Report- Suhas Meda and team

by Suhas Meda And Team

Submission date: 14-Jun-2021 01:54PM (UTC+0530)
Submission ID: 1606176877
File name: e_Based_Communication_System_for_Speech_and_Hearing_Impaired.pdf (7.33M)
Word count: 11469
Character count: 53271

Introduction

1.1 Text Summarization

All over the world there are 466 million people who have hearing impairment loss. Which is more then 6 % of people world's population. According to WHO (World Health Organization) there are 34 million of teenagers are suffering from this. According to the study and statistic they predict that it will surpass 900 million by the year 2050.

This hearing loss mostly affect the people who have low and middle income. Which is almost half of the worlds population in order to communicate with people they can use Sign Language which allows the deaf and dumb people to communicate with rest of the worlds and each other.

According to the general survey conducted in India there are 3 millions of people in India itself who are categorized as hearing and speech impaired. Because of this there is a large communication gap that is faced by the speech and hearing impairment community with the normal people and vice versa, and this is increasing day by day. The people who are deaf/ mute are taught Sign Language from a very young age to overcome this barrier. But this concept is not applicable for normal people because we are not taught Sign Language thorough out our School or College days. Government should add Sign Language in the course of the student so that they can learn the concept at the early age of there life so that they can overcome this barrier. Sign Language is the only way to communicate with the members of the world and the other member of the community. In the same community there is no problem because they learn the sign at there very early days of there life so they can communicate with each other. The problem is when they have to communicate with the other people of the world and vice versa.

But we can learn the Sign Language at any age but lost of people don't take interest in learning the Sign Language. Very few people in India or world take interest in learning the sign language. So many small percentage of the normal people can understand and can gesture the sign language back to them. So it is very difficult to find an interpreter who can help us to translate the sign front and back to both the community.

There are almost 135 different Sign Language available around the world. Few of the Sign Language which include American Sign Language (ASL), Australian Sign Language (Auslan) and British Sign Language (BSL)etc. From this different Sign Language only ASL has become the most use sign language through out the world. Since this Sign Language have reached the wider range of public. That's why it act as the primary Sign Language of the Deaf people in the United State (US) and most of the other countries in the world (few of the countries are Canada, west Africa etc).

People with hearing impairment always left behind in all find of social activity, online courses, office session or school. The only way they can communicate, is by texting with the other people. So to achieve a uniform Sign Language translator or converter machine or app is very difficult. We have two method which is commonly used to address this types of problem. Those technique is Sensor based Sign Language and Vision based Sign Language recognition.

For Sensor base SL (Sign Language) they use sensors which is heavy, hard to find and super expensive. The few sensor base Sign Language use Robotic arm with Smart gloves, golden gloves or watches which are very expensive and we can't expect everyone to have it the given time. And its always difficult to carry such stuff with us all the time because those sensor are very delicate and heavy. If they are scratched or get a little crack it will cost us mots of money to fix it or buy new one. Since it is expensive we can only expect only the reach people to buy it.

Where as Vision-base Sign Language use camera to take the sign and uses Digital Image Processing for translation. This a framework, which is used to utilize the non stop hand gesture base communication. In Vision-Base Sign Language the camera is used to take picture or video. If we set the camera mode to video it will record a video and brake down the video frames by frames to get the proper input and after that they process the data. If its pic they can directly process the data.

Well, Vision-Base Sign Language method are preferred over Gestured-Base sign language because anyone with smartphone (almost all the people around the world have Smartphone) can convert SL (Sign Language) to text/speech. Since everyone have smart phone available with them they can do the translation standing in from of there without any issue. It is completely free of cost because we r not using any extra instrument or sensor to detect the data from both side.

This is more efficient to work with the Sign Language converting program then with other for of path. It will convert the Sign Language to specific text and speech and the text or speech will convert it to Sign Language. Which will help both the party.

1.2 Deep Learning

Deep learning is a part of machine learning, which is offend known as Neural Network which consist of three or more layers. These Neural Networks always attempt to simulate (Make the model Smooth) the behavior of the human brain—albeit far from matching any kind of ability—which allow the model to "learn" from large amounts of unprocessed data. Where a neural network with single form of layer can still make the prediction approximately,by additional hidden layers which can help to optimize the model and refine the data for accuracy.

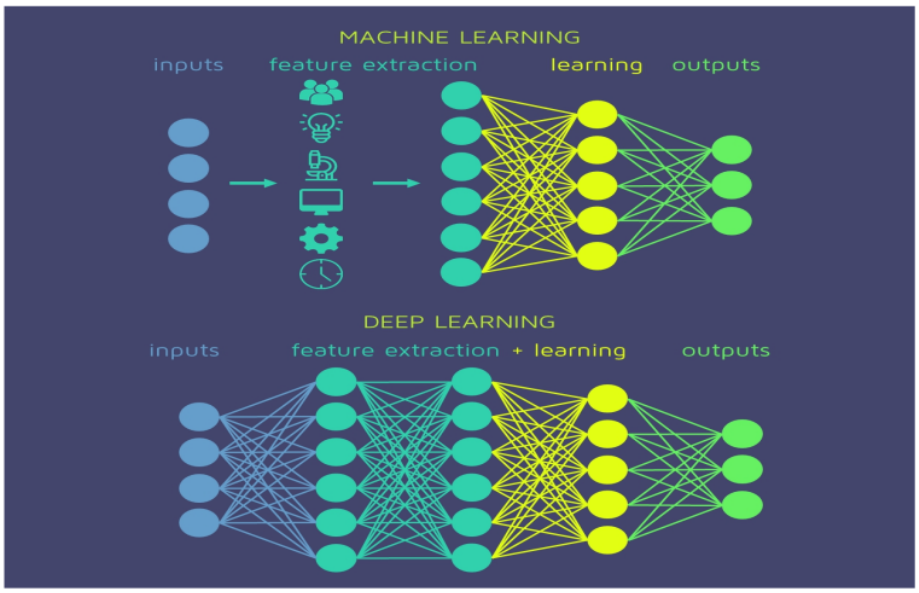

Fig: Machine and Deep Learning

Deep learning help us to work with many AI (Artificial Intelligence) applications. And lots of services as well which can improve automation, performing analytical and physical tasks and without and human help or human intervention. Deep learning technology are used in everyday activities, this products and services (such as digital assistants, voice-enabled devices, fraud detection, TV remotes with voice enabled, and credit card) as well as developing or growing technologies such as self-driving cars uses Deep Learning. Without Deep learning self-driving cars cant exist only. So Deep Learning is called the back bone of AI.

Deep learning is helped by neural networks, or artificial neural networks, attempts to give us the complete replica of human brain like how we think and all .Like the human brain they also tries to through a combination of data inputs, weights, and bias but they are efficient and can work more faster and any other human being . when this all set of elements come together and start work together on it they find accurately recognize, classify, and describe objects inside the given set of the data.

Deep neural networks have multiple layer. Which can help us in many level of the model to work on. They have multiple stages of interconnected nodes. Where each one of those building upon the previous layer so that the error can be fixed or minimized. So that they can help us to give a refine and optimize the prediction (the model is accurate if the predicted value is more closer to the accurate value)or categorization(where different set of data form).

There is a turn called forward propagation. Forward propagation help us throughout the network of Neural network . from the input and output layers of a model we can use deep neural network which is called *visible* layers. The input layer is the one where we give the model values to work on. Where as the deep learning model ingests the data for processing (one the data is processed we stored them for feature use to train the model, and the output layer is the one where the result or we can also say the final prediction or output is shown or classification of the model is made.

Another process called back propagation. Back propagation is kind of like a flow. Where we uses algorithms, like gradient descent which help us to calculate errors in the model or the prediction of the model and if the model is not accurate then they try to adjusts the weights and biases of the function so that the model work more effectively of can give batter result out of the model. By moving backwards through the layers step by step we can find the error more quickly and more accurately. In an effort to train the model we have to do back tracing for many iteration or test cases. Because for some cases it might give accurate result but for few of them it will give completely different answer.

Both forward propagation and back propagation together allow us or the neural network to make predictions. This prediction is done for the model if it is not accurate. It detect the error and correct the errors accordingly. Over time, the algorithm becomes gradually more accurate. Because we store all the test cases and all the data which give a proper output help us to give the model more train values. If train values is more obviously the model will predict the output accurately. More the test case more accurate the model is.

The above information about the Deep Learning and Neural Network is just a small part of there feature there and many more feature that can help us to work in this two algorithm. Deep Learning algorithm is extremely complex and there are difference approach for different models. They are many types of Neural Network which are specifically address to the specific problem or datasets provided.

1.2.1 TensorFlow

TensorFlow is a machine learning end to end open source platform in which its libraries are used for processing images and to test and train our model. We have used TensorFlow software library/framework python module to perform computations for algebra and to optimize the techniques used by us to allow easier calculation of the mathematical expressions used in our work.

We have used TensorFlow framework and libraries in our project to classify the labeled images and also process them before matching those images to the registered database of signs.

1.2.2 Object Detection

Object detection is a special method making use of computer vision and image processing techniques to detect instances of semantic objects of particular class in either digital images or videos. In our project , we have used object detection to detect the sign created by the hand in front of the camera in real time and provide the appropriate label for it after matching it with the taken database.

To perform object detection , we make use of a hand detection module by defining a region of interest on the screen in which the user must place his hand in for the image processing by TensorFlow to happen without any problems.We also set a specific distance between the object(detected using an object detection API) and the camera in our program.Hence if we were to place the hand within this distance , it will give more accurate results.

1.2.3 Labeling

Labelling is a part of giving a product or a item name. To display a product we use labeling or in simple word giving name. A label contains valuable info (information) about a product or a item on its container, packaging, or the product itself. We can label and item in this word. Label contains name of the item or a threat like danger sign.

For e.g. in some products like chocolate or any food item, if it is written that the products contain traces of any particular nuts that means the person allergic to nuts should avid eating it. It help the consumer to choose what to pick or what not to. This will help people to avoid mistakes without knowing what is the ingredient involve in the product, they are not going to purchase. This can safe lots of peoples life.

Labeling is always has been the most important and valuable part of product and the company. Sometime if good ingredient or good quality product are used in items(foods,cloth etc.) people tend to buy those. This means it increase the selling part of the product as well.

To Label and Image in Computer Vision there are different types:

- Label Every Object of Interest in Every Image
- Label the Entirety of an Object
- Label Occluded Objects
- Create Tight Bounding Boxes
- Create Specific Label Names
- Maintain Clear Labeling Instructions
- Use These Labeling Tools

Advantages of Labelling and Image:

- Product identification
- Product description
- Makes product companion easy
- Makes product Grading Easy

1.3 Real World-Application

This project will help the community to overcome the communication barrio between deaf/dump people. This help us to convert the sign language to text and vice versa so that we can communicate with them fluently. This doesn't require any external hardware component so its chipper and more efficient because its real time based project.

Develop sign language application for the hearing impaired, sign language can be very important, as they can easily communicate with those who do not understand. Our project is for normal, deaf or dumb people using sign language. It aims to take the basic step towards closing the communication gap.

Sign language is a method to communication primarily with the people around. Sign Language is used by the hearing impaired and mute persons. This method proposed that all the letters and words should be expressed by hand gestures. We can convert multiple letters in a meaning full sequence of sentence. Sometime a word is enough to convey any message.

