Indian sign language interpreter using image processing and machine learning

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Indian sign language interpreter using image processing and machine learning

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Abstract: Sign language plays an important part in the hearing/speech impaired person's life as it is the prime medium of communication for them. However, not everyone understands the sign language hence, it becomes difficult for the disabled to communicate in day-to-day life. The sign language constitutes of various hand gestures which can represent various words and expressions. In this paper, the aim is to build a reliable communication interpretation program for interpreting Indian sign language and converting it to a readable output. The task is accomplished using Image processing and Machine learning. Our proposed project can find its applicability in the day to day for communication, it can also work for learning various gestures in gesture based automatic systems

Keywords – Image Processing, CNN, HSV, Deep Learning, Pre-processing, ISL

1. INTRODUCTION

There has always been a communication barrier between deaf and mute people and the speaking community. This is especially apparent during the time of an emergency. Most of the times a human translator is employed for the translation. But everyone cannot afford a human translator and during emergencies, the availability of a human translator cannot be assured. This project aims to eliminate this barrier. The task is accomplished using Image processing and Machine learning. Machine-learning and Image processing are very powerful tools often used for image classification and recognition. Image Processing deals with the image, its properties, and the operations performed on it for getting some information from the images. Machine learning is the study of algorithms and statistical data used to perform tasks using various data patterns and inferences. In this project, the collection of the images of the sign language are to be done using a camera. The images are then processed and the features are extracted using image processing. These images are them compared from the available datasets and by implementing deep learning, the signs are interpreted. The data is displayed on a display that helps the person in front of a deaf/mute person understand the sign language We have developed a simple and lightweight deep learning algorithm which can detect static sign-language gestures. This algorithm is made to deploy in a Raspberry Pi. This project will act as a communicator. It will convert the sign language into text. In this project, we have built an effective algorithm for the recognition of sign language with good accuracy. A lightweight algorithm is used for deploying it in Raspberry Pi. We are not only aiming to make an accurate model but we are also aiming to make a model lightweight portable model supported by Raspberry Pi. Raspberry Pi is a small and powerful device. It is very easy to run python programs in Raspberry Pi and it can be connected to the internet very easily. It has many more features which makes it ideal for this project.

The Indian Sign Language is predominantly used in the South Asian region. It has several variants depending on the region as well. Many signers used the finger spelling technique as shown in figure 1 which is derived from the British Sign Language but that is limited to a group of people. The ISL is still evolving and works are being done to standardize it by ISLRTC. Indian Sign Language Research and training Center (ISLRTC) is an autonomous organization under the administrative and financial control of Department of Empowerment of Persons with Disabilities Ministry of Social Justice & Empowerment, Government of India.

The deaf and mute population of India is around 1.8 million. Hence it is essential to develop an effective

communication system for them. This plays a great role especially in the times of emergency.

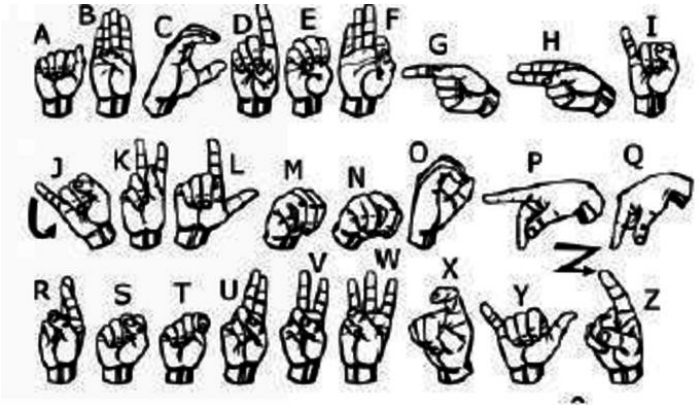

Figure 1. Alphabets in Indian Sign Language

2. LITERATURE SURVEY

Kamal Preet Kour, Dr. Lini Mathew presented a system in which the feature extraction is done using SURF algorithm and the feature matching using Minimum Euclidean Distance classifier. The 26 letters of English in Indian sign language were recognized.[1].

