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A Survey on Sign Language Recognition

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Abstract: The sign language is used widely by people who are hearing impaired as a medium for communication. A sign language is the composition of various gestures formed by different shapes of hand, its movements, orientations as well as the facial expressions. There are around 466 million people worldwide with hearing loss and 34 million of these are children. 'Hearing impaired' people have very little or no hearing ability. Hence, they use sign language for communication. Different sign languages are used by people in different parts of the world.
Compared to spoken languages they are very less in number. India has introduced its own sign language called Indian Sign Language (ISL). In developing countries there are only very few schools for deaf students. In developing countries, the unemployment rate of sensory impaired people is very high. Data from Ethnologue states that among deaf population in India, which is about one percent of total population, literacy rate and number of children attending school is very less. It goes on to state that official recognition of sign languages, increasing the availability of interpreters and providing transcription in sign languages greatly improve accessibility. Signs in sign languages are the equivalent of words in spoken languages Signed languages appear to favour.

Keywords: Indian Sign Language (ISL), Sign Language Recognition, Sign to Text, Convolutional Neural Network (CNN), Hand gesture, OpenCV.

I. INTRODUCTION

Use of sign language in day to days life has increased due to its applicability in many areas such as communication system for sensory impaired people, human control interaction, machine control in the industrial field and many more.

Sign language is made of different gestures, body language and in some cases, facial expressions. Sign language is used by sensory impaired people, mainly those who can't speak or hear. Various Sign Languages such as ISL (Indian Sign Language) and ASL (American Sign Language) use hand and finger movements to represent the words. The sign language is not spoken same in the world. It differs from one geographical section to another. For Example, Countries like America, India, China has their own sign languages named as American Sign Language, Indian Sign Language, Chinese Sign Language respectively.

The need of systems like sign language recognition system arises when sensory disabled people need to communicate with the other part of the society, and they need an interpreter who can interpret sign language to spoken language and vice versa. But it is not possible to have interpreter every time when needed. Sign language mostly includes hand and finger gesture, therefore SLR focuses on hand gesture tracking and recognition. There are between 138 to 300 sign languages and because of that, we cannot have universal Sign Language Recognition System. In general Sign Language Recognition classified in following category:

1.Word Recognition
2.Continuous Sign Recognition
3.Alphanumeric Sign Recognition

We can classify Sign Language Recognition System as:

1.Glove (Sensor) Based
2.Vision Based

1. Glove (Sensor) Based

Salma A. Essam El-Din and Mohamed A. Abd El-Ghany[1] composed A glove-based recognition system of three main units. The MPU6050 and the flex sensors represent the input unit, giving all the required input data to the processing unit. This data is then processed using the Arduino Mega micro-controller board. Upon reaching the output unit, it displays the detected gestures on a GUI using Python3. The implementation process includes three steps: hardware design, communication between Arduino and Python and last detecting and displaying the gestures.

Sensor based gloves measures tension and pressure between fingers. Examples of the most widely known sensor glove technologies are the

- Power Glove
- Data Glove

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- Cyber Glove
- Kinect Sensor

2. Vision Based

Disha Gangadia, Varsha Chamaria, Vidhi Doshi and Jigyasa Gandhi[2] Build vision-based sign language system that takes video inputs of gestures in the specified ROI and performs gesture recognition using various feature extraction techniques and Hybrid-CNN model trained using the ISL database created. The correctly identified gesture tokens are sent to a Rule-Based Grammar and for Web Search query to generate various sentences and a Multi-Headed BERT grammar corrector provides grammatically correct and precise sentences as the final output.
There are various algorithms such as SVM (Support vector Machine), K-NN (K-Nearest Neighbors), CNN (Convolutional Neural Network) which are generally used the sign language recognition System.

II. LITERATURE SURVEY

Compared to spoken languages, sign languages are very less in number. To aid those in need and to encourage the use of sign language, researches have been carried out and new projects and systems are created. This not only increases the literacy rate, but it also helps people to communicate with each other with lesser limitations.

Lance Fernandes, Prathmesh Delvi and Akash Junnarkar used HC-05 Bluetooth module to facilitate wireless communication and CNN (Convolutional Neural Network) in their research paper, Convolution Neural Network based Bidirectional Sign Language Translation System. The CNN was trained to capture features from hand. They have achieved an accuracy of 91.7 percent on cross-validation containing different users with different backgrounds from the training set and testing accuracy of 95.68 percent but it contained users and backgrounds from the training set. The drawbacks of this were that the system couldn't differentiate '2' and '3' from 'v' and 'w' respectively.