1.4 Organization of the Project Report

The report of the project is organized as given below:

In Chapter(2), we discuss about the problem statement and our solution to the problem. The same chapter also deals with the other existing technology. The Chapter that follows i.e. Chapter(3) consists of the details on the literature survey of the papers to the problem statement and the proposed solution. In Chapter(4), we present the System Outline and others system in the form of Data flow diagram and the sequence diagram. The next chapter, Chapter(5) gives the requirements and detains about the implementation of the proposed system. Chapter(6) deals with the testing of the product and their desired results. In Chapter(7), we discuss about the influencing parameters and their effect on the system. The same chapter deals with establishing the optimal parameters for the system. The Chapter(8) concludes the paper along with mention of the Future Enhancements. Chapter(9) is details about the references made during the development of the system. The other supporting information and the source code are gathered in the Appendix.

Problem Statement and Proposed Solution

2.1 Problem Statement

In order to let deaf/mute people to communicate between themselves or with other people at low cost and use simple hardware, we have created this simple yet efficient sign language to speech translator and vice versa.

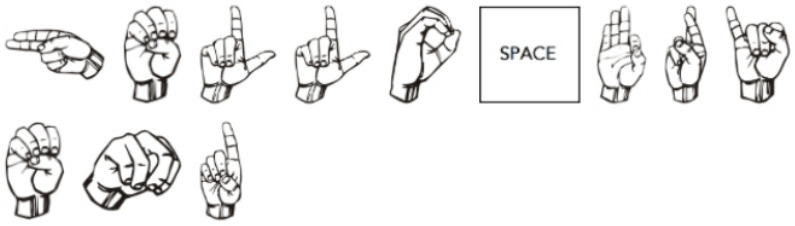

Fig: Problem Diagram

2.2 Proposed Solution

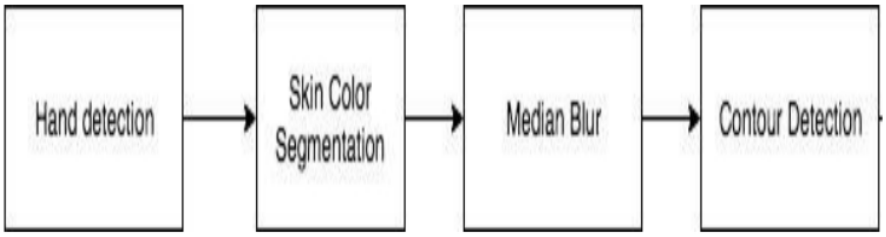

Fig: Proposed Diagram

Hand Detection

It is done by setting a region of interest means the focus on the screen in which the user or the person using want to give the hand gesture must place its hand on the screen. Once the hand is detected it will help us to take the picture for image labeling process.

It detect the hand in motion as well so we have to be careful while moving the hand if the picture capture is blur then that picture is more likely of no use but still we can use in the labeling format because it will remove those noise from the pic.

Skin Color Segmentation

We need to define the skin tone of in the range, where color of the skin in hue, saturation, lightnes (HSV) format so that skin color is recognized and the segmentation can be performed on the same. We need to create a script so that we can extracts that meaning full sets of the hand histogram for our use.

This really help if the picture taken directly below the sun. Then the entire hand will be white and the background will also be while and vice versa in dark. This will create a vast difference while training and testing the model. So we have to click picture in focus of the hand

Median Blur

In this process we convert the hand gesture into a pic and then getting the hand histogram, we extrapolate the hand that means all the rest of the image is not regured. In technical turn it is called a noise. The part which is consider as noise is filled with dark spots within and blur the image. Which is give us only the hand gesture and rest all is blued out. This is done using median blur.

This reduces the unwanted data or as we say the noise from the image up to a great extent. That means all the other stuff in the background are removed. Only concentrating on the hand so that the model is more accurate. Its done using image labeling

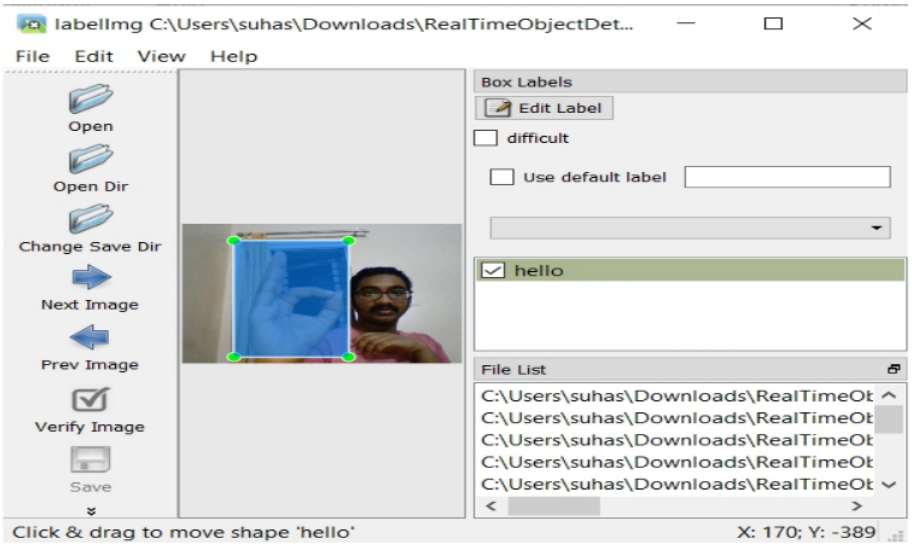

Fig: Labeling Image

Contour Detection

The next step will help us to process is contour detection. This is the one where the file without the noise will be stored. We find the contours in the image using the 'find Contours' function of OpenCV. This help us to get the real info about the hand. This will find the contour area where the maximum area of the hand is displayed and the sign is captured.

This is represent by the xml file which help us to see all the related data from the image which is important for our sign Detection.

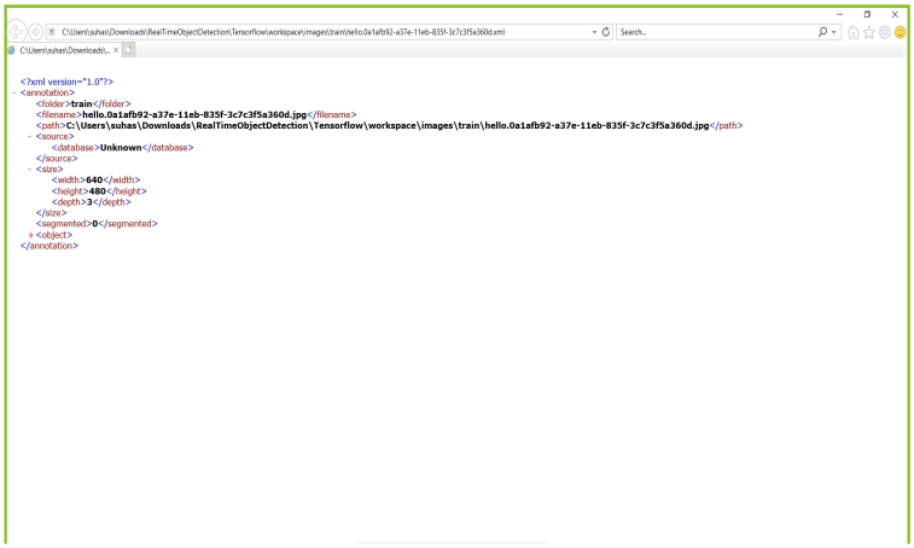

Fig: XML file

This is this for one picture. While labeling there will be same amount of XML file as the image. Because we convert each and every image into a XML file which includes all the main info about the image.

That means it clear up the entire noise stuff from the image and only focus on the hand. It remove all the background image or we can say they it blur the background so that we get the proper image of the hand to detect the model accurately.

This detect the hand of the picture and create a XML file in such a way that all the fingers are visible. The file have the details of the weigh and height of the teamed image. So that we can refer to those and train the model more accurately.

2.3 System Requirements

Webcam

Flex 14-IWL

CMOS camera

Packages Installed

TensorFlow

TensorFlow is a machine learning end to end open source platform where its libraries are used for processing images and to test and train the model.

Object Detection

Its API is used to detect the signs made from the webcam and provide a label for its conversion to human language.

pyttsx3

This is a library which help us to convert text to speech. Unlike alternative library it works in both online and offline mode. It works in both python2 as well as python3.

Win32api

This is only have to be installed when we find a error when we install pyttsx3. If not then no need of installing this package. The errors which will show up are:

No module name win32com.client

No module name win32

No module name win23api

That's when we have to install this extra package if not then we are good to go

Pandas

We have used the Panda library in our python script to perform real world data analysis of the created objects in Python language.We have also used it for importing JSON files into our program.It is also used in cleaning the datasets which are used to train our model.

Cython

The Cython language makes writing C extensions for the Python language as easy as Python itself. Cython is a source code translator based on Pyrex, but supports more cutting edge functionality and optimizations.

Hence we use cython to convert all c++ code into python code.This makes Cython the ideal language for writing glue code for external C/C++ libraries which we used, and for fast C modules that speed up the execution of Python code.

Numpy

NumPy can be used as an efficient multi-dimensional container of generic data. Arbitrary data-types can also be defined. This allows NumPy to seamlessly and speedily integrate with a wide variety of databases for our proposed work.

It provides a powerful N-dimensional array object sophisticated (broadcasting) functions tools for integrating C/C++ code useful linear algebra, Fourier transform, and random number capabilities,etc.

pycocotools (COCO)

COCO provides multi-object labeling, segmentation mask annotations, image captioning, key-point detection and panoptic segmentation annotations with a total of 81 categories, making it a very versatile and multi-purpose dataset.

This is used in our proposed work to for image detection,labelling and matching with our database hence performing the core functions of the project.

LITERATURE SURVEY

3.1 Text Summarization

3.1.1 Title: A Mobile Application of ASL (American Sign Language) Translation via Image Processing Algorithms

Year: 2016

Author Name: Mohamed Hisham Jaward,Cheok Ming Jin, Zaid Omar

In this paper they proposed a portable software implementation of SL (sign language) recognition on a smartphone platform. Without a smartphone this paper will not be able to display any output. Here Canny edge detection and region growing technique are used. They help us to segment the hand gesture from the background. This means removing all the unwanted info from the background. The image which is captured by the camera. The quality of the camera also should be good enough to distinguish the background from the hand . The SURF descriptors are then extracted from segmented hand gesture. If the hand is only not visible properly we cant work with this model. They used algorithm which are then clustered forming 16 classes by K-means clustering. K-mean clustering work for only a particular range of datasets only. So they have to b little care full while choosing the data. To train the model. A BoF model is employed to create a visual vocabulary. This package is from the cluster centrists. The most important thing is , SVM is applied to classify the SL (sign languages). or we can say classify the image or sign. The recognized SL (sign language) may then they translated the image into text. Once that part is done then they have to work on the speech part of an output. Once the mobile phone or the smartphone app created. They have to test it before publishing the app. For varous test cases. Their proposed framework uses 16 classes. That means they have divided the model into 16 different subclass so that it will help them while testing the model. Those 16 class ASL alphabet which has an accuracy of 97.13%. this is quite a high percentage for a model.that means the model is trained successfully. However, it is seen that the test images they are taking for the model, that were captured and used, were under generally and similar illumination. That means with background noises such as cars and traffic birds etc. By looking at the background conditions they trained the model accurately. This might change the quality of the results. Because the background noise can effect the model inn different ways. So that the model doesn't decrease by a certain degree they rained the model with those test cases as well if the background and illumination condition is changed still the project will work. However, visually distinctive SL (sign language) hand gestures usually tend to have more efficiency a higher accuracy.

