risk Management steps. In the next chapter, we will take a look at the implementation of the project and the tools used in making the system.

5.4.2 Management, Reporting and Communication

Regular online meetings are coducted with guide time to time to improve the areas of implementation. also the team member communicate with each other via google meet to implement the project and share the work and knowledge with each other.

Chapter 6

PROJECT IMPLEMENTATION

In this chapter, we will see the details regarding the project implementation. We will take a look at the tools and technologies used, algorithm for the project.

6.1 Overview of Project Modules

With this application a person will quickly adapt various gestures and their meaning as per ASL standards. They can quickly learn what alphabet is assigned to which gesture. Add-on to this custom gesture facility is also provided along with sentence formation. A user need not be a literate person if they know the action of the gesture, they can quickly form the gesture and appropriate assigned character will be shown onto the screen.

Concerning to the implementation, we have used TensorFlow framework, with keras API. And for the user feasibility complete front–end is designed using PyQT5. Appropriate user-friendly messages are prompted as per the user actions along with what gesture means which character window. Additionally, an export to file module is also provided with TTS (Text-To-Speech) assistance meaning whatever the sentence was formed a user will be able to listen to it and then quickly export along with observing what gesture he/she made during the sentence formation.

Our strategy involves implementing such an application which detects pre–defined sign language through hand gestures. For the detection of movement of gesture, we would use basic level of hardware component like camera and interfacing is required. Our application would be a comprehensive User–friendly Based system built on PyQt5 module...

Instead of using technology like gloves or kinect, we are trying to solve this problemusing state of the art computer vision and machine learning algorithms.

6.2 Tools and Technologies Used

1. **Pandas and Numpy:**

   Pandas is a high-level data manipulation tool. It is built on the Numpy package and its key data structure is called the DataFrame. DataFrames allow you to store and manipulate tabular data in rows of observations and columns of variables. Numpy is a Python package which stands for 'Numerical Python'. It is the core library for scientific computing, which contains a powerful n-dimensional array object, provide tools for integrating C, C+ etc. It is also useful in linear algebra, random number capability etc.

2. **Tensorflow - Keras:**

   TensorFlow is a free and open-source software library for dataflow and differentiable programming across a range of tasks. It is a symbolic math library, and is also used for machine learning applications such as neural networks. It is used for both research and production at Google. It lets uers build and train ML models easily using intutive high-level APIs like Keras. Keras is an open-source neural-network library written in Python, It is capable of running on top of Tensorflow, Microsoft Coginitive Toolkit, R, Theano, or PlaidMl. It foucus on being user-friendly, modular, and extensible. Keras contains numerous implementation of commonly used neural-network building blocks such as layers, objectives, activation functions, optimizers, and a host of tools to make working with image and text data easier to simplify the coding necessary for writting deep neural code. In addtion to standard neural network, Keras has support for covolutional and recurrent neural networks. It supports other common utility layers like dropout, batch normailization, and pooling. It also allows use of distributed training of deep-learning models on clusters of Graphics processing units(GPU) and tensor processing units (TPU) principally in conjunction with CUDA

3. **Open-CV:**

   OpenCV is a cross-platform library using which we can develop real-time computer vision applications. It mainly focuses on image processing, video capture and analysis including features like face detection and object detection.

6.3 Algorithm Details

Deep learning:

There have been several advancements in technology and a lot of research has been done to help the people who are deaf and dumb. Aiding the cause, Deep learning, and computer vision can be used too to make an impact on this cause.

This can be very helpful for the deaf and dumb people in communicating with others as knowing sign language is not something that is common to all, moreover, this can be extended to creating automatic editors, where the person can easily write by just their hand gestures. In this sign language recognition project, we create a sign detector, which detects numbers from 1 to 10 that can very easily be extended to cover a vast multitude of other signs and hand gestures and can also include the alphabets.

We have developed this project using OpenCV and Keras modules of python.

6.3.1 CNN

Neural networks, as its name suggests, is a machine learning technique which is modeled after the brain structure. It comprises of a network of learning units called neurons. These neurons learn how to convert input signals (e.g. picture of a cat) into corresponding output signals (e.g. the label "cat"), forming the basis of automated recognition.

A convolutional neural network (CNN, or ConvNet) is a type of feed¬forward artificial neural network in which the connectivity pattern between its neurons is inspired by the organization of the animal visual cortex

CNNs have repetitive blocks of neurons that are applied across space (for images) or time (for audio signals etc). For images, these blocks of neurons can be interpreted as 2D convolutional kernels, repeatedly applied over each patch of the image. For speech, they can be seen as the 1D convolutional kernels applied across time¬windows. At training time, the weights for these repeated blocks are 'shared', i.e. the weight gradients learned over various image patches are averaged

As you can observe, like any other CNN our model consists of couple of Conv2D and MaxPooling layers followed by some fully connected layers.

The first Conv2D (Convolutional) layer takes input image of shape (28,28,1). The last fully connected layer gives us output as expected in dataset.

We are using a Dropout after 2nd Conv2D layer to regularise our training.

Chapter 7

SOFTWARE TESTING

Software testing is process of checking whether the actual results match the expected results. It checks whether the developed software met the specified requirements and identifies any defect in the software in order to produce a quality product. Testing is required for an effective performance of software application. In this project, only two types of testings were used which are described following.

7.1 Type of Testing

Following types of testing is carried out for Sign Language Recognition during testing phase.

7.1.1 Unit Testing

Unit testing is type of testing where individual unit or component of software is tested. In Video Summarization tool, the four units-

1. **Text extractation from reak-time image**
2. **Geration of the 2D image.**
3. **Compairing of the processed image to dataset.**
4. **Printing the output after processsing the image.**

in all units were tested. The four units didn't produce any bugs when tested and functioned as expected.

7.1.2 Integration Testing

It is type of testing where individual components are combined and tested as a group. All the modules were integrated and tested. A bug was found in which the image from camera was blur and difficult to identify, so we a modulator(to adjust contrast, lights etc) was added for the camera input. The issue was fixed and all components work properly when integrated.

7.2 Test cases and Test Results

The results obtained after various testing procedures are depicted in table 7.1, 7.2, 7.3, 7.4 respectively. The tables are self-explanatory and hence no further explanation of the tables in detail is needed.

Table 7.1: Test Case ID 1

Summary	The real-time image is captured
Pre-requisites	web-cam
Test Procedure	image captured automatically
Expected Result	When we start the application the web-cam turns on, and images are captured on equal interval basis
Actual Result	When we start the application the web-cam turns on, and images are captured on equal interval basis
Status	Pass

Table 7.2: Test Case ID 2

Summary	To convert that image
Pre-requisites	web-cam, computer
Test Procedure	whether the image is converted properly
Expected Result	the captured image is also shown in 2D Black and white type image
Actual Result	the captured image is also shown in 2D Black and white type image
Status	Pass

Table 7.3: Test Case ID 3

Summary	recognize the gesture using given dataset
Pre-requisites	computer, image quality should be good
Test Procedure	compairing the input image and the dataset
Expected Result	the input image will match a certain dataset image so it can recognize the actual message conveyed
Actual Result	the input image will match a certain dataset image so it can recognize the actual message conveyed
Status	Pass

Table 7.4: Test Case ID 4

Summary	display the output message
Pre-requisites	computer, dataset
Test Procedure	after successfully finding the same gesture from dataset, display that expected messsage on the output screen
Expected Result	the actual meaning of the gestures is displayed on the screen in real-time
Actual Result	the actual meaning of the gestures is displayed on the screen in real-time
Status	Pass

Chapter 8

RESULTS

This section illustrates the generated output for Sign Language Recognition for physically abled users system on providing it input as hand gestures to give us the output in form of text in real-time.

8.1 Outcomes

With this application a person will quickly adapt various gestures and their meaning as per ASL standards. They can quickly learn what alphabet is assigned to which gesture. Add-on to this custom gesture facility is also provided along with sentence formation. A user need not be a literate person if they know the action of the gesture, they can quickly form the gesture and appropriate assigned character will be shown onto the screen.

Concerning to the implementation, we have used TensorFlow framework, with keras API. And for the user feasibility complete front-end is designed using PyQT5. Appropriate user-friendly messages are prompted as per the user actions along with what gesture means which character window. Additionally, an export to file module is also provided with TTS(Text-To-Speech) assistance meaning whatever the sentence was formed a user will be able to listen to it and then quickly export along with observing what gesture he/she made during the sentence formation.

8.2 Screen Shots

In this chapter, we saw some screenshots related to the application. We also discussed how we evaluated the results to find the best model out of all. The screenshots from the application running on jupyterlab are shown below. As we can see in fig. 8.1, we are given a interface that even a new user can work

with, screenshots of application are in Fig. 8.5, Fig. 8.6, Fig. 8.7. Also, Fig. 8.8 is showing particular video clip of the respective slide.