Vivek Bheda and N. Dianna Radpour provided a system to recognize ASL words in which they used Deep convolutional neural network for classification. The obtained accuracy was around 82.5% on the ASL alphabets and 97% validation on digits. [2].

Ashish S. Nikam and Aarti G. Ambedkar's system employs Contour Extraction and Convex Hull Algorithm for feature extraction and for recognition respectively. However, the system is only used to detect numbers. [3].

Kshitij Bantupally and Ying Xie's presented system uses convolutional neural network for feature extraction while for recognition, LSTM and regression was used. The system yielded an accuracy of 90-93%. The accuracy varied by varying sample sizes.[4].

Omkar Vedak, Parsad Zavare, Abhijeet Todkar and Manoj Patil presented the system in which the feature description was done by Histogram if Gradients and the recognition was done by training an SVM classifier. The system had an accuracy of 88% and the model evaluated 26 English ISL symbols. [5].

Amit Kumar Gautam and Ajay Kaushik provided an American Language Recognition System where the feature extraction was done using point descriptor system and then the extracted features were classified using Euclidean distance classifier. The accuracy obtained was around 75-85%. The accuracy could be increased by increasing the no. of point descriptors. [6].

Purva C. Badhe and Vishal Kulkarni presented a system which uses Fourier Descriptors and Vector quantization for feature extraction and the classification was done by Euclidean Distance Classifier. Several Letters, numbers and phrases were tested and the average accuracy was found to be around 93%. [7].

Md. Mohimiul Islam, Sarah Siddiqua and Jawata Afnan's system uses K convex Hull method for feature extraction, pixel segmentation, eccentricity, elongations and rotation used to correct the aquired features. Then ANN used for recognition of the signs. This system was used to recognise Numbers and Alphabets of the American Sign Language with an accuracy of 94.32%. [8].

Vijay More, Sanket Sangamnerkar, Vaibhav Thakare, Dnyaneshwari Mane presented a model where feature extraction was done using Hu moments Invariants and classification was done using KNN. The recognition of the signs was done using thresholding and Euclidean Distance. However, the presented system's accuracy was only significant in a high-resolution camera. [9].

Hadis Madani, Manoochehr Nahvi presented a model where the input video sequence is implemented with

Camshift algorithm for hand tracking. The feature extraction was done using Radon transform and finally various classifiers were implemented for recognition. [10].

G. Anantha Rao, K. Syamala, P. V. V. Kishore, A. S. C. S. Sastry presented a model where the images were passed through a CNN for recognition. No pre-processing was done for recognition. 200 Indian Signs were detected and the average accuracy achieved 92.88%. [11].

Muthu Mariappan H, Dr Gomathi V presented a system where the images were pre-processed by box filter, then morphological operations like erosion and dilation were implemented. The features were detected by Canny operation and the recognition was done using C means clustering. An accuracy of 75% was achieved with around 800 datasets.[12].

Shadman Shahriar, Ashraf Siddique, Tanveerul Islam, Abesh Ghosh, Rajat Chakraborty, Asir Intisar Khan, Celia Shahnaz, Shaikh Anowarul Fattah presented a model where the skin colour model was implemented as pre-processing. The background was removed and then the mask filtering was applied. Then the features were extracted using a bounding box and for recognition, SIANN was implemented. The accuracy achieved was around 94% for ASL. [13].

The model presented by Shirin Sultana Shanta, Saif Taifur Anwar, Md. Rayhanul Kabir had the ROI extraction using SIFT ad the features were detected using CNN. An accuracy of 90% was achieved for Bangla Sign Language. [14].

The proposed model uses Haar, Cosine & hybrid wavelet Transform for Feature extraction. The KNN classifier was implemented using Euclidean distance and City Block Distance. The recognized letters were alphabets and displayed up to 90% accuracy. [15].

3. EXISTING METHODOLOGY

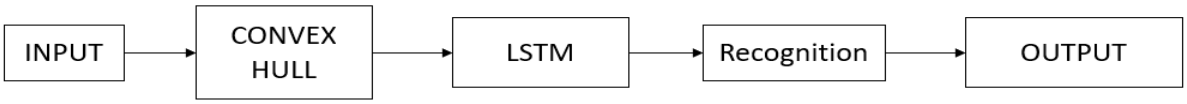

Figure 2. Block Diagram of Existing Methodology

As shown in figure 2, in the existing methodology convex hull was used for feature extraction and LSTM was used for classifying. LSTM is a good method for classifying but it needs more computation power which is not suitable for Raspberry Pi. This model had an accuracy of 90-93%.