Advantage:

- A BoF model is employed to create a visual vocabulary from the cluster centroids and lastly, SVM is applied to classify the sign languages.
- The recognized sign language may then be translated into text and then to speech in the form of an output on the smartphone app created.
- Their proposed set of framework uses only 16 classes of ASL (American Sign Language) alphabet. Which has an quite a good accuracy. The accuracy goes up to 97.13%. [SVM algorithm]

Disadvantage:

- Uses SURF technology to get an accuracy is old n out-dated 87.13%

3.1.2 Title: Glove Based Hand Gesture Recognition Sign Language Translator Using Capacitive Touch Sensor

Yeah: 2016

Author Name: Lee Chun Fai Qubeley, and Derek Ho,Kalpattu S. Abhishek

In this paper they proposed a hand gesture recognition using a glove. This glove is based on charge-transfer. The glove also have touch sensors for the translation of American Sign Language (ASL). This glove will give accurate result because of the sensors. The device was designed to be portable and uses in any low-cost and simple hardware base system. The gloves use a binary detection system. Because of this the input is consists of a set of digital touch sensors. Where few of the gloves have passed analog signals from the variable register. This allows achiest of better recognition accuracy.

The hand gestures cause capacities touch. The sensor which is moved will be selectively actively. The combination of these activated sensors will give a accurate movement of the fingers and then interpreted as characters. Once that is done the further made into words. Once all words are captured it will will combine into a meaning full sentences.

The proposed work implements that they have used 26 alphabets and 10 digits. The recognition of all 26 English alphabets from A-Z and 10 digits from 1-10 is converted into ASL. Each of the 8 touch sensors in the glove are implemented using the PIC-116 are capacities sensor based module. The advantage of using combinations of binary sensor signals is that it is unambiguous. However, there is a trade off made to increase the sensitivity of the glove at the cost of its response time. The proposed work uses a Raspberry Pi embedded model or system to recognize and translate the hand gestures is converted into sound and the accuracy achieved by the proposed work is 92%.

Advantage:

- The proposed work implements the recognition of all 26 English alphabets A-Z and 10 digits 1-10 into ASL.
- Each of the 8 touch sensors in the glove are implemented using the PIC-116 are capacities sensor base module.
- The advantage of using combinations of binary sensor signals is that it is unambiguous. [PIC-116 capacitive sensor module]

Disadvantage:

- Uses Raspberry pi embedded system with complex of connection and sencers which makes it costly n heavy.

3.1.3 Title: Software Based Sign Language Converter

Yeah: 2016

Author Name: Himadri Halder, Rajkumar Koradiya, and Karthik Raj V,Keerthi S Warrier, JyateenKumar Sahu

In this paper they proposed to create a sign language converter using the software Lab VIEW, which is a graphical designing platform. Since it is a software base it will give accurate result. That user blocks instead of codes the model become more accurate. Hence the interface of a smartphone or any other hardware is build in such a way that it work in real-time. Becomes of real-time it makes the model much easier to test. The image acquisition of the proposed work is done. It is done using Vision Acquisition Express VI. In this gestures are captured using a webcam or camera. The obtained images are then processed using Vision-Assistant-Express VI. This works fine with the model which is stored .Various different templates of sign language are used. Fro ex numbers (0 to 10) were made. They maid there gesture one after the other and used for geometric matching. Once the geometric match is done we send to recognize the geometric pattern. The will compare the patter with the data sets and give back the matching percentage. And thus, audio and visual outputs were generated accordingly to the hand gesture in real-time. The proposed work provides the users, advantage of portability. Since they are using smartphone cameras. The cameras and phone are connected through Wi-Fi to the host or the user computer and works well even in dim light which is considered as a huge problem in similar works. However, the proposed work could have used the 'Particle classification' algorithm in LabVIEW which allows the programmer to show various sign with there hand. The gestures under a class. The particular defined symbol which would have made the proposed work more efficient and easier to use. This process removes the requirement of a translator to be used by a normal human and the person with hearing impairment.

Advantage:

- [LabVIEWMicrosoft Speech SDK] Various different templates of sign language are used. Fro ex numbers (0 to 10) were made. They maid there gesture one after the other and used for geometric matching. They used geometric matching to recognize or compare the geometric pattern. And after that convert to audio and visual outputs were generated. Accordingly to the hand gesture in real-time.
- The proposed work provides users, the advantage of portability. As they are using smartphone cameras which can be connected through any Wi-Fi

Disadvantage:

- Vision-Acquisition-Express VI and Vision-Assistant-Express VI are out-dated

3.1.4 Title: Sign Language Recognition

Yeah: 2007

Author Name: Mansour Vafadoost, Majid Shahnazi,Maryam Pahlevanzadeh

In this paper they proposed an image processing algorithm. Which is used for the interpretation of the TSL (Taiwanese Sign Language), which is considered as one of the prominent Sign Languages (SL) used by the majority of the deaf or mute people. The proposed work involves 2 layers of classifications.

The first being Coarse Classification. Which classifies the image obtained according to detection of hand motion. They also tracking down the hand location. Which help to capture the hand when it is moving.

The second classification is Hand Shape Recognition of key frames and key frame selection. Motion history image along with Fourier descriptors are both used for motion direction and key-frame selection recognition respectively. Generic Cosine Descriptor (GCD) feature is used for the extraction of hand postures. Generic cosine descriptor remains constant to scale, translation and rotation of hand shapes.

The proposed work tests 15 different hand gestures. From that different hand gesture there are 10 people. And the results showed that the proposed work could achieve its full potential that is 100% recognition is done for the test persons. Which is very efficient. The hand motion is detected and classified into 4 groups: Up Down/Down Up/Left Right/Right Left using MHI. However, this work is not widely used as there are problems regarding enlargement of the library which is stored in the models. The extraction of the moving hands from the camera is a very complex method and the frequently interrupt backgrounds.

Advantage:

- [3D Hopfield NN] [GCD hand shape features] Motion history image along with Fourier descriptors are both used for motion direction and key frame selection recognition respectively.
- Generic Cosine Descriptor (GCD) feature is used for extraction of hand postures.
- Generic cosine descriptor remains constant to translation, scale and rotation of hand gesture.

Disadvantage:

- 3D Hopfield NN - 91% accuracy for input recognition
- GCD hand shape features -96% accuracy For input recognition

3.1.5 Title: Real-time Conversion of Sign Language (SL) to Text and Speech

Yeah: 2020

Author Name: Aishwarya Ramesh, Kohsheen Tiku, Jayshree Maloo,Indra R

In this paper they proposed an android application to demonstrate a vision-based approach which removes the need of any hardware like gloves, smart watch, sensors, etc. As proposed by other authors for sign to text and speech conversion.

Color-based hand segmentation has been implemented. Using the required libraries present in the OpenCV tool. Their work uses digital image processing to obtain the images from the video recording of the hand gestures. The technique used for there work is Histogram of Gradients (HOG) descriptors and it is preferred over other techniques. Since using this library the appearance and shape of any local object such as chair,mug,etc, can be easily detected. This help by the means of intensity gradients / edge directions through this technique. The image obtained is then further divided into smaller connected regions called cells, and a histogram of gradient directions is compiled for the pixels. This is done within each cell of the image.

The descriptor is then plated. The concatenation of the histograms depends upon the items captured. For higher accuracy, they use the local histograms. Which are contrast-normalized by measuring the intensity. Intensity variance over a wider area of the image is compared and it is called a block. This block will help to difference the data model. And then using this value from the model to normalize all cells present within a block. This normalization results in always greater in variance. Since the variance is greater the normalization is faster. With shifts in lighting and shadowing the image is captured. The algorithm used in the proposed work is Support Vector Machine (SVM). This is a Machine Learning technique or Algorithm which descriptors as the features of the image by uses HOG method .

Advantage:

- Using the libraries present in OpenCV, Color-based segmentation has been implemented .
- Their work uses digital image processing to obtain the images from the video recording of the hand gestures.
- The technique used for there work is Histogram of Gradients (HOG) [IMU Sensor Fuzzy logic]

Disadvantage:

- IMU Sensor which is used to obtain a low accuracy and its very sensitive

3.1.6 Title: Sign Language to Speech Conversion Using Smart Band and Wearable Computer Technology

Yeah: 2018

Author Name: Abey Abraham , Rohini V

In this paper they proposed the working of a wrist band. This is a hardware bases model again which will give accurate values because of the sensor. Which could convert hand gestures to speech as output. This will enable the mute people to communicate with a normal person or other set of people. The wearable device(smart band) uses electrical impulses. This is generated by movement of fingers to produce signs. The movement of the fingers trigger the nerves to move with the help of the sensor they they predict which finger is move. Each sign depicting a particular word.

The band is a combination with wearable computer aided which used technology that can perform sign to speech. This watch help to conversion using a specific sensor suite. If we compared to the method which exist, the proposed design provides a user-friendly experience. It doesn't store the model so it is said that it does not take any specific parameter from the end user. Hence this making the model more accurate. It a generalized band, which can be worn by any person. This doesn't need to be ware by only grown up it can be worn by children as well.

The biological electrical reading is taking in millivolt units for precise detection. The problem with this work is that type of data is very susceptible. Because of the noise and signal interference. With other signals near it thus hampering the expected result hence lowering the accuracy of the device. The major challenge for this kind of approach is the placement of the EMG. The electrodes, which should be placed in the perfect location. This will help us to read any mount of strong values for EMG. To improve the accuracy they used dry electrodes which would increase the proposed work.

Advantage:

- Uses flex sensors to detect gestures from the glove.
- For finding the difference they uses AverageOfSquaresOfErrors or deviation between the actual values and the expected values.

Disadvantage:

- Uses hardware gloves equipped with heavy sensors that are costly and heavy to carry.
- Also the flex sensors need to detect many needs of the mute person as input to convert gestures to weights for the model.

Architecture And Design

4.1 System Overview

install protoc

In our project we have multiple programs that store and retrieve data over a specific network.However since many programs are accessing the same data , errors may occur if they try to access the data at the same time,etc. To prevent this from happening we make use of the protocol buffer which allows the various programs to communicate with one another hence resolving these issues and preventing the above specified problems. It also designs a structure for the data present in the source code and generates a stream of bytes to represent the structured data.

install cudnn toolkit and cuda

Since our laptop which we used for creation of the project uses the NVIDIA graphics card which is not the most optimum GPU to be used for image processing and training the model with the dataset in default state, we install cuDNN library from the cuDNN toolkit present in the NVIDIA GPU software.This improves the ability of the GPU to process images and reduces a lot of time to train the model as well.Cuda and cuDNN are image processing libraries used to improve the processing power of the GPU.

However if a laptop having Intel processor is used to run this project, then Cuda and cuDNN are not required to be installed since Intel has good enough graphics to process the images.