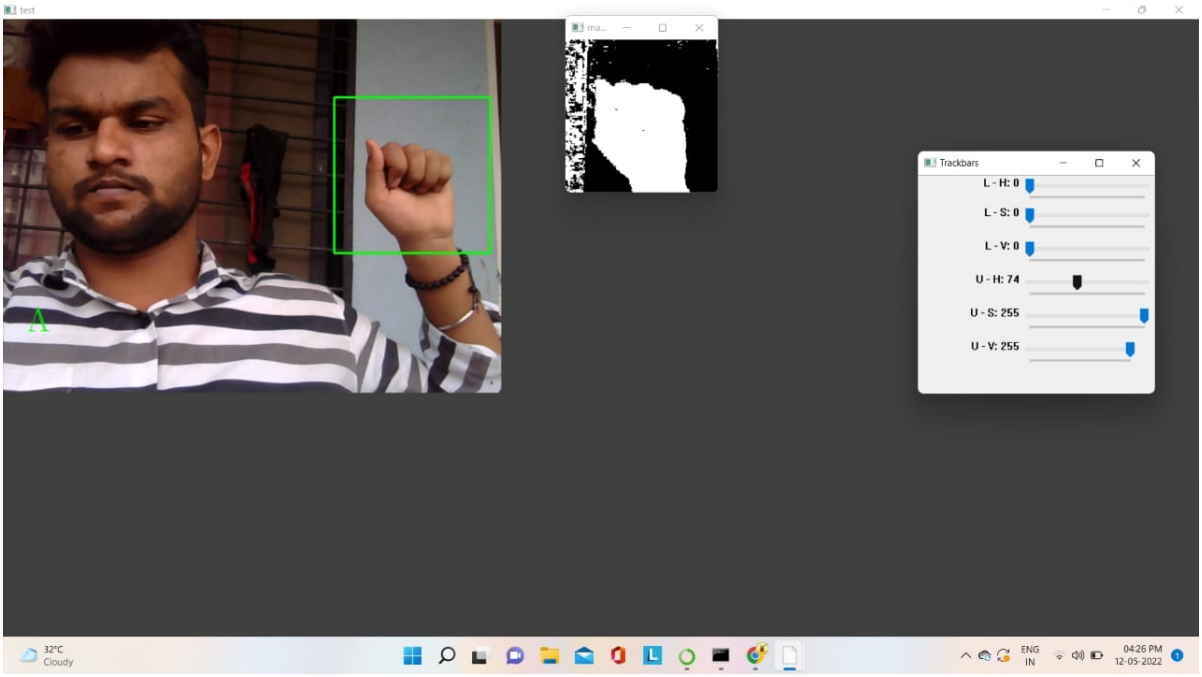

Figure 8.1: interface

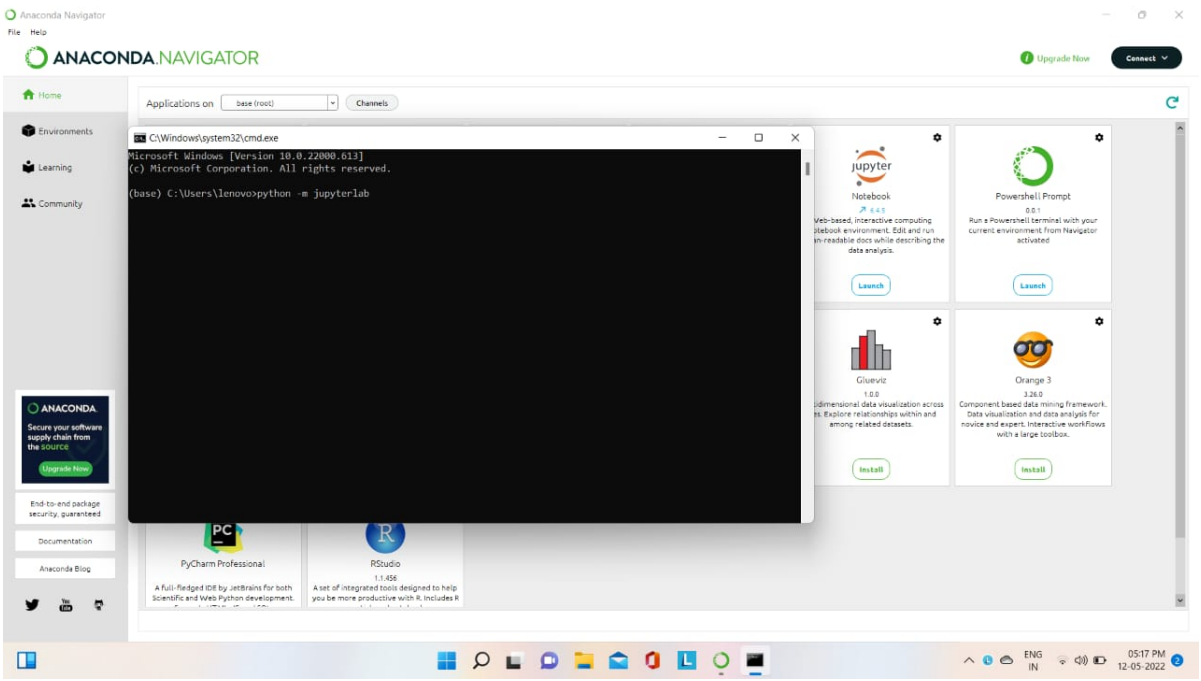

Figure 8.2: run code from terminal

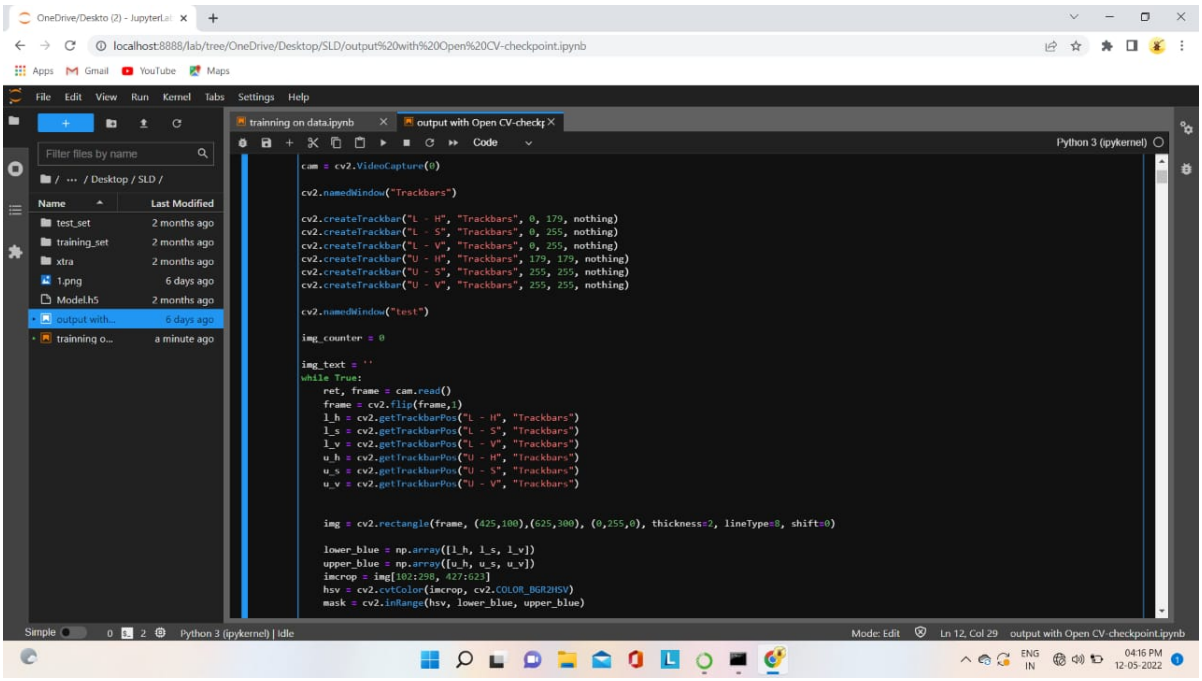

Figure 8.3: Training the module on data - 1

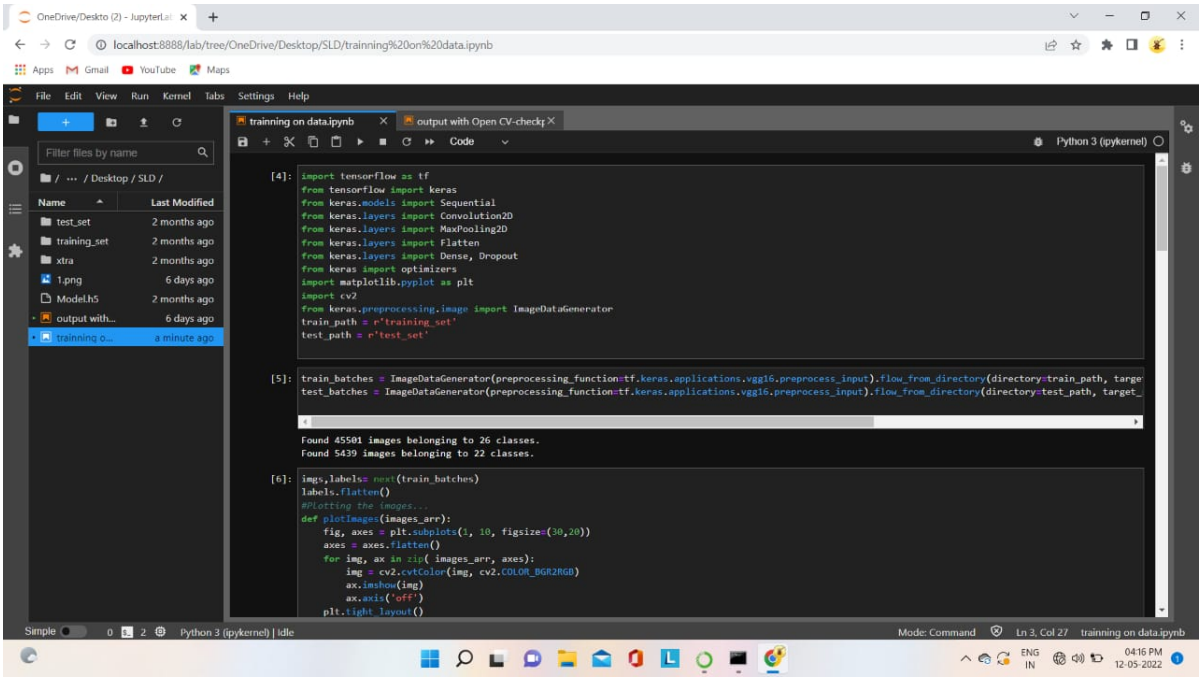

Figure 8.4: Training the module on data - 2

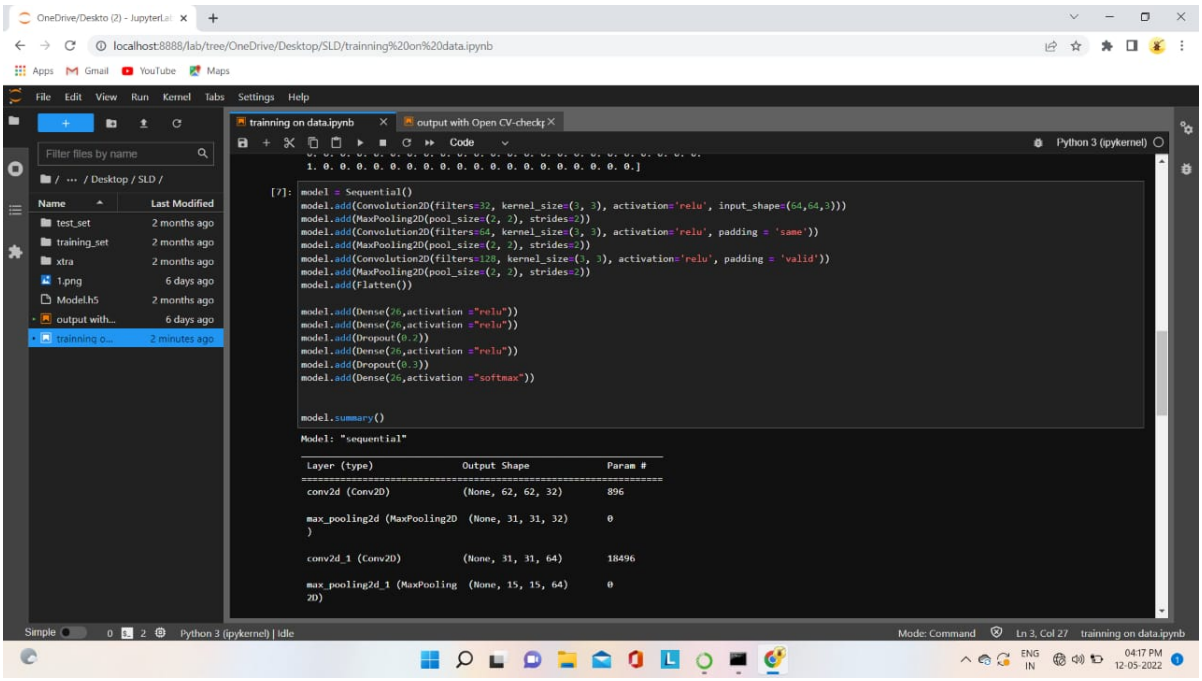

Figure 8.5: Training the module on data - 3

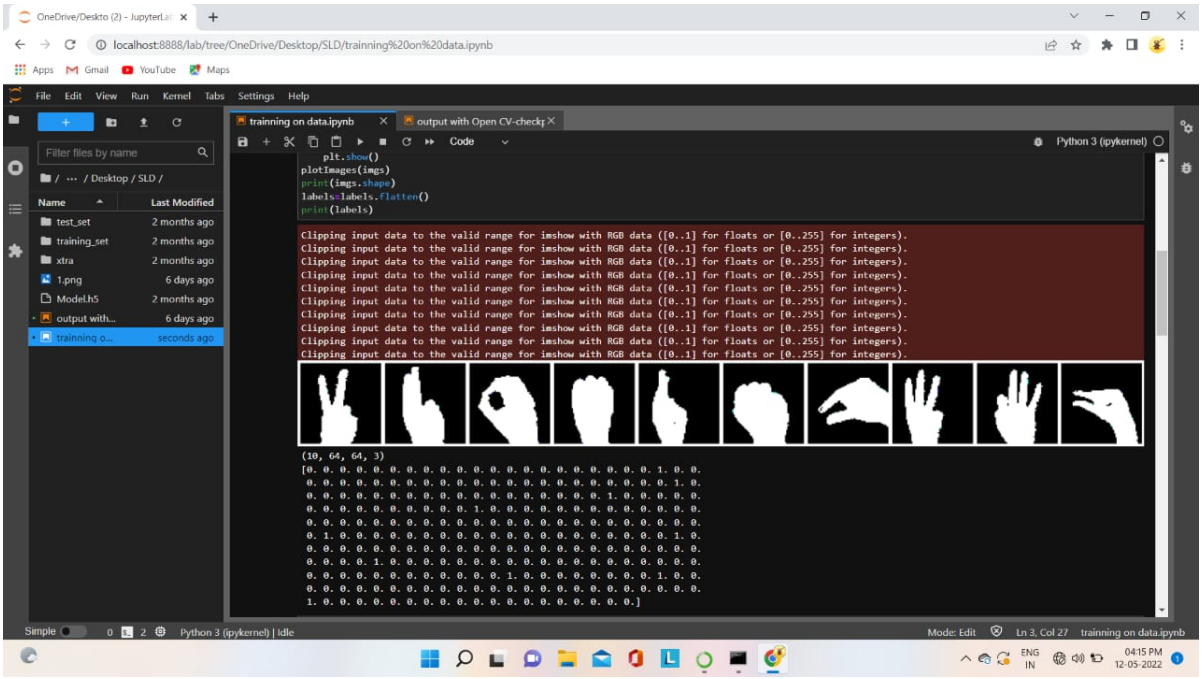

Figure 8.6: dataset used

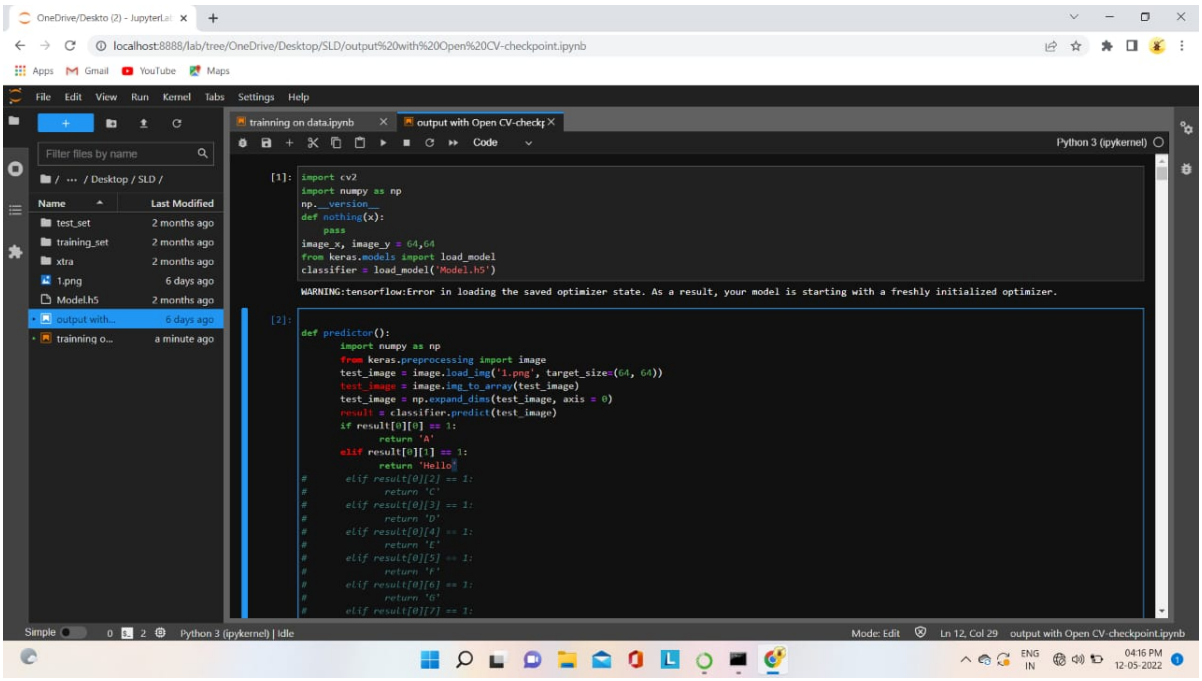

Figure 8.7: user can customize the output

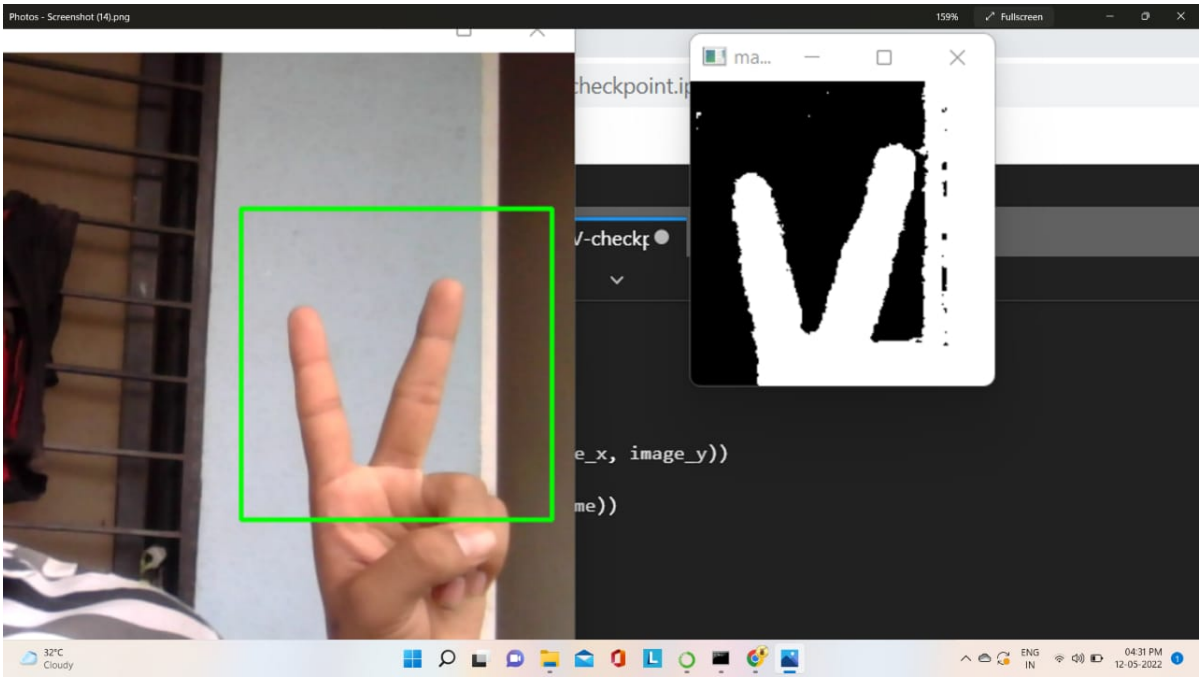

Figure 8.8: conversion of web-cam image to 2D image in real-time

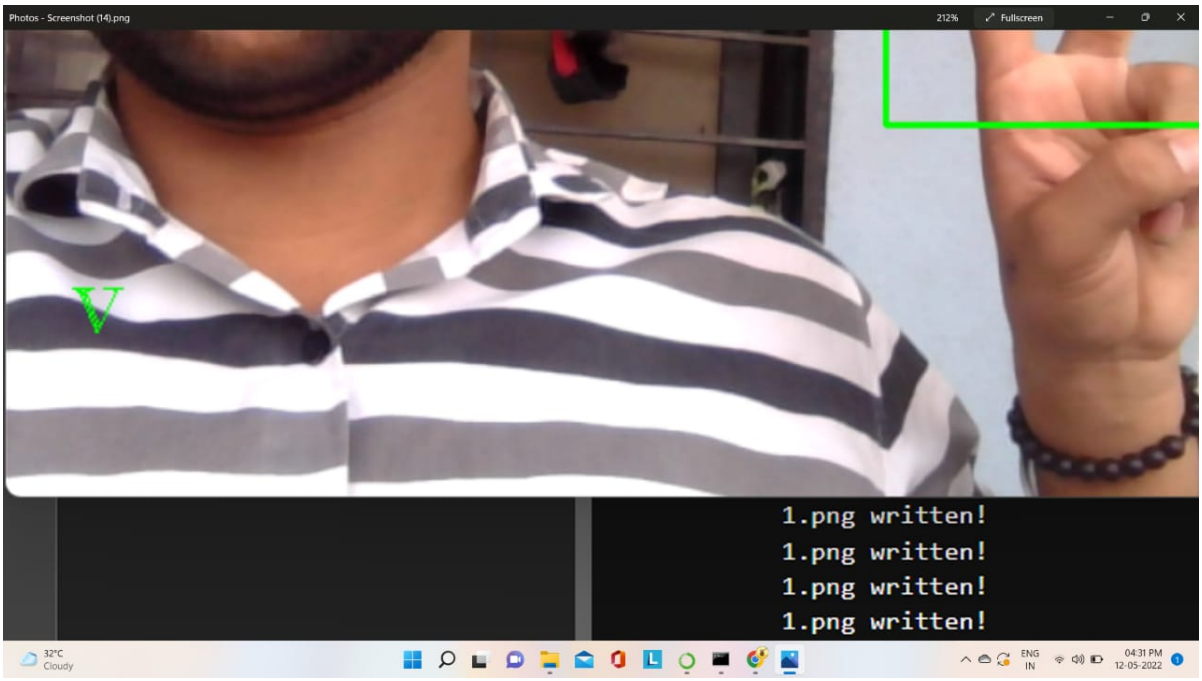

Figure 8.9: real-time output of gesture shown on screen

Chapter 9

CONCLUSIONS

9.1 Conclusions

With this application a person will quickly adapt various gestures and their meaning as per ASL standards. Add-on to this custom gesture facility is also provided along with sentence formation. A user need not be a literate person if they know the action of the gesture, they can quickly form the gesture and appropriate assigned character will be shown onto the screen.

Concerning to the implementation, we have used TensorFlow framework, with keras API. And for the user feasibility complete front-end is designed using PyQT5. Appropriate user-friendly messages are prompted as per the user actions along with what gesture means which character window. Additionally, an export to file module is also provided with TTS(Text-To-Speech) assistance.

9.2 Future Work

- **Increasing the accuracy of each component.**
- **Developing ways to filter and cover up for the errors getting carry forwarded from the previous components.**