4. PROPOSED METHODOLOGY

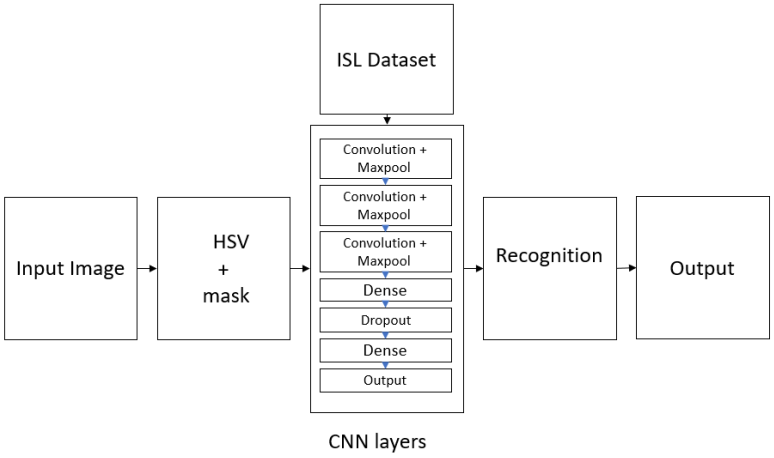

Figure 3. Block Diagram of proposed methodology

As shown in figure 3, in the proposed methodology, HSV method for feature extraction is used and 3-layer CNN network is used for classification. CNN is lightweight and is suitable for Raspberry Pi as it requires lower computational power. The observed accuracy is 98%.

4.1.Pre-Processing

The images are acquired using a camera and then the features are extracted using HSV filtering. The skin tone values are selected to isolate the hands form the background. Then it is converted into the grayscale image to obtain the features of the hand. These images are then separated as training and test sets and then fed to the model.

4.2.Training Model

For simplicity and to make the code light weight for deploying in Raspberry Pi this model is chosen. The proposed model has three convolution layers with 'tanh' activation and two dense layers with the first dense layer having the activation function as 'tanh' and the second dense layer having the 'SoftMax' activation function. This combination of layers and activation functions gives the highest accuracy and least loss. Then the trained model is used to classify the various signs and the output is produced on the screen with the recognized letter.

5. RESULT

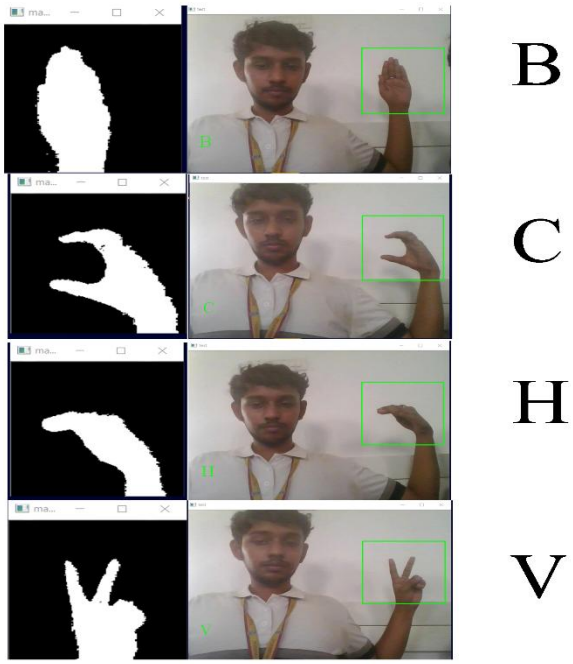

Figure 4. HSV output and the Real-time recoginition output

Figure 4 shows the preprocesed output, and the real time recognition output. The preprocessing is done by selecting the values for Hue, Saturation and Value(HSV) acoording to the background. This is done to remove the background to get the proper hand features. The real time recognition shows the recognised letter of the Indian Sign Language(ISL).