In another paper, Recognition of Sign Language Symbols using Templates, published in the year 2020, the authors, Deepika Pahuja and Sarika Jain, used the non-Parametric approach for skin colour detection and the image processing toolbox of MATLAB. This had a success rate of 78 percent with the only limitation being that due to recognizing sign language symbols using static im- ages, the vocabulary of the system was limited.

In 2020, a paper named Sign Language Interpreter System: An alternative system for machine learning was published by Salma A. Essam El-Din1 and Mohamed A. Abd El-Ghany. The authors used Arduino for receiving the readings and turning it into outputs and glove-based motion tracking sensor to identify gestures. However, given the limitations of having such delicate sensors and gloves makes it inconvenient to use.

III. METHODOLOGY

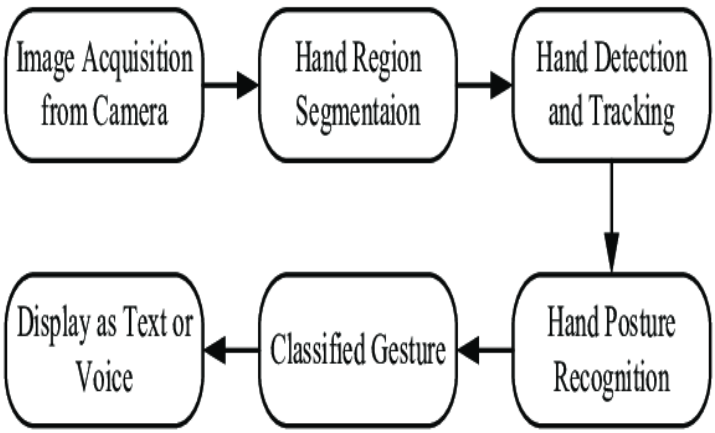

Figure 1 General Architecture of Sign Language Recognition System

A. Image Acquisition from camera

Camera is the input device for our SLR as we acquire the required sign for the system. There is ample research is going in the field of Sign language recognition researcher create standard database of signs and made available for fellow researcher. As Sulochana Nadgeri Dr. Arun Kumar[5] mentioned in their survey.

Standard dataset is available for following language:

- ASL- Kaggle, ASL Lexicon Video Dataset.
- German sign Language- RWTH German Fingerspelling Database, RWTH-PHOENIX
- Australian Sign Language (Auslan): UCI Australian Sign Language
- Brazilian Sign Language: UCI- Libras Movement Data Set

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- Spanish Sign Language: (ARAAC)
- Indian Sign Language: IIITA-ROBITA ISL
- Irish sign language: ATIS Corpus
- Dutch Sign Language: Corpus NGT Indian Sign Language: IIITA-ROBITA ISL

But there are so many sign languages for which standard dataset is not available. Researcher creates their own database for training purpose. 32 Tamil sign is created using web camera using 5 signers as no dataset is available for Tamil sign language[6]. The Signs World ArSL DB is an image and video DB that has been developed by the authors for Arabic Sign Language. The dataset contains manual and non-manual sign performed by 10 signers[7]. Bangladeshi hand sign language Recognition system use a dataset of 17 words and 8 popular sentences which has been created using videos[8]. Swedish sign language vocabulary of 51 sign for Tivoli game recorded with Kinect sensor which colour, depth and skeleton data. The vocabulary is composed of four subsets - objects, colours, animals, and attributes[9]. The image acquisition can be done using web camera, digital camera or [10][9] Microsoft Kinect

B. Hand Region Segmentation

Hand gesture plays a vital role in the Sign Gesture Recognition System since rest of the steps depends on the result of this step, due to improper segmentation, the system fails to give correct result. Using Haar classifier the face is removed from image and simultaneously motion is also detected finally morphological operations were performed on both the images separately. The AND operation on the outputted images is performed which will give good result in complex background also[11]. Input video is converted from RGB to YCbCr colour Model to detect skin colour and largest region of skin colour which is face subtracted from image[12]. The researcher presents combination of dynamic adaption and Bayesian decision framework which is illumination invariant real time skin colour detection technique[13]. Skin colour area is detected using hue, Saturation and RGB threshold. Median Blur preserves the edges of the hand gestures[14]. Person Independent Hand Segmentation using HSV Colour Space by Decision Rule is proposed in which algorithm refresh the feature vector for every new user[15]. RGB colour converted in HSV and YCbCr and threshold value of Cb, Cr and Hue define Skin colour[16]. RGB image is converted in grey scale retaining the luminance information. First derivative Sobel edge gives better result in the presence of noise also[17]. In the proposed method image is resized and vertically/horizontally a predetermined number of pixels were skipped to reduce CPU time for skin colour detection process[18]. Image with background and without background is captured separately then image is converted into YCrCb and HSV and the binary images are then added to get maximum result. Region filling and morphological operation which enhance image. This method gives better result even if there is drastic illumination changes and cluttered backgrounds which does not require background subtraction[19]. YCgCr colour space is illumination invariant, secondly, the Y channel extract the features of gray image, which can reduce the amount of computation. The YCgCr colour space has strong skin colour aggregation, the Cg and Cr components can effectively distinguish skin and non-skin colour. The advantage of this method is high locating accuracy and low computational complexity, which is more suitable for the hand gesture recognition[20].