- **It can be integrated with various search engines and texting application such as google, WhatsApp. So that even the illiterate people could be able to chat with other persons, or query something from web just with the help of gesture.**
- **This project is working on image currently, further development can lead to detecting the motion of video sequence and assigning it to a meaningful sentence with TTS assistance.**

Appendix A

Appendix: Assignments

Problem statement feasibility assessment using, satisfiability analysis and NP Hard, NP-Complete or P type using modern algebra and relevant mathematical models.

Title:

Project problem statement is feasibility assessment using NP-Hard, NP Complete or satiability issues using modern algebra and relevant mathematical models.

1. **What is P?**
    - **P is set of all decision problems which can be solved in polynomial time by a deterministic.**
    - **Since it can be solved in polynomial time, it can be verified in polynomial time.**
    - **Therefore, P is a subset of NP.**
2. **What is N?**
    - **"N" in "NP" refers to the fact that you are not bound by the normal way a computer works, which is step-by-step.**
    - **The "N" actually stands for "Non- deterministic". This means that you are dealing with an amazing kind of computer that can run things simultaneously or could somehow guess the right way to do things, or something like that.**

- **So this "N" computer can solve lots more problems in "P" time – for example it can just clone copies of itself when needed.**
- **So, programs that takes dramatically longer as the problem gets harder (i.e. not in "P") could be solved quickly on this amazing. "N" computer and so are in "NP".**
- **Thus "NP" means "we can solve it in polynomial time if we can break the normal rules of step-by-step computing".**

