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Sign Language Recognition System for Impaired People

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Abstract: *This paper presents a rigorous review of various technologies and methods used for sign language recognition along with its advantages and disadvantages. More than 70 million impaired people globally use sign language to communicate. It is characterized by fast, highly articulate motion of hand gestures which is difficult for verbal speakers to understand. Nowadays, Hand Gesture recognition is considered to be an important aspect of Human-Machine Interaction (HMI). A hand gesture recognition system provides a natural, innovative and modern way of nonverbal communication.*
In addition, we also proposed a system that will detect various hand-knuckle coordinates and then use a machine-learning model to classify the various hand signs into respective English language alphabets in real-time using a webcam which will eliminate skin-tone related biases and the need for any additional hardware.

Keywords **- Hand Recognition, Sign Language Recognition, Speech Impaired People, Neural Network.**

I. INTRODUCTION

Hand gestures are an important part of nonverbal communication and form an integral part of our interactions with the environment. Notably, sign language is a set of hand gestures that is valuable to millions of disabled people. However, deaf/dumb users experience difficulty in communicating with the outside world as most neither understand nor can use sign language. Gesture recognition and classification platforms can aid in translating the gestures for those who do not understand sign language. In a more complex set of gestures such as sign language where some gestures are identical, machine learning is required to accurately classify those gestures. In addition, dynamic gestures such as sentences can only be classified with machine learning algorithms.[1]

The only affliction deaf and dumb people have is verbal communication since they can't talk like normal people and this is why the sole way to communicate with them is through signing. For humans, verbal communication is important to share thoughts, ideas and lots more but many of us are dumb and deaf and for them signing is the only way through which we can communicate. To express ideas, they create to use their hands referred to as gestures.[2] Sign language is a complex combination of hand movements, sometimes it also includes facial expression and body language. Different placements of fingers represent different characters/signs. There is no single sign language used around the world. Like spoken language, sign language developed naturally through different groups of people interacting with each other, so there are many varieties.

Interestingly, most countries that share the same spoken language do not necessarily have the same sign language as each other. English for example, has three varieties: American Sign Language (ASL), British Sign Language (BSL) and Australian Sign Language (Auslan).

There are three types of sign language. Are as follows

1. Non-manual features: Tongue, facial expression, body pose, and hand gesture
2. Word level sign spelling: Each gesture presents a whole word.
3. Finger vocabulary: One gesture represents the alphabet/numbers.[3]

There are many types of sign languages used in different parts, regions and countries across the world. Each sign language has its grammar and syntax. This paper mainly focuses on American Sign Language (ASL).

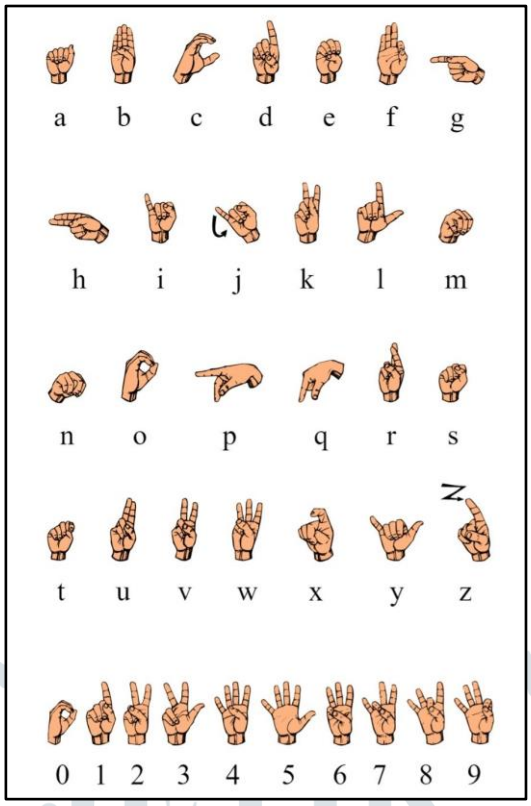

Fig 1: The American manual alphabet and numbers.[4]

American Sign Language (ASL) is a natural language that serves as the predominant sign language of Deaf communities in the United States of America and most of Anglophone Canada. ASL is a complete and organized visual language that is expressed by employing both manual and nonmanual features. Besides North America, dialects of ASL and ASL-based creoles are used in many countries around the world, including much of West Africa and parts of Southeast Asia.[4]

Therefore, this paper presents a rigorous review of various sign language recognition techniques and approaches. Also compares them and gives an idea about the advantages and disadvantages of each approach.