For our proposed work if we have an NVIDIA graphics card instead of intel, we need to install both Cuda and cudnn toolkit so that the image processing libraries we used are compatible with the graphics card.This allows us to train the machine model at a faster pace as well.

create env: sign_detect

Here we create an environment called sign_detect in the anaconda command prompt and activate it using the command-

>conda activate sign_detect

once we have activated the environment,we install various libraries like -

A. pip install cython:

Cython is a library we have imported and installed for our project.It was imported mainly to convert all out C++ code into python code so that it is compatible with our project.It is also used to speed up the execution of code in python.

B. pip install numpy==1.19.5

We have installed and imported NumPy in our project so that we could define arbitrary data types that we had created.We have also used it so that we can integrate C/C++ code that we have for mathematical computations.

C. pip install pandas

This command is used to install pandas library into our system and we have then imported it into our python program.The main use of pandas in our project is to import JSON file types which we have , into our python script.We also used it to perform real world data analysis of the created objects in Python language and to also clean the datasets to be used for training the model every time.

D. Pip install git +https://github.com/philferriere/cocoapi.git #subdirectory=PythonAPI

This is done to install cocoapi tools from github directly. COCO provides multi-object labeling, segmentation mask annotations, image captioning, key-point detection and panoptic segmentation annotations with a total of 81 categories, making it a very versatile and multi-purpose dataset.

This is used in our proposed work to for image detection,labelling and matching with our database hence performing the core functions of the project.

#conda install -c conda-forge pycocotools (only for linux)

#cd %HOMEPATH%/Downloads/RealTimeObjectDetection/TensorFlow/models/research/

protoc object_detection/protos/*.proto --python_out=.

copy object_detection\packages\tf2\setup.py .

This is done to copy the object_detection\packages\tf2\setup.py folder into the object_detection/protos/*.proto --python_out file to allow the setup installation file for object detection to take place.

install Tensorflow and object detection API

Install the TensorFlow PIP packageL: pip install --ignore-installed --upgrade tensorflow==2.2.0

cd TensorFlow/models/research/ :

cp object_detection/packages/tf2/setup.py .

python -m pip install1 .

These commands are used to install Tensorflow 2.2.0 in our enviornment and download the object detection API in the research folder of RealTimeOject folder and ready the setup file along with installing all necessary python libraries.

python -m pip install . #uses tensorflow 2.5.0 -> (removes earlier tensorflow 2.3.0)

Once we execute the code in our python file to train the system with specified number of steps, we get some lines of code-

Python Tensorflow/models/research/object_detection/model_main_tf2.py --model_dir=Tensorflow/workspace/models/my_ssd_mobnet --pipeline_config_path=Tensorflow/workspace/models/my_ssd_mobnet/pipeline.config --num_train_steps=3000

This code is copied into our command prompt inside our RealTimeObjectDetection to train our model to detect the sign language by using the datasets saved into our train folder. After this is done we can then see the output of our work.

4.2 Software Architecture

4.2.1 System Block Diagram

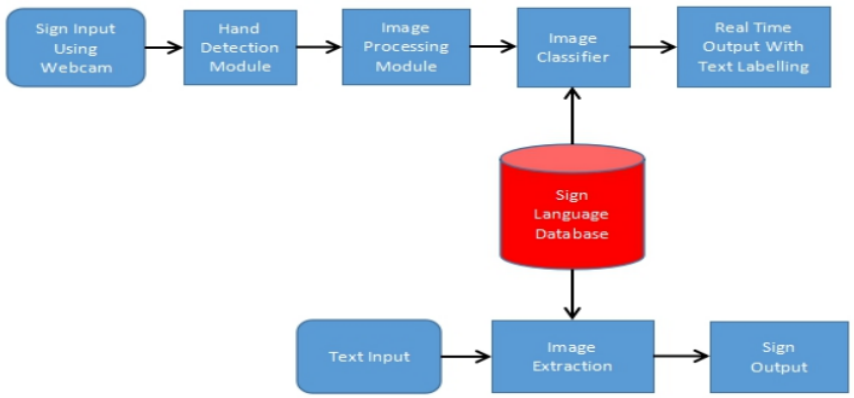

Fig: Block Diagram

Step I:

This help us to take the pic from the webcam so that we can capture all the sign maid by the person. This is the only way for sending any useful form of data to the model. It works with all types of camera which can capture pic in any given time.

Step II:

It is done using defining a region of interest on the screen in which the user must place its hand. Once the hand is detected it will help us to take the picture for image labeling process.It only detect the hand in the frame so that other part of the image is consider as noise.

Step III:

In his we will capture all the related data from the picture which we choose. As the name goes it process the image until we reach our goal. The final image can be in image format or a corresponding feature of the same image. It retain the same data but in most district form. Here it was converted to a XML file which gives all the info about the file.

Step IV:

Once the image is processed then we have to classify the image in two part called as training and testing we have to copy certain amount of image and the XML file to that folder. We have taken almost 80% of the set in the training folder to get more accuracy. And rest of the 20% is placed in the testing folder.

Step V:

This will show the output in real time. It means when we turn on the webcam and as soon as we plash the hand in front of it webcam it starts detecting. And if the sign maid by the hand matches the data set it will show what that sign mean directly

that's what means real time output. As shown below it says thanks: 85% and no: 98% that means the sign is match with that much percentage with the data model available with us. If the percentage is more that means it matches with that sign accurately.

Step VI:

This hold all the data set for the Sign Language to work efficient. All the data set is divide in two folders one for training and one for testing. Training data-set help us to train the model more accurately. More data present in train part it will give batter output. Which means more data for training the model more accurate result we get. So we have split the data set in 80% training. So that we get more accurate result.

Step VII:

It will ask us what text we want to convert it to sign language. Once we enter what we want to say it check in the Data-Base which is more suited for the words which we enter and display us the same picture which matches the words in the entry. We can enter what ever we want in the text input field. What ever we enter it will search for in the DB. Once it matches with the DB we will simply print the picture in the screen so that the other person can read it and understand what we wan to say to them in response. Once we enter sentence or single word and hit Enter button it will check for the info in the data set which is present.

Step VIII:

This will extract the appropriate Sign Language from the Data set which is present. Once the image is extracted from the Data set we just have to display that on the screen. If the image is not present in the Data set it will print that the data which we enter is not present in the DB. If this message pop up we will simply have to give a different set of text which might be giving the same meaning but in different way. That's how we can avoid this message which comes up in the screen.

Step IX:

Once the data set is match with with text which we have written it will pop us the image which is related to that sign. Once it is done its available for us to read the image in view mode. This is how we can convert the text to sign Language which will let the other person see what we what we want to say. Once they see what we want to say in Sign Language then he/she can understand the symbol then they can again show sign to reply back. This process will continue until the conversion is done.

4.2.2 Data Flow Diagram

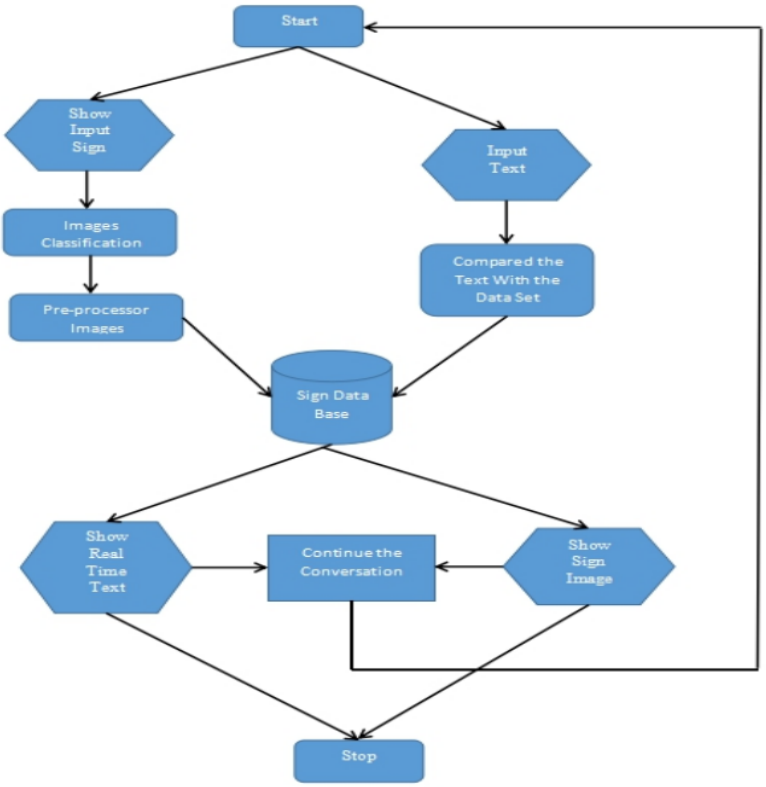

Fig: Flow Diagram

We can start either by showing hand gesture or by typing what we want to convert to sign. Let's consider we start with showing the hand gesture and the web cam will click the pic and match with our data set and it will give us a real time output above the hand with a frame which will show the name of the sign shown and the % which tell us how much it matches the sign in the data base. Once this is done we can understand what the other fellow is trying to say with the help of sign language.

Once we understand what they want to say we can start communicating with them by typing what we want to say in the prompt box and hit enter. It will speak out what we have type and it will help us to verify what we have typed in there. Once it is done it will match the text with the data set which we have stored for the model. So if something is match with the sign present in out set it will display the picture of sign in front of the system. This well help us to convey our message to the other side of the person. Once he/ she show the pic of the sign language, he/she will start showing sign again to continue the consideration. We can stop at any point in between the conversation once it is done.

We can also start the conversation by typing in the bar and it will show the equal representation of the sign. This way we can communicate with each other for any amount of time.

Implementation

5.1 Implementation Platform

5.1.1 Hardware

Graphics Card: NVIDIA

Ram: 8GB

5.1.2 Software

Operating System: Windows (32 & 64 bit)

Software Used: Python, Image Labelling

Programming Language: Python, XML

5.2 Implementation Details

5.2.1 Sign Input Using Webcam

This help us to take the pic from the webcam so that we can capture all the sign maid by the person. This is the only way for sending any useful form of data to the model. It works with all types of camera which can capture pic in any given time.

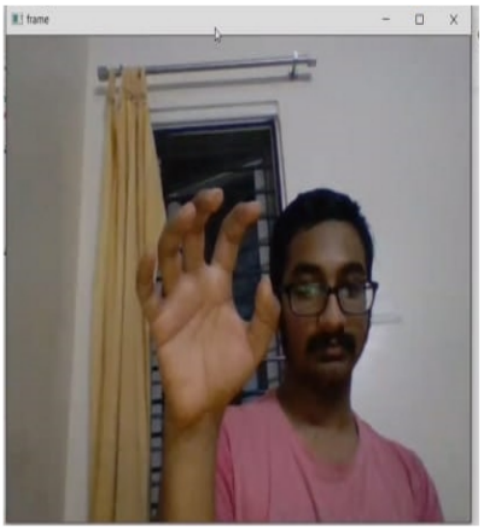

Fig: Image Taken by Webcam

5.2.2 Hand Detection Module

It is done using defining a region of interest on the screen in which the user must place its hand. Once the hand is detected it will help us to take the picture for image labeling process.