3. **What is NP?**
   - **"NP" means "we can solve it in polynomial time if we can break the normal rules of step-by-step computing".**
4. **Project status -**

   Problem:
   The main problem is how to find users image and check for copyright of image.

   Solution:
   In the Feasibility Study stage, the assigned project is analyzed, then information about the project participants is collected, and the requirements for the system are gathered and analyzed. During the Feasibility Study stage, the project's goals, parameters and restraints are agreed and a conceptual problem solution is prepared. It can be seen from figure 6.1 that we can get users image and accordingly check for any copyright. So, this project is NP-Complete.

MATHEMATICAL MODEL:

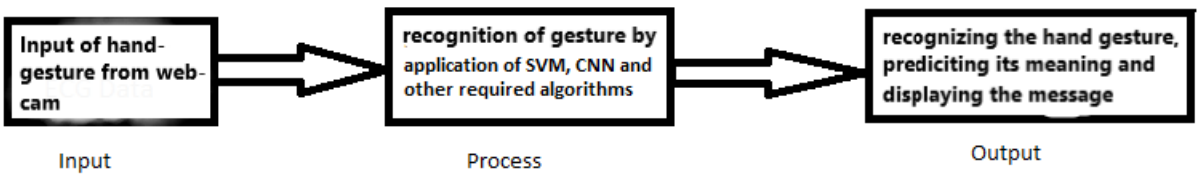

Figure A.1: Mathamatical Model

- **Set Theory:**

S = s, I, O, F, e, V

Where
s = Start of program
I = I1, I2
I1 = Recorded video of User,
I2 = Live video if required
O= O1, O2
O1= Detection of Hand Gesture.
O2= Recognizing the meaning of the sign/gesture.
F= F1
F1= Gesture/sign detection
E=end of program
V = Failures and success conditions.
Success if:

- **Gesture/Sign detected accurately.**
- **It's recognition done accurately.**
- **Accurate message displayed as output.**

Failure if:

- **More time consumption by the system.**
- **Hardware failure.**
- **Software failure.**
- **Improper network connection.**

Space Complexity:
The space complexity depends on slide-summary and desired-shot .More the hashed data means more is the space complexity.

Time Complexity:
If system has n records then, the time complexity of checking the records is O(1) in best case and O(n) in worst case.
E=end of program
T = Failures and success conditions.