I. LITERATURE SURVEY

Month & Year	Paper	Methodology	Advantages	Disadvantages
April 2022	Real Time Sign Language Recognition System for Hearing and Speech Impaired People.[3]	Works on Python with the YOLOv5 Algorithm	This system can be used by both verbal speakers and sign language users for communication	Only translate words received as input into sign language.
January 2022	Real-Time Hand Gesture Recognition Using Fine-Tuned Convolutional Neural Network[6]	Data acquisition, Pre-processing: Segmentation & Filtering, Recognition of hand gestures: AlexNet and VGG-16	Using RGB-D sensors segmentation process of the hand regions became easier even in presence of human noise and complex backgrounds.	The hand is assumed as the closest object in front of the Kinect sensor.
May 2021	Real-Time Hand Gesture Recognition Based on Deep Learning YOLOv3 Model[8]	YOLOv3 (You Only Look Once) Algorithm.	Lightweight model based on YOLOv3 and DarkNet-53 Gesture recognition without additional preprocessing, image filtering, and	High computational power

			enhancement of images. High accuracy in real-time	
October 2020	Deep Learning-Based Approach for Sign Language Gesture Recognition With Efficient Hand Gesture Representation[10]	3DCNN Algorithm MLP concept	Hand segmentation based on the open-pose framework Optimizing the level of C3D architecture for HGR	Complex implementation. No user interface.
September 2020	Sign Language to Text and Speech Translation in Real Time Using Convolutional Neural Network[5]	Uses OpenCV, Keras CNN model and pyttsx3 library.	Has an accuracy of 95%. The project can be extended to other sign languages by building the corresponding dataset and training the CNN.	Needs gloves to eliminate the problem of varying skin complexion of the signee. Bad gesture postures will not yield correct predictions.
March 2020	Combining Hand Detection and Gesture Recognition Algorithms for Minimizing Computational Cost[13]	Classical computer vision algorithms are used Skeleton model is used as a static gesture recognizer combination of gesture recognition and hand detection.	It's possible to efficiently use computing resources depending on the context Expected performance increase can be calculated in advance by the formula.	Processing time is increased significantly as compared to other previous models. Prediction accuracy is decreased slightly.
December 2018	Research on the Hand Gesture Recognition Based on Deep Learning[11]	Camshift Algorithm used for gesture tracking. LeNet-5 network to recognize hand gestures. AdaBoost classifier is used for the strong learning algorithm.	Accuracy is medium up to 98%. Rotational hand gestures are also covered. Increased iteration decreases the loss curve.	Unable to obtain 3d information. Requires proper background lightning
June 2018	Real-time Hand Gesture Communication System in Hindi for Speech and Hearing Impaired[9]	32 binary number combinations used for recognition. YCbCr and Canny Edge modules were used.	Accuracy is very high. Flexible modification according to user needs.	Made using MATLAB. No use of AI / ML. Not a universal language.
January 2018	Real-time Two Hand Gesture Recognition with Condensation and Hidden Markov Models [12]	Gesture recognition system using Hidden Markov Models (HMM). AdaBoost classifier is used for the strong learning algorithm. Baum- Welch algorithm is used to train for initialized HMM	Provides good results for recognizing gestures in real-time. Multiple hand gestures can be recognized.	Requires lots of processes to segment the required image. Currently not optimized for sign language detection. Only used for normal regular gestures
May 2017	Real-Time Recognition of Sign Language Gestures and AirWriting using Leap Motion[7]	SVM for initial classification. BLSTM-NN classifier-based for Gesture Recognition	Accuracy of 100% using SVM classifier and overall accuracy of 63.57% for gesture classes	The accuracy of the system is low because it has been tested with a lexicon-free approach.