It only detect the hand in the frame so that other part of the image is consider as noise. Here noise means unnecessary data such as if the background is full with useless stuff such as chair and other sort of stuff which is not required for our model.

5.2.3 Image Processing Module

In his we will capture all the related data from the picture which we choose. As the name goes it process the image until we reach our goal. The final image can be in image format or a corresponding feature of the same image.

It retain the same data but in most district form. Here it was converted to a XML file which gives all the info about the file

5.2.4 Image Classifier

Once the image is processed then we have to classify the image in two part called as training and testing we have to copy certain amount of image and the XML file to that folder.

We have taken almost 80% of the set in the training folder to get more accuracy. And rest of the 20% is placed in the testing folder.

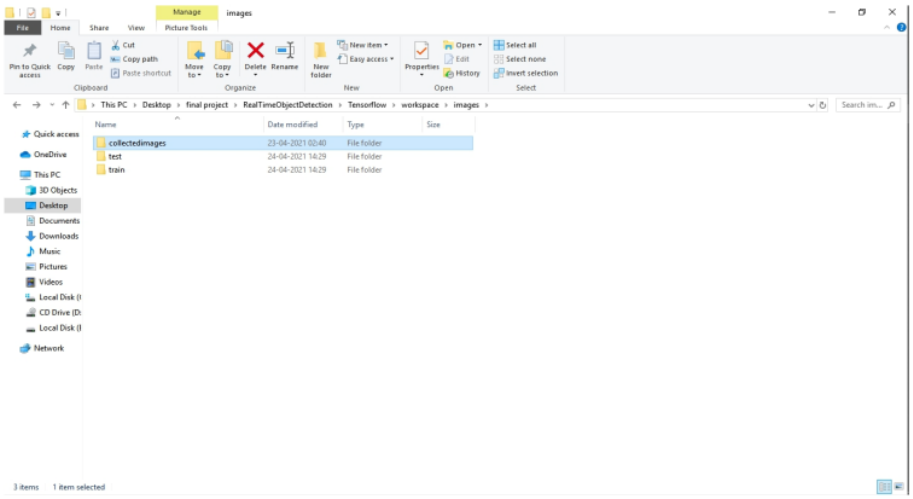

Fig: Training and Testing Folder

5.2.5 Real Time Output With Text Labeling

This will show the output in real time. It means when we turn on the webcam and as soon as we plash the hand in front of it webcam it starts detecting. And if the sign maid by the hand matches the data set it will show what that sign mean directly that's what means real time output.

As shown below it says thanks: 85% and no: 98% that means the sign is match with that much percentage with the data model available with us. If the percentage is more that means it matches with that sign accurately.

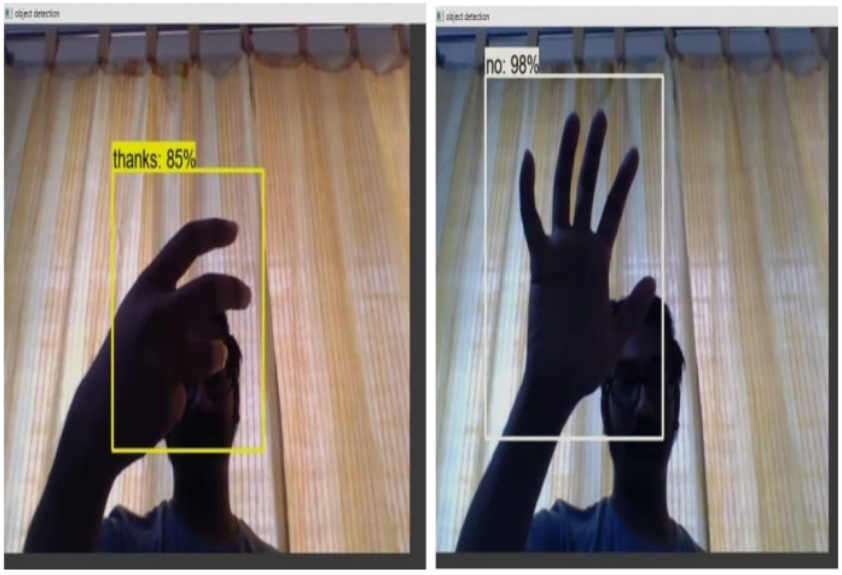

Fig: Real time Output

5.2.6 Sign Language Data-Base

This hold all the data set for the Sign Language to work efficient. All the data set is divide in two folders one for training and one for testing.

Training data-set help us to train the model more accurately. More data present in train part it will give batter output. Which means more data for training the model more accurate result we get. So we have split the data set in 80% training. So that we get more accurate result.

A machine learning (ML) model map on input to a desired output. This is a learnable parameter which keeps on learning when we execute n number of data sets. The optimal parameters are obtained by training the model on data.

Training involves several steps:

- ❖ Getting a batch of data to the model.
- ❖ Asking the model to make a prediction.
- ❖ Comparing that prediction with the "true" value.
- ❖ Deciding how much to change each parameter so the model can make a better prediction in the future for that batch.

A well-trained model will provide an accurate mapping from the input to the desired output.

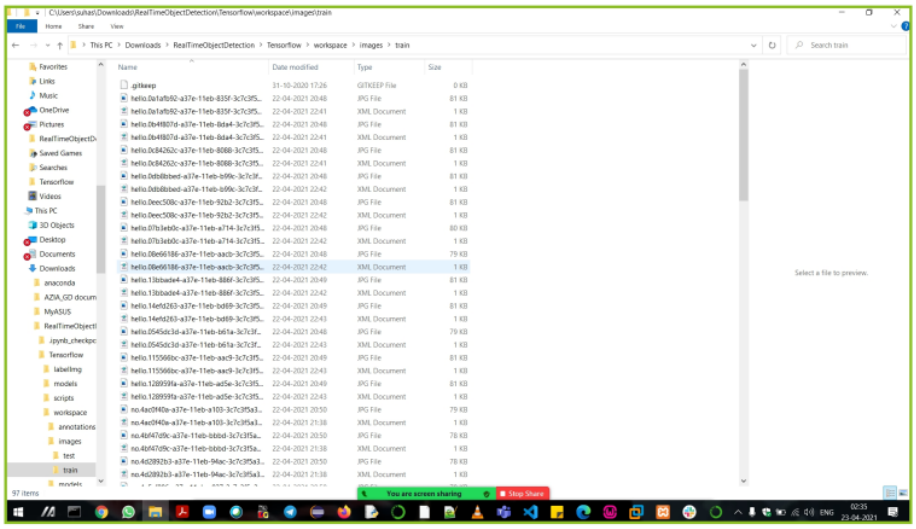

Fig: Training folder for the data set

Testing data-set help us to test the model more accurately. It check what all data set is matching with the input set of data. If the max number of data point matches the test case it will give the output from that test result.

If not it will choose a different set from for the model it always give a accurate result. If the model is giving different output that means the training was not proper. We have to increase the training so that the model is trained properly to give batter output

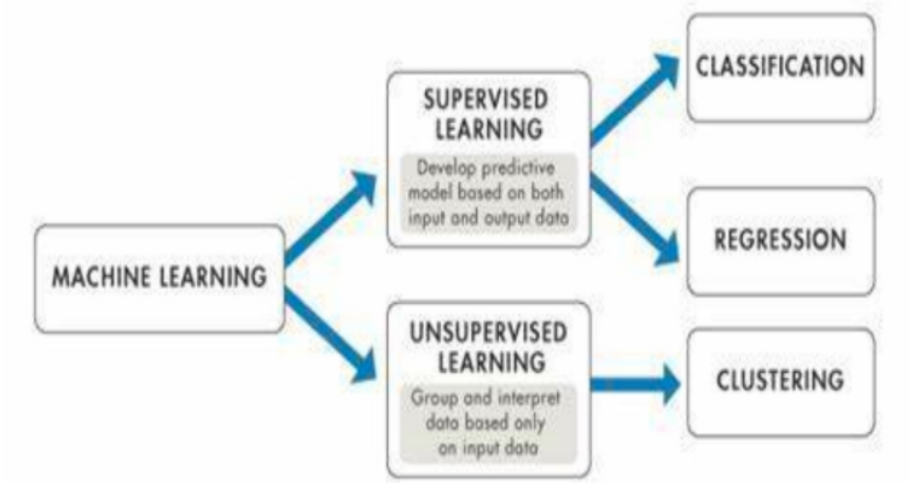

Fig: how testing works

This created prediction model by our model. If the behavior of the system and the data matches its call that the model is tested perfectly and the result can be shown according to the match found.

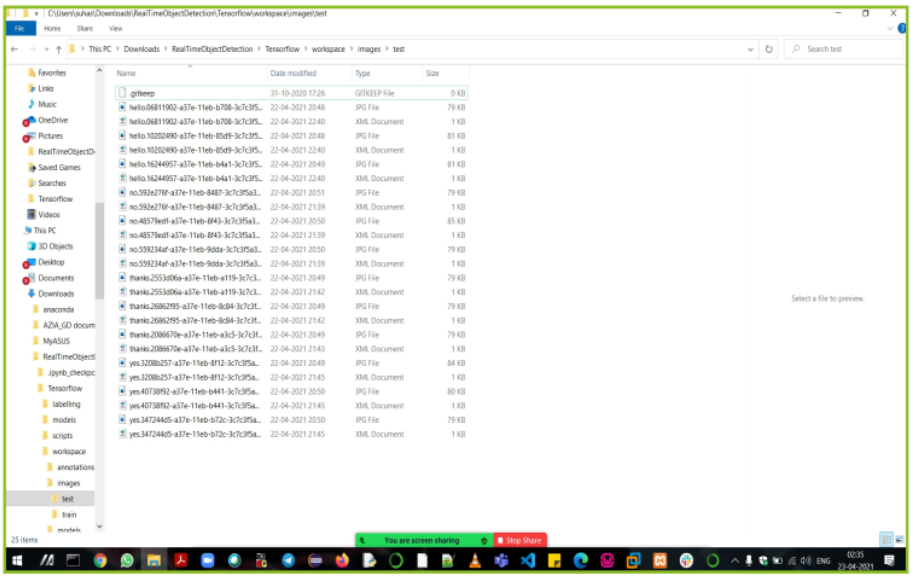

Fig: Testing folder for the data set

5.2.7 Text Input

Here is the input where we will type what we want to convey using the sign language.