Appendix B

Appendix: Publications

Details of paper publication:

1. **Paper Title:**

   "Sign Language Recognition Application Using Python and OpenCV"

2. **Name of the Conference/Journal where paper submitted :**

   INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN TECHNOLOGY (IJIRT)

3. **Paper accepted/rejected : Accepted**

4. **Review comments by reviewer :**

   - **6.87 impact factor calculated by Google scholar**
   - **Unique Contents: 70 %**

5. **Corrective actions if any : N/A**

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Sign Language Recognition Application using Python and OpenCV

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Abstract: *Deep learning (DL) is a machine learning method that allows computers to mimic the human brain, usually to complete classification tasks on images or non-visual data sets. Deep learning has recently become an Industry-defining tool for it's to advances in GPU technology. Deep learning is now used in self-driving cars, fraud detection, artificial intelligence programs, and beyond. These technologies are in high demand, so deep learning data scientists and ML engineers are being hired every day. Sign language recognition has gained focus over the last few years, it is a difficult task for normal human beings to interpret sign language. The project deals with the real time input which is given by the user , recognition of gesture is done by application of support vector machine(SVM), Convolutional neural network (CNN) and other required algorithms, after this step the hand gesture is recognized and its meaning is predicted and message.*

Keywords: CNN, Sign Language, Gesture Recognition, OpenCV, ROI, Relu, Silhouette, Pooling, Histogram

I. Introduction

Deep learning (DL) is a machine learning method that allows computers to mimic the human brain, usually to complete classification tasks on images or non-visual data sets. Deep learning has recently become an industry defining tool for its advances in GPU technology. Deep learning is now used in self-driving cars, fraud detection, artificial intelligence programs, and beyond. These technologies are in high demand, so deep learning data scientists and ML engineers are being hired every day. Today, we'll help you take the first step toward those exciting careers. You'll learn how deep learning works, why it's become so popular, and teach you to implement your first deep learning model. Deep learning and other ANN methods allow computers to learn by example in a similar way to the human brain. This is accomplished through passing input data through multiple levels of Neural Net processing to transform data and narrow the possible predictions each step along the way. Types of Learnings Machine Learning Algorithms can be classified into 3 types as follows:

1. Supervised learning
2. Unsupervised Learning
3. Reinforcement Learning

There are various models in deep learning, Supervised Models are Classic Neural Networks (Multilayer Perceptron), Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs) and for Unsupervised Models Self-Organizing Maps (SOMs), Boltzmann Machines, Auto Encoders.The proposed recognition model have used Convolutional Neural Networks (CNN) for detecting gesture from real time input. Deep learning algorithms have powerful advantages over other models like:

- **Unstructured data handling:** Once trained with structured data, deep learning models can automatically make sense of unstructured data. This means businesses can plug all available data they have without formatting or standardizing it first.
- **Recognize unexpected patterns:** Most models require engineers to select what pattern the ML algorithm will look for. Any correlations beyond those directly selected go undetected. Deep learning algorithms can track all correlations, even those not requested by engineers.
- **Unmatched accuracy:** Deep learning delivers more accurate results and scales better with large data pools than other methods.

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II. Related Work

In [1],A Saudi Sign Language Recognition System based on Convolutional Neural Networks, Alaa H Al-Obodi, Ameerh M Al-Hanine, Khalda N Al-Harbi, Maryam S Al-Dawas, and Amal A. Al-Shargabi, International Journal of Engineering Research and Technology,2020, The system is based on the Saudi Sign language dictionary, which was published recently in 2018. In this study, we constructed a dataset of 40 Saudi signs with about 700 images for each sign. We then developed a deep convolutional neural network and trained it on the constructed dataset.

In [2], Real-time Vernacular Sign Language Recognition using MediaPipe and Machine Learning Arpita Halder a , Akshit Tayade, International Journal of Research Publication and Reviews Vol (2) Issue (5) (2021), The main purpose of this paper is to demonstrate a methodology that simplified Sign Language Recognition using MediaPipe's open- source framework and machine learning algorithm. The predictive model is lightweight and adaptable to smart devices. Multiple sign language datasets such as American, Indian, Italian and Turkey are used for training purposes to analyze the capability of the framework. With an average accuracy of 99%, the proposed model is efficient, precise and robust.

In [3],.Towards Continuous Sign Language Recognition with Deep Learning,Boris Mocialov, Graham Turner, Katrin Lohan , Helen Hastie ,2017, paper focuses on natural language and in particular on sign language recognition. The approach described here combines heuristics for segmentation of the video stream by identifying the epenthesis with stacked LSTMs for automatic classification of the derived segments. This approach segments continuous stream of video data with the accuracy of over 80% and reaches accuracies of over 95% on segmented sign recognition

In [4], An Efficient Indian Sign Language Recognition System using Sift Descriptor, em using Sift Descriptor Jasmine Kaur, C. Rama Krishna, International Journal of Engineering and Advanced Technology (IJEAT),Aug 2019, In this paper to address these issues, Scale-Invariant Feature Transform (SIFT) as a descriptor is used. It extracts the features that train the Feed Forward Back Propagation Neural Network (FFBPNN) and optimizes it using Artificial Bee Colony (ABC) according to the fitness function. The dataset has been collected for alphabet from the video by extracting frames and for numbers it has been created manually from deaf and dumb students of NGO "Sarthak"

In [5], A Review Paper on Sign Language Recognition System For Deaf And Dumb People using Image Processing, Manisha U. Kakde , Mahender G. Nakrani , Amit M. Rawate,IJERT ,March 2016, This paper reviews a different methods adopted to reduce barrier of communication by developing an assistive device for deaf-mute persons. The advancement in embedded systems, provides a space to design and develop a sign language translator system to assist the dumb people, there exist a number of assistant tools. The main objective is to develop a real time embedded device for physically challenged to aid their communication in effective means.

In [6], A Comprehensive Analysis on Sign Language Recognition System Rajesh George Rajan, M Judith Leo, International Journal of Recent Technology and Engineering (IJRTE), March 2019, Thriving efforts in the area of Sign Language Recognition (SLR) research within the last few decades makes a good interaction between human and computer system. SignLanguage is basically a means for dissemination through signing which, utilizes specific sign patterns performed to deliver the meaning with the use of hands, lips and facial expressions to conveniently be able to express the signer's thoughts

In [7], Sign Language Recognition using Convolutional Neural Networks, Lionel Pigou, Sander Dieleman, Pieter-Jan Kindermans, Benjamin Schrauwen,2018, There is an undeniable communication problem between the Deaf community and the hearing majority. Innovations in automatic sign language recognition try to tear down this communication barrier. Our contribution considers a recognition system using the Microsoft Kinect, convolutional neural networks (CNNs) and GPU acceleration. Instead of constructing complex handcrafted features, CNNs are able to auto- mate the process of feature construction. We are able to recognize 20 Italian gestures with high accuracy

In [8], A Comprehensive Study on Deep Learning-based Methods for Sign Language Recognition, Nikolas Adaloglou ,Theocharis ,ax 19 March 2021, In this paper, a comparative experimental assessment of computer vision-based methods for sign language recog-nition is conducted. By implementing the most recent deep neural network methods in this field, a thorough evaluation on multiple publicly available datasets is performed. The aim of the present study is to provide insights on sign language recognition, focusing on mapping non-segmented video streams to glosses. For this task, two new sequence training criteria, known from the fields of speech and scene text recognition, are introduced.

In [9],Real-time American Sign Language Recognition with Convolutional Neural Networks, Brandon Garcia Alarcon Viesca, 2017,In This paper present the development and implementation of an American Sign Language (ASL)

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fingerspelling translator based on a convolutional neural network. We utilize a pre-trained GoogLeNet architecture trained on the ILSVRC2012 dataset, as well as Surrey University and Massey University. A real-time sign language translator is an important milestone in facilitating communication between the deaf community and the general public

In [10]Sign Language to Text, Rajesh Singh, Satyam Shekhar,Shashank Shaurya , Shivang Kumar , Dr. Rekha. K.S 5, 2020 IJESC, This paper shows the sign language recognizing of 28 including backspace and whitespace hand gestures in American sign language. The proposed system contains five modules such as: Setting up the model, caching bottlenecks, adding FC layer to the model, training the model and writing about trained graphs and labels.

In [11], Automatic Sign Language Finger Spelling Using Convolution Neural Network: Analysis, Beena M.V., Dr. M.N. Agnisarman Namboodir, International Journal of Pure and Applied Mathematics,2017, This paper focuses on the recognition of static gestures of ASL which are collected from Kinect sensors. The most challenging part in the design of an automatic sign language translator is the design of a good classifier that can classify the input static gestures with high accuracy.

III. Motivation

The 2011 Indian census cites roughly 1.3 million people with “hearing impairment”. In contrast to that, numbers from India’s National Association of the Deaf estimates that 18 million people –roughly 1 percent of the Indian population are deaf. These statistics formed the motivation for our project. As these speech impairments and deaf people need a proper channel to communicate with normal people, there is a need for a system .Not all normal people can understand sign language of impaired people.

IV .Problem Statement And Objectives

To train a Convolutional Neural Network (CNN) model for recognition of Sign Language gestures from video input and develop a UI which will work using Python and OpenCV.

1. To provide an efficient and accurate way to convert sign language into text or voice.
2. To generate dataset related to gestures for further synthesis.
3. To train a pre-trained CNN model for gesture recognition.
4. To develop proper and user friendly UI, for fluent user experience for getting desired result from the model.

V. System Architecture

System architecture is a conceptual model which specifies the overview of the whole process of the project. It describes each step in the project making with the help of a flow. It specifies each and every step descriptively.

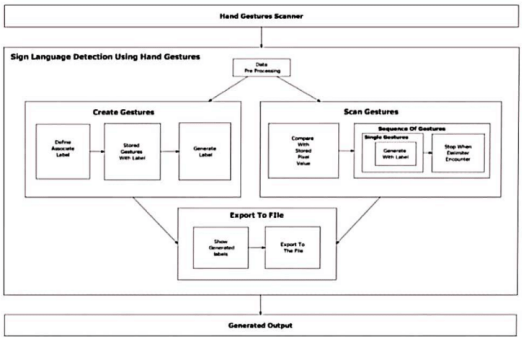

Figure 5.1: System Architecture

The system architecture is as follows,

- There are mainly two parts in system Architecture: In first part, based on the object detected in front of the camera its binary images are being populated.
- Meaning the object will be filled with solid white and the background will be filled with solid black.