C. Feature Extraction (Hand Detection & Tracking and Hand Posture Recognition)

The input images are containing lots of information which take large processing real time and every feature does not contribute in recognition of Sign language. feature extraction technique reduces the dimension and contents of the input image, retains only those features which are unique for each sign and essential for recognition. Feature extraction is an essential pre-processing step to pattern recognition as well as machine learning.

TABLE I FEATURE EXTRACTION METHODS SUMMARY

Sr. No	Ref. No.	Feature Extraction Method /Parameter	Import Source
1	21	DCT coefficients of head area, the left-hand area and the right-hand area.	Video
2	22	Fourier descriptors	Video
3	23	Shape Descriptors	Image
4	24	Elliptical Fourier descriptors	Video
5	25	Eigen value and Eigen vector	Video
6	26	Hand Shape circularity and extent, Hand Motion-motion detection code, Hand Orientation-direction of change	Video
7	27	Principal Component	Image
8	28	Haar Like Feature	Image
9	29	Direct Pixel Value	Image
10	29	Hierarchical centroid	Image
11	12	Hand Shape circularity and extent, Hand Motion-motion detection code, Hand Orientation-direction of change	Video

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12	30	Colour, Intensity and texture.	Video
13	31	Fourier descriptors	Video
14	32	Hand Width and height, hand Orientation, Euler number	Video
15	33	Orientation Histogram	Video
16	34	Fusion descriptor -combination of contour and region-based descriptors.	Image
17	35	Edge Orientation Histogram	Image
18	36	Haar Like Feature	Image
19	37	Global Features and Local Features	Image
20	14	Orientation Histogram	Video

D. Classified Gesture

Classification is important in Sign Language Recognition system as it takes the features extracted as an input and recognize correct gesture. This process identifies to which category the given sign gesture belongs. Classification generally done on the basis on the training set of data of the observation, whose category is known. Support Vector Machines, Naive Bayes Classifier, Artificial Neural Network, Hidden Markov Model few classifiers to mention.

TABLE II SIGN GESTURE CLASSIFICATION SUMMARY

No. of Signs.	**Sign Language**	**Methodology**	**Accuracy ()**
32	Malaysian Sign Language (MSL).	Artificial Neural Network (ANN)	92.07%
23 words, 40 sentence	Arabic Sign Language	Naive Bayes Classifier (NBC)	Sentences75% Words94%
80	Indian Sign Language	Fuzzy inference system	96%
24	Indian Sign Language	Euclidean Distance based classification	96.25%.
51	Swedish Sign Language	Hidden Markov Model	89.70%
21	Indian Sign Language	MSVM	95.30%
21	Indian Sign Language	BKNN	89.90%
10	Indian Sign Language	k-Nearest Neighbor	97.04%
1 word, 4 sentences	Indian Sign Language	Haar Cascade	92.68%
10	Indian Sign Language	k-Nearest Neighbor	97.10%
28	Arabic Sign Language	Naive Bayes Classifier (NBC)	98.30%
28	Arabic Sign Language	Multilayer Perceptron Neural networks	99.10%
22	Indian Sign Language	MSVM	90.46%
5	Indian Sign Language	Artificial Neural Networks	NA
26	American Sign Language	Back Propagation Neural Network	90% for each sign
46	Indian Sign Language	Minimum Distance	92.91%
75	Indian Sign Language	Distance Based Classifier	NA
26	American Sign Language	Haar like classifier	98.7%
26	American Sign Language	Distance Based Classifier	88.26%
15	Thai Sign Language	SVM+RBF	91.20%
26	American Sign Language	1A1SVM	99.23%
31	Bengali Sign Language	Geometric Hashing	51.35%
32	Bangladeshi sign language	SVM	94.26% for words and 94.49% for sentences
33	Brazilian Sign Language	SVM	Above 80%

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IV. CONCLUSION

In this project, we proposed an idea for feasible communication between hearing and vision impaired people and a person with ability to hear and see more compared to the former, with the help of deep learning and machine learning approach.

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International Journal of Advanced Research in Computer and Communication Engineering

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