II. PROPOSED METHOD

Using direct classification comes with many issues such as wrong predictions for different skin types, and the need for gloves to get accurate results. Also, it requires large datasets for training and testing models to make it robust. Studying all papers above we proposed a system that will work on any device with a web browser and a working camera.

In our proposed system, we will be using MediaPipe's Hand detection model to detect hand knuckles landmarks and detect sign poses by passing those landmarks into our trained classification model. Using this approach we eliminated the need for an extensive dataset, also Mediapipe's Hand detection model is trained on various combinations of skin tone and perceived gender which helps to eliminate skin-colour biases.

MediaPipe offers cross-platform, customizable ML solutions for live and streaming media. MediaPipe Hands is a high-fidelity hand and finger tracking solution. It employs machine learning (ML) to infer 21 3D landmarks of a hand from just a single frame.

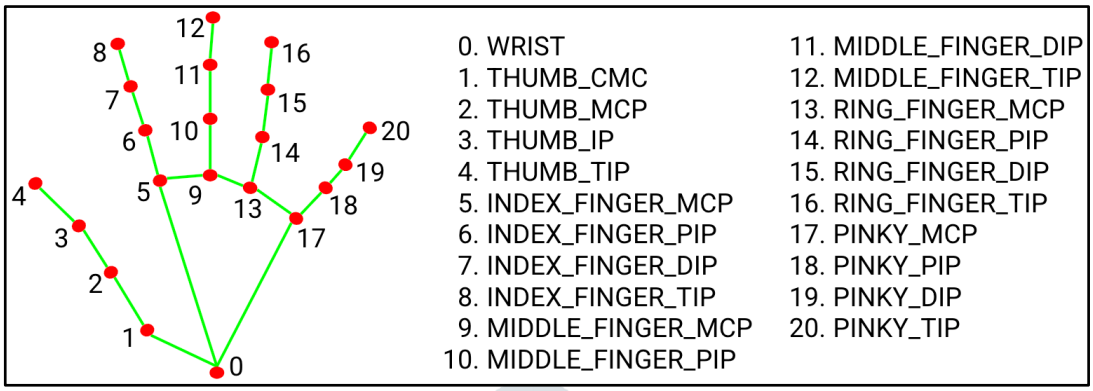

Fig 2: Hand Landmarks (Mediapipe Hands)

In our proposed system, a live camera feed will be taken as input and each image frame of the camera stream then will be passed to our application. The application will detect hand landmarks and correctly identify ASL signs. Also, the corresponding English alphabet for ASL Sign will be printed on the screen. There will be an additional algorithm to combine detected letters into words.

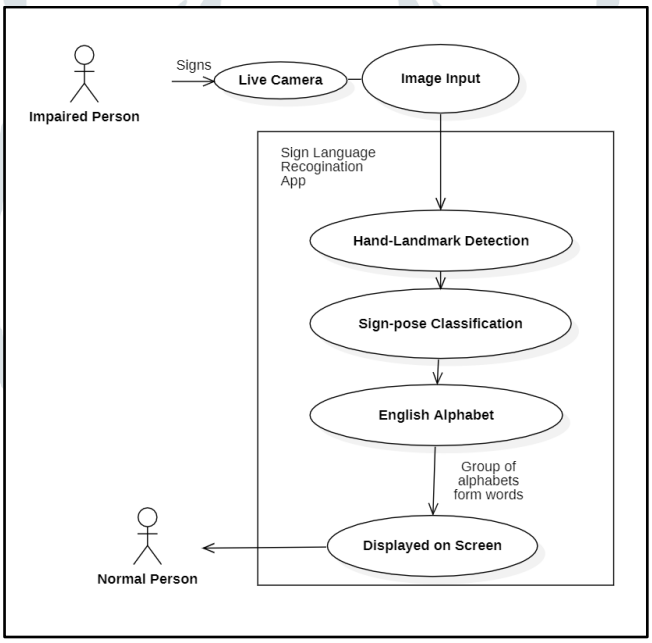

Fig 3: Proposed System Structure

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