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- Based on the pixel's regions, their numerical value in range of either 0 or 1 is being given to next process for modules.
- In second part, A gesture scanner will be available in front of the end user where the user will have to do a hand gesture. Based on Pre-Processed module output, a user shall be able to see associated label assigned for each hand gestures, based on the predefined American Sign Language (ASL) standard inside the output window screen

VII. IMPLEMENTATION

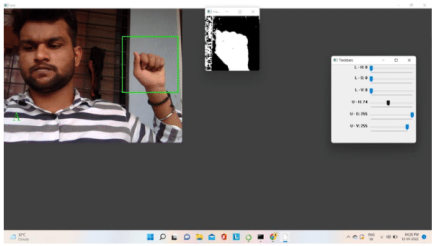

Figure: User interface

We take input from the user which is in real time through the webcam.

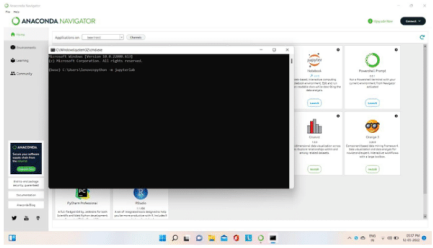

Figure: Run code.

To start the application we have to run it through the command line / terminal.

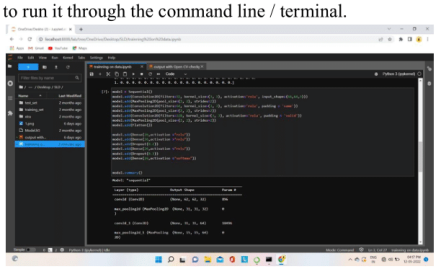

Figure: Training data

After taking the required input we train the available data in 3 parts.

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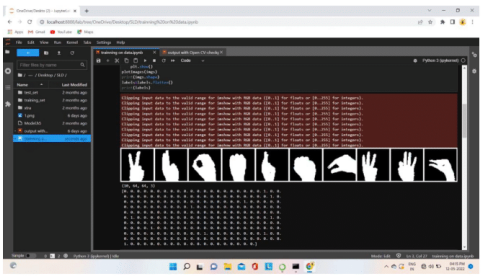

Figure: Dataset used

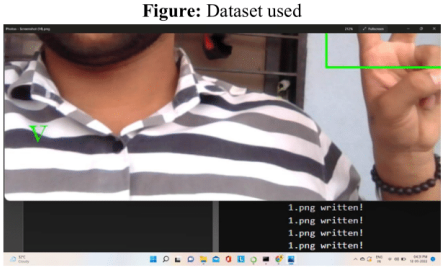

Figure: Conversion of image

Here we convert the real time data to 2-D image

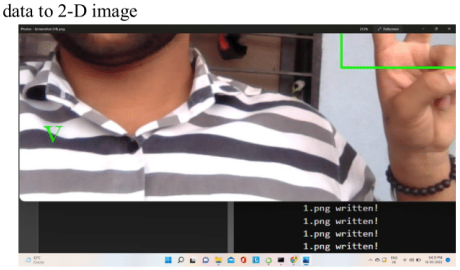

Figure: Output

Real time output of gestures is shown on screen.

VII. Future Work

It can be integrated with various search engines and texting applications such as google, WhatsApp. So that even the illiterate people could be able to chat with other persons, or query something from the web just with the help of gestures. Developing ways to filter and cover up for the errors getting carried forward from the previous components.

VII. Conclusion

With this application a person will quickly adapt various gestures and their meaning as per ASL standards. They can quickly learn what alphabet is assigned to which gesture. Add-on to this custom gesture facility is also provided along with sentence formation. A user need not be a literate person if they know the action of the gesture, they can quickly form the gesture and appropriate assigned character will be shown onto the screen.

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Appendix C

Appendix: Certificates

Certified to -

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2. **Mr. Suraj Adsul**
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Appendix D

Appendix: Plagiarism Report

Plagiarism Report of project report

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LITERATURE SURVEY
The previous chapter tells about the description of this project. The problem statement gives a brief idea about the project and the objectives gives a stepwise execution process of the project. In this chapter, some concrete basis supporting and extending the applicability of the project will be reviewed with the hope of providing better insights into the foundations of the project.
In Literature, We went through additional comparable studies that are performed in the domain of the sign language recognition. The following are summaries of each of the project's works:
2.1 Literature Review
2.1.1 A. Literature survey on Methods of Hand-Gesture Recognition in Sign Language Recognition :-
Given paper focused on methods used in the prior Sign Language Recognition systems. Based on our review, HMM-based approaches have been extensively explored in prior research, including its modifications. Deep Learning, such as Convolutional Neural Networks, has been popular in the past five years. Hybrid CNN-HMM and completely deep learning systems have yielded encouraging results and provide avenues for additional research. Clustering and high computational needs, however, continue to stymie their adoption. We believe that the research's future focus should be on developing a simplified network that can reach high performance while requiring little CPU resources, and that embeds the feature learner within the classification in a multi layered neural network approach
2.1.2 Literature survey on Normal People and Deaf-Dumb People Communication:-
The overall purpose project is facilitate the interaction between deaf and dumb people and normal people to makes the communication between normal people and dumb people easier, by translate the sign language to voice or text with high accuracy. The dumb and deaf communicate via sign language, which is hard to decipher for those who are not familiar with it. As a result, it is necessary to develop a device that can translate gestures
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into speech and text. This will be a significant step in allowing deaf and dumb people to communicate with the broader population.
2.1.3 Literature survey on A System for Recognition of Indian Sign Language for Deaf People using Otsu's Algorithm
In proposed paper, some methods for making sign recognition easier for people while communicating and the result of those symbol signs will be converted into the text. In this project, we are capturing hand gestures through a webcam and converting this image into a grayscale image. The segmentation of the grayscale image of a hand gesture is performed using the Otsu thresholding algorithm. . The whole picture level is split into

two categories: hand and backdrop. The best threshold value is calculated by computing the proportion between total class variance and class variance. The Canny edge detection technique is used to locate the border of a hand gesture in a picture. We employed edge-based segmentation and threshold-based segmentation in Canny edge detection. Then Otsu's algorithm is used because of its simplified calculations and stability. This algorithm fails when the global distribution of the target and background varies widely

2.1.4 Literature survey on Image Processing for Intelligent Sign Language Recognition:-

HMMs are suited for full sign recognition of ASL, because to their inherent time-varying nature. Because a series of several of the 36 basic hand shapes may be used to gesture most ASL signs. The continuous indications can be split, with the fundamental hand shapes retrieved as the input to the HMM processor. The fundamental hand shapes may then be identified and chained as ASL words' output. With the approaches presented in this work, the system may be expanded to a full-sign recognition system

2.1.5 Literature survey on Sign Language Interpreter using Machine Learning and Image Processing:-

Pham Microsoft Kinect is used by the Hai to interpret Vietnamese Sign Language. The user must align himself with Kinect's field of view and then conduct sign language movements in the suggested system. Using multiclass Support Vector Machine, it can distinguish both dynamic and static gestures. The gesture features are retrieved, filtered out and normalize on Euclidean distance during recognition.

2.1.6 Literature survey on Hand-Gesture recognition by using Digital Image Processing using MATLAB :-

The introduction of modern techniques significantly expands the possibilities of traditional microscopic procedures in the forensic field, allowing for the acquisition of necessary quantitative data in forensic analysis of pedological phases, mineral phase discrimination, or the option of organic phase analysis straight forwadly in the SEM chamber.

Sources	Similarity
Hierarchical Attention Networks for Document Classification by Z Yang · Cited by 4109 — used deep learning, such as convolutional neural net- works (Blunsom et al., 2014) and recurrent neural networks based on long short-term memory (LSTM). https://www.cs.cmu.edu/~./hovy/papers/16HLT-hierarchical-attention-networks.pdf	10%
SIGN LANGUAGE RECOGNITION USING PYTHON AND ... by D Golekar — The overall purpose project is facilitate the interaction between deaf and dumb people and normal people to makes the communication between normal people ... https://www.irjmets.com/uploadedfiles/paper//issue_2_february_2022/19203/final/fin_irjmets1645622414.pdf	18%

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Chapter 3
SOFTWARE REQUIREMENTS
SPECIFICATION
In the last chapter, the basis of implementing this project were discussed. Following that, in this chapter Software Requirement Specication document will be elaborated. In the subsequent sections, there will be a discussion regarding the technical requirements, methodology to be used in SDLC, etc.
3.1 Assumptions and Dependencies
• User must have basic knowledge of computer.
• User follows instruction as shown by the application.
• Maintenance and updates will be provided by Administrators.
• Must be familiar basic with the Software and their knowledge of basic functions of python.
• The organization device should be a laptop or computer.
3.2 Functional Requirements
3.2.1 System Feature 1
User-friendly based GUI built using industrial standard PyQT5.
3.2.2 System Feature 2
Real time American standard character detection based on gesture made by user. Also, forming a stream of sentences based on the gesture made after a certain interval of time
3.2.3 System Feature 3
Customized gesture generation. Allowing the users to customize any specic gesture according to their needs and requirements.
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3.3 External Interface Requirements
3.3.1 User Interfaces
Simple user-friendly interface allows anyone not from technical background to easily use the application. The frameworks used will help to make the interface responsive and support the functioning on a computer device.
3.3.2 Hardware Interfaces
The hardware interface will include a computer to run the software and a webcam to capture real-time hand gestures of the user.
3.3.3 Software Interfaces
The GUI is built using industrial standard PyQT5. Which is also quite easy to understand and learn for a person who recently have entered in technology eld.
3.3.4 Communication Interfaces
The application software will be showing the output in the form of text on your computer screen in real-time with negligible delay to recognize the given hand-gesture.
3.4 Nonfunctional Requirements

These requirements specify the criteria that can be used to judge operation of system, rather than specic behaviour.

