[[1]](#footnote-1)

Sign Language Recognition Model

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# Abstract –

Sign Language is used by deaf & dumb people who have hearing or speech problems to communicate among themselves or with normal people. It is natural for humans to find connection with the help of communication, many researchers are working on it with the objective of making lives of such people easier and more natural without the use of any additional equipment. As a result, the primary goal of sign language recognition research is to develop systems that can recognize and understand these signs and convey it to the other people or use it in some form or another to perform computations. Our project aims to improve the existing models and optimize them to increase their efficiency and accuracy.

# INTRODUCTION

Communication is a necessary part of life for humans. It is a basic and effective method of communicating ideas, feelings, and views. However, a large portion of the global population is unable to do so. Hearing loss, speech disability, or both affects many individuals. With a surplus of spoken languages existing, there is a tendency to be ignorant of Sign Language as a proper language. There is a small minority of people who know sign language and most of them are either mute, dumb or they have a family member with the same disability.

There is a great discrepancy in normal daily things even in modern times for the challenged, whether it be for a job, education, or even just mental state. Moreover, deaf and dumb people feel as though they are deprived of normal communication. Not being able to be understood makes it even harder for those who are mute or deaf, so they face depression and anxiety much faster and harsher very easily.

With the rise of many social constructs in recent years, the differently abled have been sentenced to the sidelines and their problems are not discussed as heavily as they should be to diminish the gap between the impaired and the abled. To shorten this communication gap between people we are going to make a machine learning model.

There have been a few difficulties faces by researchers who have attempted to develop a sign language recognition model, such as image pre-processing and finding good and cost-efficient sensors to detect the sign language that is needs to be translated. Since there are wide range of recognition methods, some researchers even find it difficult to focus and select the best method. Classification methods have also given researchers some drawbacks.

After reading already existing work around this problem of sign language detection, we came across a few missing features, which are important for conversation with another person. Such as existing models use small datasets and are not completely able to identify the various kinds of sign languages. Therefore, we are implementing a ML based model where one can create sentences/words with our proposed model based on recognizing the individual letters.

In this paper we aim to discuss how we have prepared this sign language recognition model. We use static hand gesture recognition which is a recognition method that only requires a single image at the input of the classifier to process. We are going to take multiple datasets such as MNIST Sign Language dataset, WLASL-2000 etc. and combine them to form a larger dataset on which we will train a classification model so that it can recognize sign language from a webcam and convert into alphanumeric characters and words.

# RELATED WORK

Sign Language recognition is a field that has been touched upon but has not been fully researched and developed to great efficiency. One of the earliest approaches proposed by (Zimmerman, et al., 1987) used flux sensors of a glove to recognize hand movements along with gesture and orientation of the hand. However, with the inadequate amount of technology at that time, there is much to be desired in terms of recognizing images due varying backgrounds and resolutions and many other exterior discrepancies in the images.

Following upon the works of others, with the boom in technology in the recent decades, there has been a great performance boost to sign language recognition such as a vision based ISL alphabets recognition method proposed in (Sahoo, 2014). It was designed to recognize basic and cut-off signs which can also be used anywhere as compatibility of diverse backgrounds is available. A similar method is proposed in (Sharma, et al., 2014) which used centroid and directly used pixel values to extract features. Presently, most of the notable works basically do the same things where it uses datasets and recognize only one image or character at one time.

There is an abundance of importance in the understanding and recognition of sign language to help boost the deaf and mute communities in every field of their life.

In conclusion, there is a variety of work done in this field using multiple different algorithms and proceedings with success to different extents. The creation of sentences and words however is not developed to its potential.

# Flow Diagram

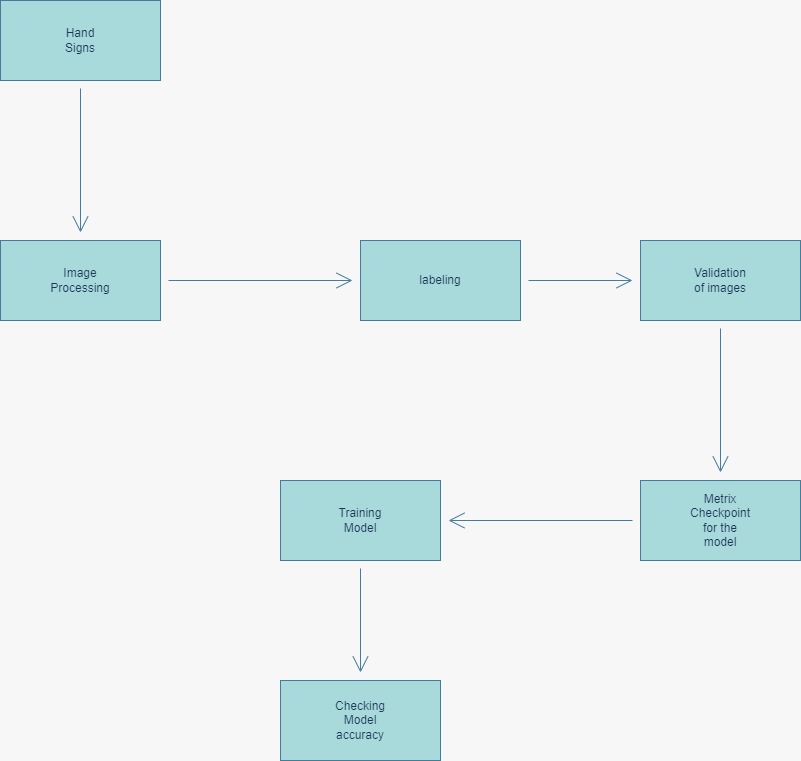


Figure 1: Flow Diagram

Starting with the image collection and dataset cleaning, the images are processed by the model also known as pre-processing. The model has a set of normalization and generalization algorithms to make it easier for the model to be trained. Then it goes into training which is further segregation of the data. The data is split into training and testing using a random shuffle function, a training set is implemented to build up a model, while a test set is to validate the model built. This is a classification problem where the target variable is categorical. After having trained the model, we move onto evaluation of the model this is an important part of model development, this helps in finding what best represents our data and gives room for fine tuning of small parameters.