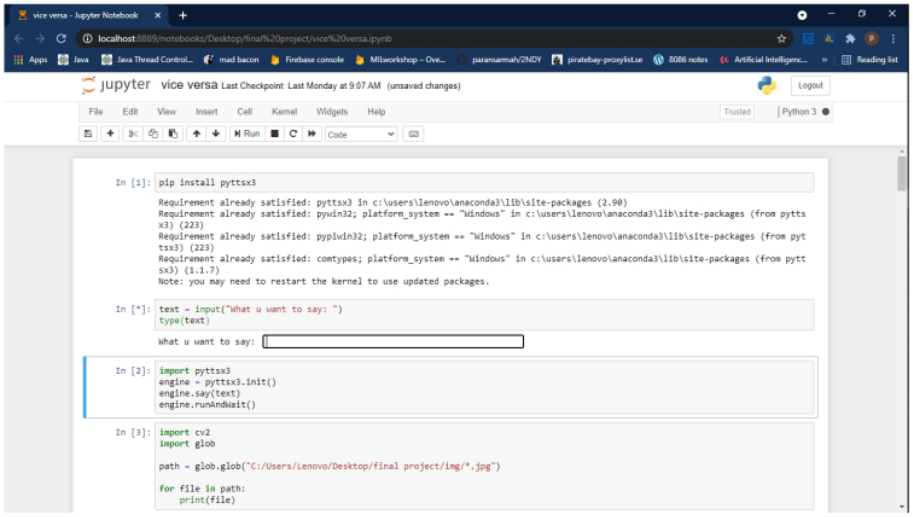

Fig: Where We Input the Text

It will ask us what text we want to convert it to sign language. Once we enter what we want to say it check in the Data-Base which is more suited for the words which we enter and display us the same picture which matches the words in the entry. We can enter what ever we want in the text input field. What ever we enter it will search for in the DB. Once it matches with the DB we will simply print the picture in the screen so that the other person can read it and understand what we wan to say to them in response.

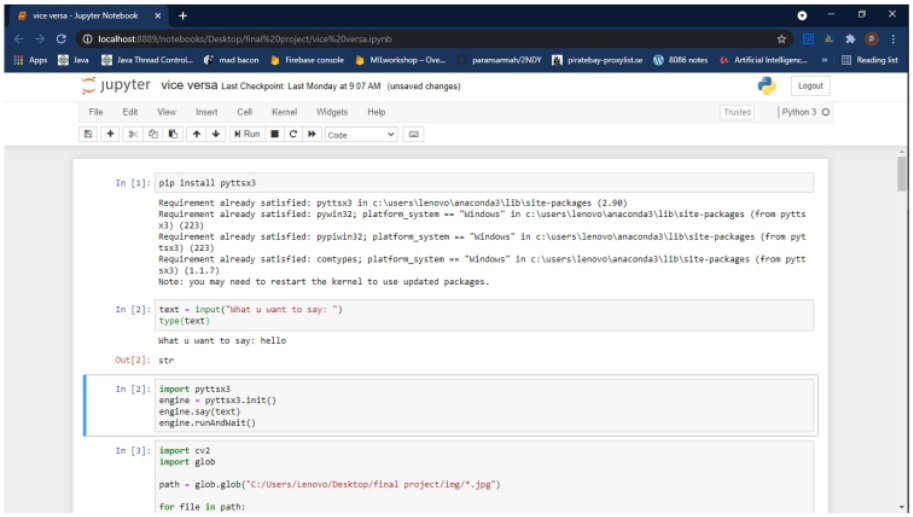

Fig: Once We Enter the Text

Once we enter sentence or single word and hit Enter button it will check for the info in the data set which is present.

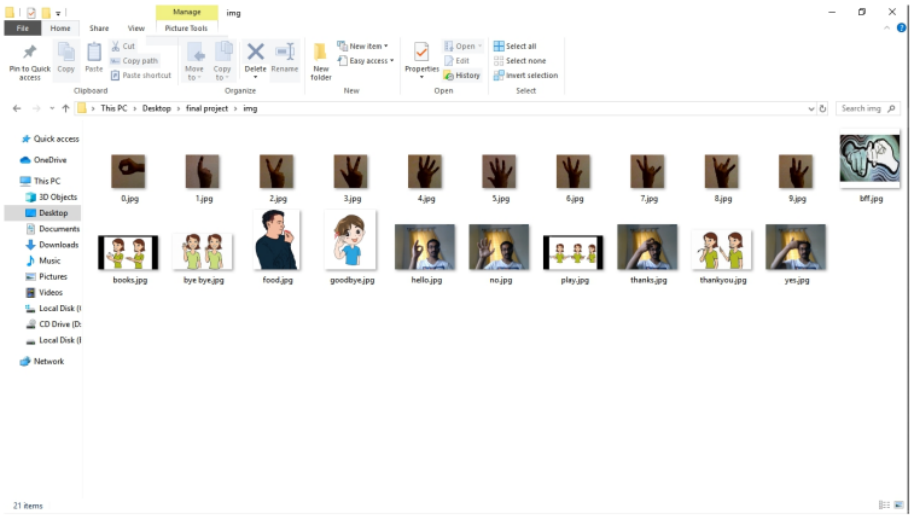

Fig: Data Set For Text to Speech

5.2.8 Speech

Once the word or the sentence is executed it will tell us out loud what we have typed in the form. The code which is used can be seen in the screen shot bellow.

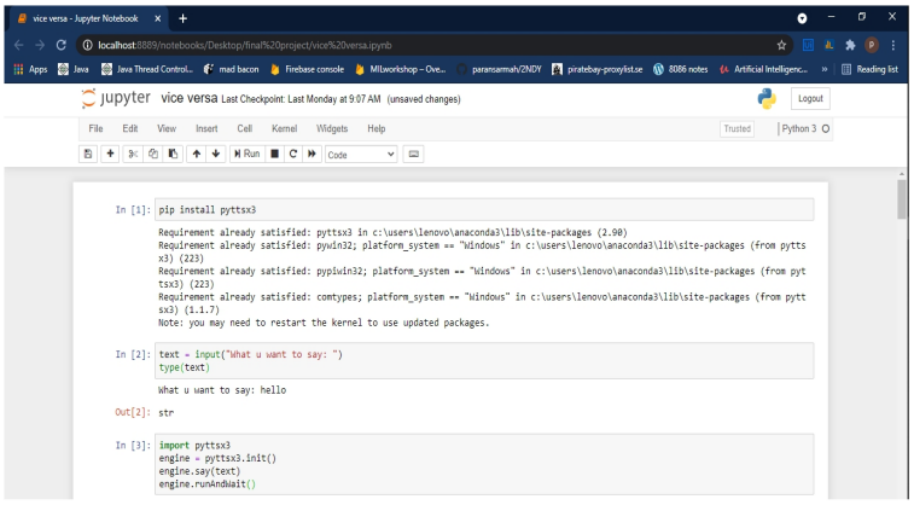

Fig: Convert Into Speech

5.2.9 Image Extraction

This will extract the appropriate Sign Language from the Data set which is present. Once the image is extracted from the Data set we just have to display that on the screen.

If the image is not present in the Data set it will print that the data which we enter is not present in the DB. If this message pop up we will simply have to give a different set of text which might be giving the same meaning but in different way. That's how we can avoid this message which comes up in the screen.

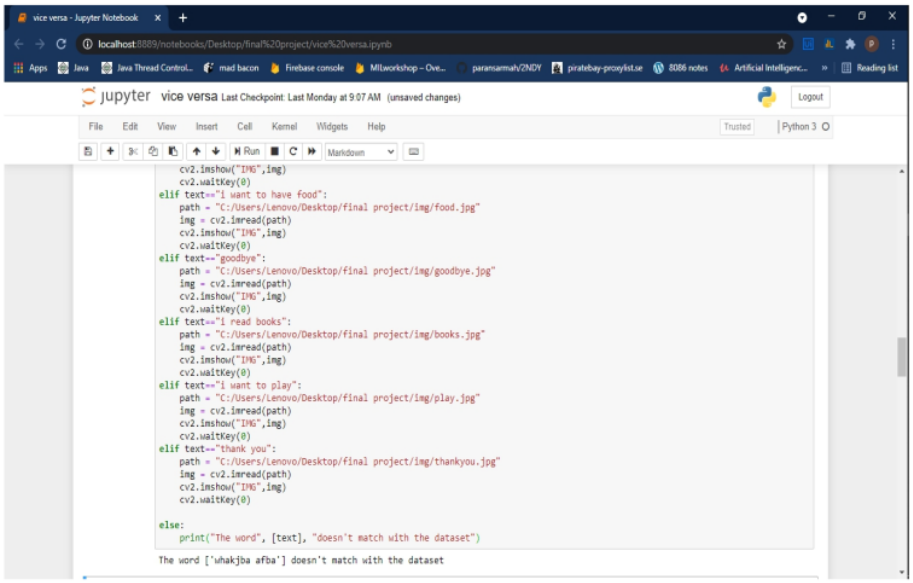

Fig: entered message doesn't match error

We have enter something which doesn't make any sence and which is not present in the Data Set. Hece the error comes up at the end saying that:

The word ['whakjba afba'] doesn't match with the dataset

5.2.10 Sign Output

Once the data set is match with with text which we have written it will pop us the image which is related to that sign. Once it is done its available for us to read the image in view mode. This is how we can convert the text to sign Language which will let the other person see what we what we want to say. Once they see what we want to say in Sign Language then he/she can understand the symbol then they can again show sign to reply back. This process will continue until the conversion is done.

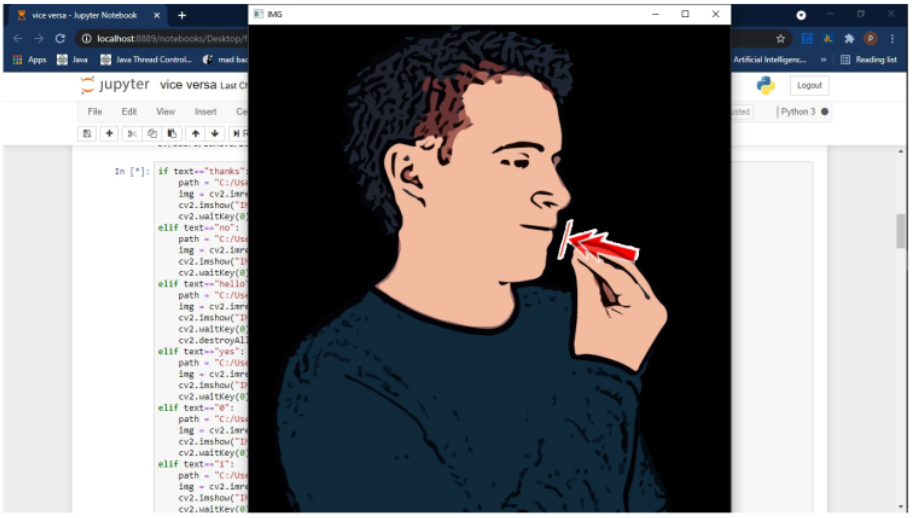

Fig: Sign for "I am hungry "

There are lots of sign available in the data set which will pop up like this if we enter the correct text. Once the data is match with the text then the given sign will be displayed on the screen.

5.3 Datasets

5.3.1 Data Set for Text

We have data sent which include (hello, yes, thanks, ok) that will help us to segregate the model from each other. This hold all the data set for the Sign Language to work efficient. All the data set is divide in two folders one for training and one for testing.

Training data-set help us to train the model more accurately. More data present in train part it will give batter output. We split them as 80% training and 20% of testing for our model to work accurately.

5.3.2 Data Set for Sign

We have the picture of some sign in our data base which help us to convert the text to a meaning full sign. We match the text with the picture so that the appropriate form of sign is showed in the screen

We match most of the words in the line to make the model more accurate to give the appropriate translation of the test to sign. If the test matches a certain amount of the word with the picture it will pop out those picture from the data set.

If there is no related picture or sign available in the data set it will just ask us to enter the data again with a error test saying that's text is not available in the Data set..