3.4.1 Performance Requirements

These requirements give the performance aspects required from the project. This is part of the general capacity planning process. The performance requirements are as follows.

1. The UI will be user friendly.
2. It will show results in real-time.

3.4.2 Safety Requirements

Safety requirements specify the needs that can help a system to keep intact after any problem takes place. The requirements are as follows.

1. A backup of the database is stored.
2. There is no need of user login and hence the authentication is not required which saves us from auth safety procedures.

3.4.3 Security Requirements

Security requirements are needed to prevent any malicious attack that can take place on the project. These requirements are as follows.

1. The website will have login and sign-up options.

7

2. only signed user can login.
3. user can upload answer-sheet on the website.
4. The website is user friendly, and prevented from malicious attack

3.4.4 Software Quality Attributes

1. Security: This is achieved by send the essay via POST method and neglecting the need of login.
2. Eciency: System fulllment its purpose with utilization of all necessary resources.
3. Portability: The ease with which a system can be adapted to run on computers.
4. Testability: Suitability for allowing to follow program execution.
5. Readability: Form of representation is understandable.
6. Maintainability: The separation of the modules allows easy maintainability.
7. Resource Utilization: The resource requirements are similar to a standard website as most of the work is done at the backend.

3.5 System Requirements

System requirements give us the components that are needed to make the project possible.

3.5.1 Database Requirements

a. Logical Database Requirements: A logical database can stretch over multiple physical hard disks and information les. To have a logical database, all given hard disks and information les must be accessible from a single source.

b. Physical Database Requirements: A physical database is technically a smaller unit of storage referred to as a company, eld, record or table, depending on how much informa- tion the physical storage device contains. A eld is the smallest unit of storage housing only a single le.

3.5.2 Software Requirements (Platform choice)

• Microsoft Windows XP or later / Ubuntu 12.0 LTS or later /MAC OS 10.1 or later.

Python Interpreter (3.6).

1. Language { Python
2. Libraries

(a) Numpy
(b) Pandas
(c) OpenCV
(d) Matplotlib
(e) Scikit Learn
(f) Mahotas
(g) Keras
(h) Tensor

ow

It is recommended to use Anaconda Python 3.6 distribution and using a Jupyter Notebook.

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3.5.3 Hardware Requirements

• Processor: Intel Core i3 3 rd gen processor or later
• Hard Disk: 512 MB disk space
• RAM: 512 MB
• Camera :(300ppi or 150lpi) 4-megapixel cameras and up

3.6 Analysis Models: SDLC Model to be applied

SDLC is a step by step procedure or systematic approach to develop software. It consists of various phases like requirement, feasibility study, design, coding,
testing, installation and maintenance.

3.6.1 Waterfall Model
Waterfall approach was rst SDLC Model to be used widely in Software Engineering to ensure success of the project and we have also used this Model for the development of the website. The following Figure ?? is a representation of the dierent phases of the Waterfall Model.
Figure 3.1: Waterfall Model
• Requirements Analysis and Documentation: The specications of the input and output or the nal product are studied and documentation is done with IEEE papers.
• Design: The requirement specications are studied here and system design is prepared.
• Implementation: In this stage system is developed according to module wise.
• Testing: This stage all developed software are installed and they are tested with dierent way against system requirements.
• Deployment: Once the testing is done the website will be deployed on Web Services.
9
• Maintenance: According to software's new version and there use them need to update.
According to software's new version and there use them need to update.

Sources	Similarity
ii. technical specification - StudyLib https://studylib.net/doc/7345071/ii.-technical-specification	5%
Stereoscopic structured light measurement of scene - Course ... https://www.coursehero.com/file/p2bm56b7/The-proposed-model-for-still-images-accurately-identifies-the-static-signs-9433/	5%
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www.subjectcoach.com › tutorials › detailIntroduction to software development life cycle (SDLC) The software development life cycle (SDLC) is a process which is used to develop software. SDLC is a step by step procedure need to be followed by the organization to design and develop a high quality product. The phases of software development life cycle are which describes that how to develop, maintain particular software. https://www.subjectcoach.com/tutorials/detail/contents/introduction-to-software-development-life-cycle-sdlc/	2%
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Chapter 4
SYSTEM DESIGN
The third chapter described the study of Software requirement specication. It included functional requirements, non-functional requirements, hardware and software requirements, external requirements, system requirements. This SRS needed to be represented into pictorial form for better understanding. This chapter is about system design. The system design consists of architecture and the system implementation
ow. It includes
diagrams like system architecture, data
ow diagram, use case diagram, activity diagram,
class diagram. These diagrams help in understanding the functioning of the system.
4.1 System Architecture
System architecture is the conceptual model that denes the structure, behavior, and more views of a system. System architecture of our project is System design denes the system architecture. It also describes the modules and interfaces. As shown in g 4.1 explains the architecture of our system. The system architecture provides an insight of how the ow of process will be. Entire process of how the system will move forward that will generate the end-result is depicted.There are mainly two parts in system Architecture: In rst part, based on the object detected in front of the camera its binary images is being populated. Meaning the object will be lled with solid white and background will be lled with solid black. Based on the pixel's regions, their numerical value in range of either 0 or 1 is being given to next process for modules. In second part, A gesture scanner will be available in front of the end user where the user will have to do a hand gesture. Based on Pre-Processed module output, a user shall be able to see associated label assigned for each hand gestures, based on the predened American Sign Language (ASL) standard inside the output window screen. 4.1
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Figure 4.1: System Architecture
4.2 Mathematical Model
Figure 4.2: Mathamatical Model
• Set Theory:
S = s, I, O, F, e, V
Where
s = Start of program
I = I1, I2
I1 = Recorded video of User,
I2 = Live video if required
O= O1, O2
O1= Detection of Hand Gesture.

O2= Recognizing the meaning of the sign/gesture.
F= F1
F1= Gesture/sign detection
E=end of program
V = Failures and success conditions.
12
Success if:
• Gesture/Sign detected accurately.
• It's recognition done accurately.
• Accurate message displayed as output.
Failure if:
• More time consumption by the system.
• Hardware failure.
• Software failure.
• Improper network connection.
Space Complexity:
The space complexity depends on slide-summary and desired-shot .More the hashed data means more is the space complexity.
Time Complexity:
If system has n records then, the time complexity of checking the records is O(1) in best case and O(n) in worst case.
E=end of program
T = Failures and success conditions.
4.3 Data Flow Diagrams
The use case diagram as shown in gure 4.3
Figure 4.3: Use case Diagram
13
4.4 Entity Relationship Diagrams
The Entity Relationship Diagram as shown in gure 4.3
Figure 4.4: Entity Relationship Diagram 2
14
4.5 UML Diagrams
4.5.1 Use Case Diagram
The use case diagram as shown in gure 4.7
Figure 4.5: Use case Diagram
15
4.5.2 Sequence Diagram
A sequence diagram shown in g. 4.8 is a type of interaction diagram because it describes how and in what order a group of objects works together. These diagrams are used by software developers and business professionals to understand requirements for a new system or to document an existing process. Sequence diagrams are sometimes known as event diagrams or event scenarios. User uploads an image and then according to his request a result is displayed.
Figure 4.6: Sequence Diagram
16
4.5.3 Activity Diagram
Activity diagram g. 4.9 is basically a
owchart to represent the
ow from one activity to another activity. The activity can be described as an operation of the system.
The control
ow is drawn from one operation to another. Firstly, the application will be started. The user can select the architectural plans according to their wish.

Sources	Similarity
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Based on the pixel's regions, their numerical value in range of either 0 or 1 is being given to next process for modules. 2) Scan Single Gesture A gesture scanner will be available in front of the end user where the user will have to do a hand gesture. Grounded on Pre- https://www.ijraset.com/best-journal/text-to-speech-and-language-conversion-in-hindi-and-english-using-cnn/	
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Chapter 5
PROJECT PLAN
A project plan is a formal document designed to guide the control and execution of a project. The following chap-
ter contains necessary points to be considered for the project plan.
5.1 Project Estimate
The project estimate is prior calculation of the cost, resources and other needs. The estimated cost include the cost of hosting the servers which can be range from INR 2000 - INR 5,000 based on the providers and the type of service used.
5.1.1 Reconciled Estimates
The budget of project is calculation or estimation of all the eorts and costs required to implement the project. The basic CoCoMo model was used in Organic mode as the project is small and doesn't have too many complex budgeting factors. The basic CoCoMo equa-
tions are:-
E = ab(KLOC)(bb) (5.1)
D = cb(E)(db) (5.2)
SS =
E
D
(5.3)
Estimated size of the project = 5 KLOC
So, using equations 5.1 5.2, we get
E = 2.4(5)1:05 = 13:01PM
D = 2.5(13.01)0:38 = 6:63M
SS = 13.01/6.63 = 1.96P
Here, E is Eort (measured in Person Months),
D is Deployment Time (measured in Months)
SS is Sta Size (units is Persons)
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Hence, Total Eort required is 13 person months(approx.) yielding a Development Time of 6.63 months and a Sta Size of 2 persons.
As, the team size is 4 persons, the development time of 6.63 months can be speeded up and calculated as follows:
Person D
2 1/6.63
4 1/x
So, x = 2 6.63/4 = 3.3
Hence, the project will require 3 month (approx.) to complete (theoretically).
5.2 Risk Management
Risk management is dened as the process of identifying, assessing and controlling threats to a project. It is the responsibility of project manager to go through potential threats. The project manager can identify the risks and accordingly control them with the help of other stake holders.