# Proposed Methodology

The algorithm used to detect the image and classify it is using a deep learning model called VGG-16. The algorithm works in a way where the image is sent to the model which will process it into a grayscale image and recognize the pixels forming a pattern. It will then use its pattern recognition to classify the image in of the 28 classifications - namely the 26 alphabets, delete, spacebar and no input. We will train the model using multiple optimizers such as Adam, RMSProp, softmax, etc. with multiple layers for the best results. Then we compare the model to the pre-existing models for the same and try to improve on the model

# Experimental Setup

The dataset is picked from Kaggle and has about 87,000 images each having 200x200 pixels. The dataset is classified into 29 classes which are the 26 alphabets from A-Z as well as 3 additional classes for space, delete and no input. These images are the backbone of our model and have a variety of different lightings and camera angles for better optimization of the model.

The images are converted to a BGR colour filter so that the hand pixels can easily be identified on which the model will do its classification. The images are already in the required format so no further pre-processing or feature extraction is required.

Chart, histogram

Description automatically generated

Figure 2: Image Prieview and Pixel Density

# Result

After working on the project, we were able to interpret that the accuracy of the finished project will be approximately 92% which is better than other models that exist. Average of other parameters such as f1 score, recall, precision is 0.91,0.91,0.91 respectively. We are able to predict basic alphabets with the help of the code at the movement. There is a possibility of creating sentences by adding single words and giving an indication for creating space. For example, we can keep a 3 sec interval in which if there is no presence of a hand we can use it to determine that the word is complete and now we can add space.

Chart, line chart

Description automatically generated

Figure 3: Accuracy vs Number of Epochs

Graphical user interface, diagram

Description automatically generated

Figure 4: accuracy, loss vs number of epochs

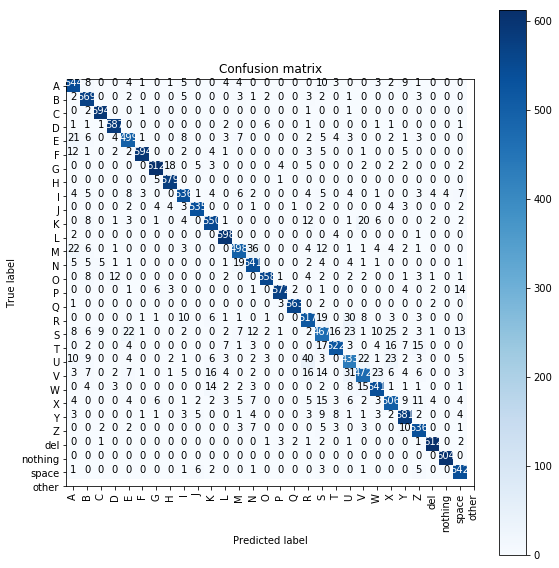


Figure 5: Confusion Matrix

# Future Scope

At the current state of this project, we were able to create Alphabets that were recognized by ASL. In the future, we plan to add numbers and some words which can be communicated with the help of sign language. We also plan to create sentences with the help of sign language with the help of a sign which will be used when we need to take space in the sentence. We plan to introduce a GUI for this project which will be used to make it easier for the user to use and utilize the potential of this application. We also plan to add more languages and make our portfolio of models diverse in nature. In addition, we would like for the model to be capable of converting normal alphanumeric characters to sign language.

# Use Case diagram

![Chart, diagram, bubble chart

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generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4SxORXhpZgAATU0AKgAAAAgABgALAAIAAAAmAAAIYgESAAMAAAABAAEAAAExAAIAAAAmAAAIiAEyAAIAAAAUAAAIrodpAAQAAAABAAAIwuocAAcAAAgMAAAAVgAAEUYc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAFdpbmRvd3MgUGhvdG8gRWRpdG9yIDEwLjAuMTAwMTEuMTYzODQAV2luZG93cyBQaG90byBFZGl0b3IgMTAuMC4xMDAxMS4xNjM4NAAyMDIyOjA0OjI1IDE4OjMwOjA1AAAGkAMAAgAAABQAABEckAQAAgAAABQAABEwkpEAAgAAAAMwMAAAkpIAAgAAAAMwMAAAoAEAAwAAAAEAAQAA6hwABwAACAwAAAkQAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Figure 6: Use Case Diagram

User performs a hand gesture/ sign language which is captured using a webcam/camera and fed into the model using an application/webapp, this image is then investigated by the model and a prediction is made with 90%+ accuracy. The output is a string stating the sign that was shown by the user.

# Conclusion

Our sign language recognition model uses static hand gesture detection, to recognize words from the American Sign Language (ASL). It is a very user-friendly approach since the sign language can be recognized from a webcam. Different techniques are used to capture the gesture, recognize it and attempt to compare and match it to the gestures in the database. We have managed to combine multiple datasets to make a larger dataset to make the results more accurate. Optimizers such as Adam, which made it easier to work with large datasets and parameters, RMSProp which utilizes the magnitude of the recent gradients to normalize the gradients and softmax which helps in calculating the probability distribution, were used in our model. We did face a few difficulties while programming our model, one of which is that our model was underfitting, but we did manage to come up with a solution. Our model has come out to be 92% accurate which makes it comparatively better than those models that exist. This will help bridging the communication gap between deaf and hearing communities and it will help them communicate better.

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