5.4 Data Pre-processing

5.4.1 Labeling Image

Labelling is a part of giving a product or a item name. To display a product we use labeling or in simple word giving name. A label contains valuable info (information) about a product or a item on its container, packaging, or the product itself. We can label and item in this word. Label contains name of the item or a threat like danger sign

That means all the other stuff in the background are removed. Only concentrating on the hand so that the model is more accurate. Its done using image labeling. This help us to process the required amount of data from the taken picture to training and test our model for batter accuracy.

Data pre-processing includes cleaning of the data (Unwanted for of data for the datasets), Instance selection (Occurrence), normalization (naturalized the set of data), transformation (convert the data into a useful product by removing all the unwanted things), feature extraction (it will keep all the tested model for feature training and testing the model) and selection (once a certain amount of files will be selected for the model to train because the training part is more crucial. If we don't train the model properly with proper data points it will give us less accuracy which is bad for our model), etc

This help our image to clear out the noises. The product of data pre-processing helps us in the final training set. When we do data pre-processing it will make all the data more accurate. This will make the model more affective. Hence the outcomes of the final data points are processed and can be showed or interpreted.

Fig: Labeling Image

As we can see from the above pic we are cropping the essential part form the image which help out for batter result. The face behind the hand is not required for out model to get trained. So we consider that part of the pic as noise and throw them it out from the data.

Once it is save we can only see the model of the hand not the other part behind the hand. All the part which comes after cooping we just used median blur which remove the remaining part of the noise to make a proper data set for out model.

Testing

Once everything is set by us we will test the model so that it give accurate result for both the cases. From sign to text and from text to sign. If the model give accurate result then we are good to go with the data set if not we have to do all the steps again from the beginning.

Here is the step by stem procedure of execution of the project to find the model is working fine or not.

After execution of the python program in Jupyter Notebook , a webcam window pops up and takes pics of the different signs at periodic intervals. It captures images in real time.

We have set the limit to 15 pictures for better training and testing of the model. We can increase the set by any number. We can reduce as well as increse the number of image taken for each set of data.

These pics are then stored inside a folder created by the program for training and testing purposes. We program the outputs in such a way that 4 folders are created with different labels. Which help us to differentiate all the different sign which we have shown while the webcam was on. All those picture will be stored in this set of folders only.

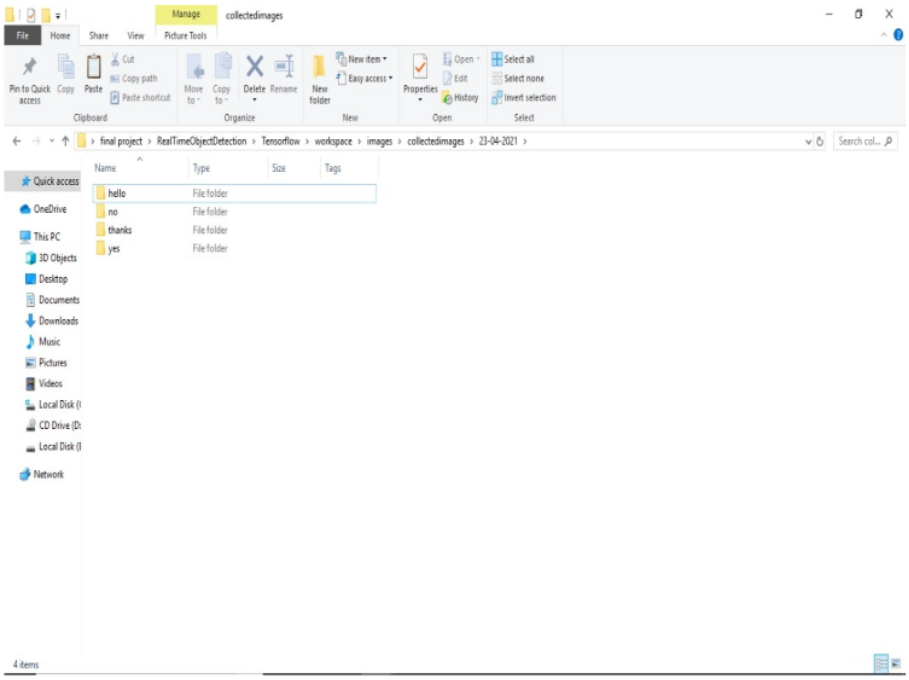

Fig: Picture are Stored in this Folders

All the hello sign are stored in the hello folder and same goes with the other folder. All folder have unique sign and each fold have same sign with both left and right hand. This help if the person is left handed. So that we can detect for both left and right hand.

Each of these labels contains multiple images of the same sign to improve the accuracy and train the model.

```
labels  = ['hello' ,'thanks','yes','no']
number_imgs = 15
```

This shows the folder will b named as 'hello' ,'thanks','yes','no' if we ant to give different then we can change the name in the label form. And if we want to increase the number of pic then we can increase it in number_imgs.

After the images have been obtained for detection purpose , we put all these pics into a single directory for labelling. We create a python script to perform labelling for each and every image that has been taken by the webcam. Upon executing this python script the labelling tool opens ,where we specify the source folder and saved folder where all the images to be labelled are stored.

Here we label each and every image taken by the webcam and provide a label for it. All the labelled images are cropped in such a way that only the sign is taken from the whole picture to be labelled.

This help us to focus only on the hand and remove all the noises present in the pic. Noises such as background item which are not required for our model and can be neglected entirely. We use this process to do that creation.

After the labelling of these images has been completed , the labelling tool automatically creates an xml file for each of these images which gives the full description of that specific image.

Here we split a certain % of the images into 2 folders- 1 for testing and 1 for training where more weight is given towards the training part so as to make the model more accurate for testing.

When we copy the images to the folder we also transfer the XML file which was created in the labelling process. Every pic give a different XML file so we have to copy all the XML file as well in those folder.

We have also installed Tensor Flow software to perform object detection for detecting hand movements from the camera. Which means when we move our hand in front of the camera it detect the hand movement accordingly and give the appropriate result.

The text frame also move with the hand. It always give the percentage wt which the data match the model. If the percentage is more then the model is more accurate. We have train the model for 3000 iteration.

It takes hours to train the model and if we want to increase the test model we can do it was well but it will take long time to train the model. B[illegible] the model will give more accurate result which we can expect. So if we give more time to train the model the more accurate the model will get.

We created a python script which converts text to speech. we have added a timer to control the rate of speech as well.

It ask us what we want to say and convert into Sign. Once we enter the text in the input form and hit enter it store the data in a variable and that variable is used through out to manipulate with the model.

So using the text we used pyttsx3 library to change the test to speech. engine.say(text) help us to convert the text to speech. And the text is the variable used to stored the entire data which we entered.

We also use the same text to convert into sign. It check for the text which we enter and compare it with the data set present with us. Once it matches it show up the sign in a pop up form. If it doesn't match it will simply say the word or the sentence is not availabel in the data set.

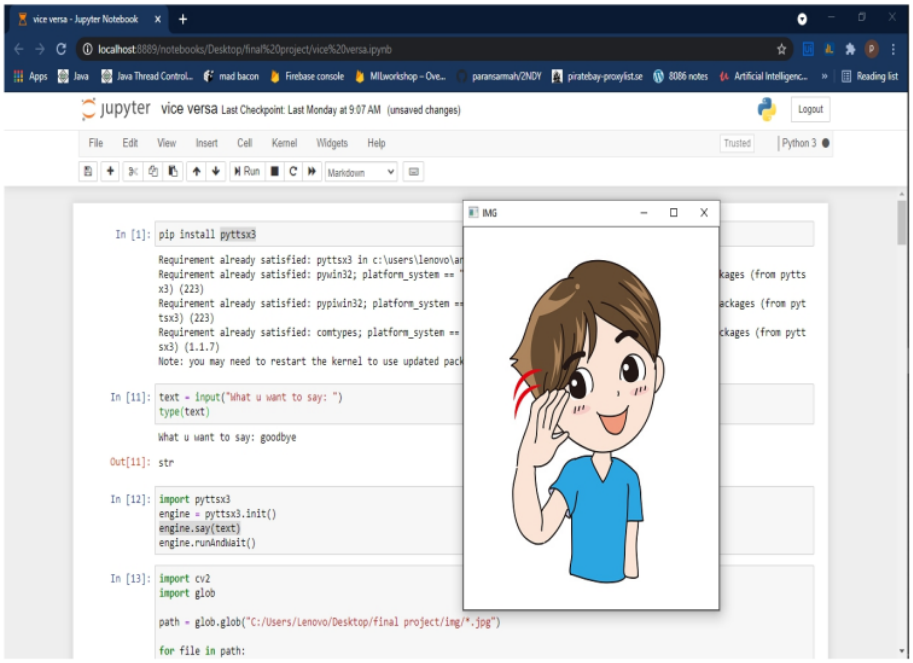

Fig: Convent Text to Sign

If the text doesn't match with the data Set present with us it will give this type of error.

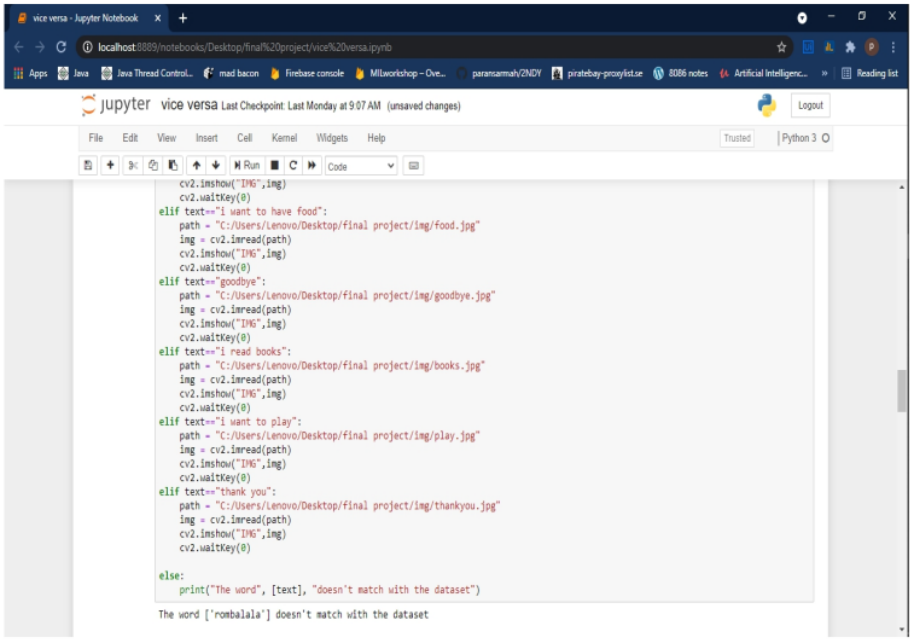

Fig: When it Doesn't match with the Data Set

We don't have any sign available for this word so we get a error message. It will ask us to try again with different set of words.

Experimentation and Results

7.1 Sign to Text

Once the webcam is one we ask the person to show the hand gesture of what they want to say. They will express themself with sign and the system will detect what they want to say by using real time object detection. Once the object in our case the hand is detected it will test for the data which is present in the Data set and check if the hand matches with any of the data if yes it will give a percentage of the match and it will also say what they want to say in real time so that normal people can understand them.