5.2.1 Risk Identication
The risks identied in the project are very few because of high cohesiveness and low coupling involved. Also, open-source technologies are used throughout and no external APIs are used which makes the project self-dependent and hence the probability of error is less.
5.2.2 Risk Analysis
Risk analysis is handling the system response in the risk conditions which are identied. Risk analysis can aect on project objectives which can work incorrectly
in the risk cases. The risk analysis assigns the severity to the risks and developers start working accordingly.
1. High severity: Catastrophic
2. Medium severity: Critical
3. Low severity: Marginal
5.2.3 Overview of Risk Mitigation, Monitoring, Management
There are few risks which were encountered while developing the project, these risk have low probability but high impact. The risks are described
in the tables 5.1 and 5.2 and are self-explanatory.
5.3 Project Schedule
The project schedule is a set of activities which covers the development of all functionalities in the project. It comes with the start and end date of each and every activity. The
19
Table 5.1: Risk 1
Risk ID 1
Risk Description application Crash
Category Technical
Source code
Probability Low
Impact High
Strategy Wait for a while
Risk status Not Occured
Table 5.2: Risk 2
Risk ID 2
Risk Description Inappropriate key-point
Category Technical
Source dataset
Probability Low
Impact High
Strategy Re-evaluation of Model
Risk status Occured
project schedule includes every single detail of the project, such as who will be completing each task, the deliverables that will be produced, the goals and objectives the project will achieve and the amount of time it will take to complete the project.
5.3.1 Project Task Set
1. To provide an ecient and accurate way to convert sign language into text or voice.
(a) To take video as input from the user's camera.
(b) To process the input video.
2. To generate dataset related to gestures for further synthesis.
(a) To create a database for the newly generated outputs.
(b) To store the text/voice message generated from the given input video to the database.
3. To train a pre-trained CNN model for gesture recognition.
(a) To train Stage-I and Stage-II CNN for generation of text or voice message about gestures from input video.
(b) Training Stage-I CNN will recognize the gesture in the given input video.
(c) Stage-II CNN will predict given gesture and display output text or voice message.
4. To develop proper and user friendly UI, for
uent user experience for getting desired result from the model.
(a) To develop a UI for user to give video input and convert sign language into text or voice.
(b) To learn and Understand Client Side scripting.
20
5.3.2 Timeline Chart
Figure 5.1: Schedule of Project Work
The schedule is shown is shown in Fig. 5.1.
5.4 Team Organization
According to Savitribai Phule Pune University rules, the team was supposed to be of 3 students from Final year of Computer Engineering. The team was formed in June 2021.
5.4.1 Team Structure
• Project Guide : Prof. Ms. S. B. Borhade

• Project Preparation and Planning :Mr. Suraj Adsul, Mr. Amit Dighe, Mr. Saurabh Wankhede
• Front-End : Mr. Suraj Adsul, Mr. Amit Dighe, Mr. Saurabh Wankhede
• Back-End : Mr. Suraj Adsul, Mr. Amit Dighe, Mr. Saurabh Wankhede
All the members contributed equally in the project and all the tasks received appropriate attention from all the members starting from designing, implementation and testing.
In this chapter, we took a glance at the project plan including project estimates along with Risk Management steps. In the next chapter, we will take a look at the implementation of the project and the tools used in making the system.
5.4.2 Management, Reporting and Communication
Regular online meetings are coducted with guide time to time to improve the areas of implementation. also the team member communicate with each other via
21
google meet to implement the project and share the work and knowledge with each other.

Sources	Similarity
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Chapter 6
PROJECT IMPLEMENTATION
In this chapter, we will see the details regarding the project implementation. We will take a look at the tools and technologies used, algorithm for the project.
6.1 Overview of Project Modules
With this application the person will quickly adapt various gestures and their meaning as per ASL standards. They can quickly learn what alphabet is assigned to which gesture. Add-on to this custom gesture facility is also provided along with sentence formation. A user need not be a literate person if they know the action of the gesture, they can quickly form a gesture and appropriate assigned character will be shown on the screen.
Concerning to the implementation, we used TensorFlow framework, with the keras API. And for the user feasibility complete front{end is designed using PyQT5. Appropriate user-friendly messages are prompted as per the user actions along with what gesture means which character window. Additionally, an export to le module is also provided with TTS (Text-To-Speech) assistance meaning whatever the sentence was formed a user will be able to listen to it and then quickly export along with observing what gesture he/she made during the sentence formation.
Our strategy involves implementing such an application which detects pre{dened sign language through hand gestures. For the detection of the movement of gestures, we would be using basic level of hardware components like cameras and interfacings. Our application would be a comprehensive User{friendly Based system built on PyQt5 module...
Instead of using technology like gloves or kinect, we are trying to solve like these problems using state of the art computer vision and machine learning algorithms.
6.2 Tools and Technologies Used
1. Pandas and Numpy:
Pandas is a high-level data manipulation tool. It is built on the Numpy package and the key data structures are called the DataFrames. which allow you to store and manipulate tabular data in rows of observations and columns of variables. Numpy is Python package which stand for "Numerical Python". It is the core library for scientic computing, which contains a powerful n-dimensional array object, provide
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tools for integrating C, C+ etc. It is very very useful in linear algebra, random number capability etc.
2. TensorFlow - Keras:
TensorFlow is a free and open-source software library for data flow and differential programming across a range of tasks. It is a symbolic math library, and
also can be used for machine learning applications such as a neural network. It is used for both research and production at Google. It lets uers build and train ML models easily using intutive high-level APIs like Keras. Keras is an open-source neural-network library written in Python, It is very capable of running on top of Tensorflow,

Microsoft Coginitive Toolkit, R, Theano, or PlaidML. It foucus on being user-friendly, modular, and extensible. Keras contains numerous implementation of commonly used neural-network building blocks such as layers, objectives, activation functions, optimizers, and a host of tools to make working with image and text data easier to simplify the coding necessary for writting deep neural code. In addtion to standard neural network, Keras has support for covolutional and recurrent neural networks. It also support other common utility layers like dropout, batch normailization, and pooling. It also allows use of distributed training of deep-learning models on clusters of Graphics processing units and tensor processing units principally in conjunction with CUDA

3. Open-CV:

OpenCV is a cross-platform library used for developing real-time computer vision application. It mainly focuses on image processing, video capture and analysis including various new age features like face detection and object detection.

6.3 Algorithm Details

Deep learning:

There have always been several advancements in technology and lots of research has been done which help the people who are deaf and dumb. Aiding the causes for Deep learning and computer vision can be used to make an impact on such a cause.

This can be pf great help for deaf and dumb people for communicating with others as knowing sign language is not something that is common to all, moreover, this can be extended to creating automatic editors, where the person can easily write by just their hand gestures. In this sign language recognition project, we have created a sign detector, which detects numbers from 1 to 10 that can very very easily be extended to cover a vast multitude of other signs and hand gestures and can also include the alphabets.

We have developed this project using OpenCV and Keras modules of python.

6.3.1 CNN

Neural networks, as its name suggests, is a machine learning technique which is modeled after the brain structure. It comprises of a network of learning units called neurons. These neurons learn how to convert input signals (e.g. picture of a cat) into corresponding output signals (e.g. the label \cat"), forming the basis of automated recognition.

A convolutional neural network (CNN, or ConvNet) is a type of feed¬forward articial neural network in which the connectivity pattern between its neurons is inspired by the organization of the animal visual cortex

CNNs have repetitive blocks of neurons that are applied across space (for images) or time (for audio signals etc). For images, these blocks of neurons can be interpreted as

2D convolutional kernels, repeatedly applies over each part of image. For speech, they can be seen as a 1D convolutonal kernels applied across time windows. At training time, the weights for these repeated blocks are 'shared', i.e. the weight gradients learned over various image patches are averaged

As you can see, like every other CNN our model consists of couple of Conv2D and MaxPooling layers followed by some fully connected layers .

The rst Conv2D (Convolutional) layer takes input image of shape (28,28,1). The last fully connected layer gives us output as expected in dataset.

We are also using Dropout aftr 2nd Conv2D layer to regularize the training.

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www.arshad-kazi.com › sign-language-recognitionSign Language Recognition Using CNN and OpenCV | Journey of ... We will use MNIST (Modified National Institute of Standards and Technology)dataset. You can download the dataset here. Basically, our dataset consists of many images of 24 (except J and Z) American Sign Language alphabets. Each image has size 28×28 pixel which means total 784 pixels per image. See full list on arshad-kazi.com We will use CNN (Convolutional Neural Network) to recognise the alphabets. We are going to use keras. Here’s our model: As you can observe, like any other CNN our model consists of couple of Conv2D and MaxPooling layers followed by some fully connected layers (Dense). The first Conv2D (Convolutional) layer takes input image of shape (28,28,1). The ... See full list on arshad-kazi.com Create a Window. We have to create a window to take the input from our webcam. The image which we are taking as an input should be 28×28 grayscale image. Because we trained our model on 28×28 size image. To create the window Prediction Now we have to predict the alphabet from the input image. Our model will give outputs as integers rather than alphabets that’s because the labels are given as integers (1 for A, 2 for B, 3 for C and so on..) Our model’s accuracy is 94%so it should recognise alphabets without any problem with plain background and descent lights. Done! The entire project is available at: https://github.com/Arshad221b/Sign-Language-Recognition- See full list on arshad-kazi.com https://www.arshad-kazi.com/sign-language-recognition-using-cnn-and-opencv//	2%

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