Fig: One Hand Sign to Text

The 51% and the 98% are the matching set of data from out data set. It means that almost that much percentage of the hand is tested as match with the data set. If the percentage is higher that means that the translation is done accurately. If low that meant it some what matches it the fame.

If we plash both out hand in front of the webcam then also it detect the sign accurately with a grater percentage of accuracy. It help us to convey two words at a time or two set of sign at one frame itself.

This help if the sign is combined with both the hand and it can only get detected if both hands r present. But it works for individual set of sign as well.

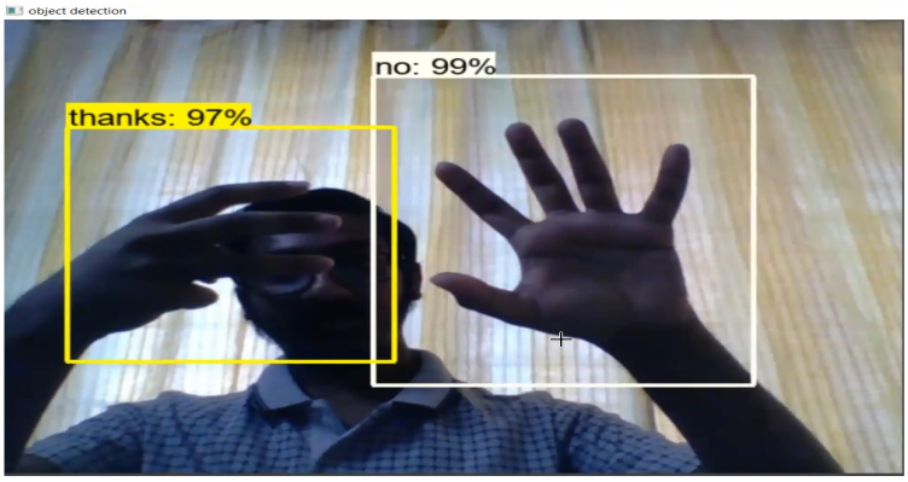

Fig: Two hand Sign to Text

7.2 Vice Versa (Text to Sign)

We have entered “I want to play” in text format and we executed the form. Once it is executed it will check in the Data set if something like this is present in sign format if yes then it will give us the output back.

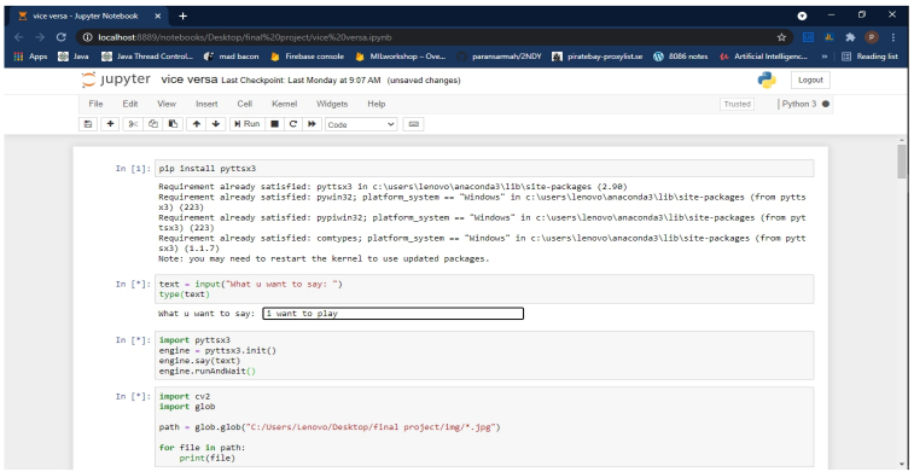

Fig: Text Entered

The data which is present in the data set is displayed in the picture format so that they can understand what we want to say. Once they see the image they will get to know what we want to say in sign format.

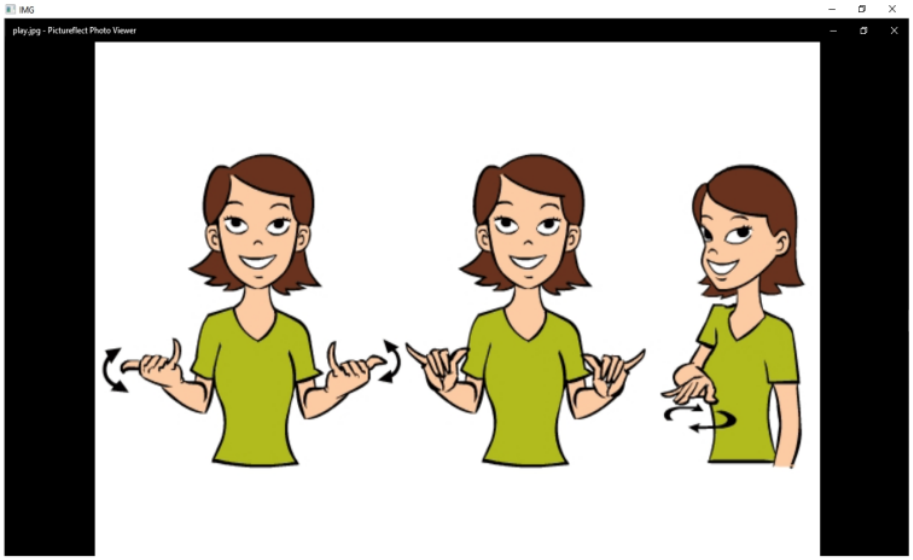

Fig: The Text is Converted to Sign

CONCLUSION

Many unique approach are proposed by other author in different papers with different software and hardware solution for Sign Language to Speech Translator. Which has been reviewed for our paper. All the papers have different method and algorithm that have been used or proposed by the author's. To bring a simple and best solution for Sign Language, different author approach for various Machine Learning(ML) and Image processing techniques. Through out the year many other are working for a simple and more effective approach for Sign Language.

By surveying for different papers we have come to a batter technique and algorithm to to make our proposed work more efficient , convenient and easy to use for the SL. We think our paper present the most effective way compared to the other papers which we have gone through from the last couple of years. This will improve the Sign to Speech translator more easy and batter for us.

REFERENCES

[1] Cheok Ming Jin, Zaid Omar , Mohamed Hisham Jaward “A Mobile Application of American Sign Language Translation via Image Processing Algorithms” 2016 IEEE Region 10 Symposium (TENSYMP), Bali, Indonesia.

[2] Kalpattu S. Abhishek, Lee Chun Fai Qubeley, and Derek Ho “Glove Based Hand Gesture Recognition Sign Language Translator Using Capacitive Touch Sensor” 2016 IEEE International Conference on Electron Devices and Solid-State Circuits (EDSSC).

[3] Keerthi S Warrier, JyateenKumar Sahu, Himadri Halder, Rajkumar Koradiya, and Karthik Raj V “Software Based Sign Language Converter ” International Conference on Communication and Signal Processing, April 6-8, 2016, India.

[4] Maryam Pahlevanzadeh, Mansour Vafadoost, Majid Shahnazi “Sign Language Recognition” 1-4244-0779-6/07/$20.00 ©2007 IEEE.

[5] Kohsheen Tiku , Jayshree Maloo , Aishwarya Ramesh , Indra R “Real-time Conversion of Sign Language to Text and Speech [5]” Proceedings of the Second International Conference on Inventive Research in Computing Applications (ICIRCA-2020) IEEE Xplore Part Number: CFP20N67-ART; ISBN: 978-1-7281-5374-2.

[6] Dasari Vishal, H M Aishwarya, K Nishkala, B Toshitha Royan, T K Ramesh “Sign Language to Speech Conversion Using Smart Band and Wearable Computer Technology” 2017 IEEE International Conference on Computational Intelligence and Computing Research.

Report- Suhas Meda and team

ORIGINALITY REPORT

10%	4%	8%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Kohsheen Tiku, Jayshree Maloo, Aishwarya Ramesh, Indra R.. "Real-time Conversion of Sign Language to Text and Speech", 2020 Second International Conference on Inventive Research in Computing Applications (ICIRCA), 2020 Publication	2%
2	Cheok Ming Jin, Zaid Omar, Mohamed Hisham Jaward. "A mobile application of American sign language translation via image processing algorithms", 2016 IEEE Region 10 Symposium (TENSYMP), 2016 Publication	1%
3	Maryam Pahlevanzadeh, Mansour Vafadoost, Majid Shahnazi. "Sign language recognition", 2007 9th International Symposium on Signal Processing and Its Applications, 2007 Publication	1%
4	Dasari Vishal, H M Aishwarya, K Nishkala, B Toshitha Royan, T K Ramesh. "Sign Language to Speech Conversion", 2017 IEEE	1%

	International Conference on Computational Intelligence and Computing Research (ICCIC), 2017 Publication	
5	Kumar Saurav, Seul Jung. "Robust Detection of the Coordinate of a Solar Panel Using Deep Learning Algorithm", 2019 19th International Conference on Control, Automation and Systems (ICCAS), 2019 Publication	1 %
6	Keerthi S Warrier, Jyateen Kumar Sahu, Himadri Halder, Rajkumar Koradiya, V Karthik Raj. "Software based sign language converter", 2016 International Conference on Communication and Signal Processing (ICCSP), 2016 Publication	1 %
7	www.ibm.com Internet Source	1 %
8	www.jiser.net Internet Source	1 %
9	towardsdatascience.com Internet Source	<1 %
10	Submitted to University of Sydney Student Paper	<1 %
11	blog.paperspace.com Internet Source	<1 %

12	www.warse.org Internet Source	<1 %
13	Nazmus Saquib, Ashikur Rahman. "Application of machine learning techniques for real-time sign language detection using wearable sensors", Proceedings of the 11th ACM Multimedia Systems Conference, 2020 Publication	<1 %
14	ichi.pro Internet Source	<1 %
15	www.ijert.org Internet Source	<1 %
16	www.irjet.net Internet Source	<1 %
17	Submitted to Freedom High School Student Paper	<1 %
18	Submitted to University of Adelaide Student Paper	<1 %
19	Submitted to Universiti Tunku Abdul Rahman Student Paper	<1 %
20	tensorflow-object-detection-api-tutorial.readthedocs.io Internet Source	<1 %
21	Jose Simoes, Thomas Magedanz. "Can you predict human behavior?", 2010 14th	<1 %

	International Conference on Intelligence in Next Generation Networks, 2010 Publication	
22	link.springer.com Internet Source	<1 %
23	packages.bosslinux.in Internet Source	<1 %
24	Jyotiprakash Panigrahi, Priyanka Pattnaik, Bibhuti Bhushan Dash, Satya Ranjan Dash. "Rice Quality Prediction using Computer Vision", 2020 International Conference on Computer Science, Engineering and Applications (ICCSEA), 2020 Publication	<1 %
25	dokumen.pub Internet Source	<1 %
26	inpressco.com Internet Source	<1 %
27	www.rcinstrument.com Internet Source	<1 %
28	"[Front matter]", 2016 IEEE International Conference on Electron Devices and Solid-State Circuits (EDSSC), 2016 Publication	<1 %
29	"Table of Contents", 2020 Second International Conference on Inventive	<1 %

Research in Computing Applications (ICIRCA), 2020

Publication

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		