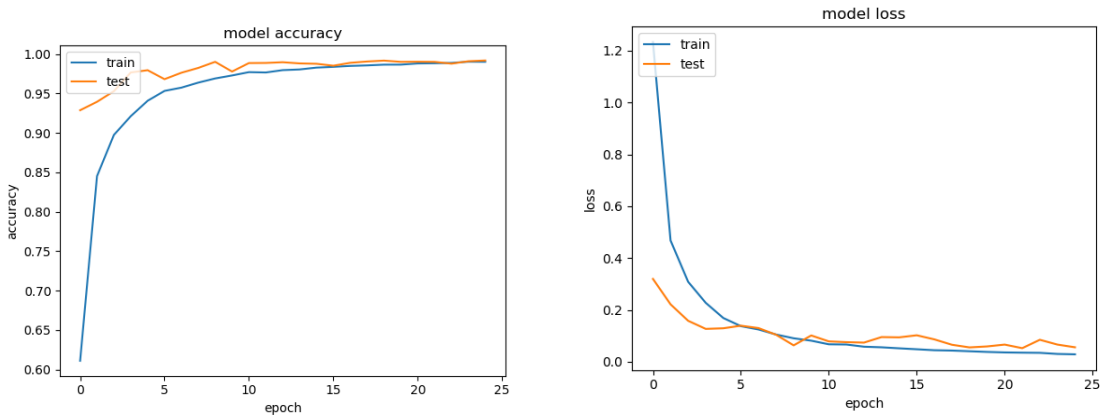

Figure 5. Accuracy and Loss graphs of the model

The first graph as shown in figure 5 compares the training and testing accuracy during the training of the model per epoch. The second graph in figure 5 compares the training and testing loss during the training. It can be seen that the accuracy is high and the loss is less.

6. CONCLUSION

Thus, communication gap between the deaf and mute and the people that could not understand the sign language is bridged. By making it a portable device the usage will be increased. The improved speed and accuracy help us use the device in real-time with less lag. It can be deployed in potential places like hospitals and police stations where emergency communication is of at most important. It will help us to make a better society.

REFERENCES

[1]. Kamal Preet Kour, Dr. Lini Mathew, 2017 "Sign Language Recognition Using Image Processing". *International Journals of Advanced Research in Computer Science and Software Engineering*, August ,ISSN: 2277-128X, Vol.**7**, Issue-8

[2]. Suharjito, Herman Gunawan, Narada Thiracitta and Ariadi Nugroho, 2018 "Sign Language Recognition Using Modified Convolutional Neural Network Model". 978-1-5386-9422-0/18/$31.00 ©2018 IEEE. *The 1st 2018 INAPR International Conference*, Jakarta, Indonesia.

[3]. Ashish S. Nikam and Aarti G. Ambedkar,2016 "Sign Language Recognition Using Image Based Hand Gesture Recognition Techniques". *Online International Conference on Green Engineering and Technologies (IC-GET)*. 978-1-5090-4556-3/16/$31.00, IEEE.

[4]. Kshitij Bantupally and Ying Xie, 2018 "American Sign Language Recognition using Deep Learning and Computer Vision".*IEEE International Conference on Big Data (Big Data)*. 978-1-5386-5035-6/18/$31.00 ,IEEE.

[5]. Priyanka M, Anisha S and Sakthi Prabha R, 2016. " VLSI Design For A Pso-Optimized Real-Time Fault-Tolerant task allocation algorithm in Wireless Sensor Network," *ARPN Journal of Engineering and Applied Sciences* Vol. **11**, no. 13, July 2016 ISSN 1819-6608

[6]. Omkar Vedak, Prasad Zavre, Abhijeet Todkar, Manoj Patil, "Sign language Recognition using image processing and machine learning". International Reasearch Journal of Engineering and Technology(IRJET).Vol. **6**,Issue:4,April2019 e-ISSN: 2395-0056, p-ISSN: 2395-0072.

[7]. R.Sakthi Prabha, "Channel aware reputation system with adaptive detection using AODV protocol during forward attack in wireless sensor network" IOP Conference Series: Materials Science and Engineering 561(2019)012121,DOI:10.1088/1757-899X/561/1/012121

[8]. Amit Kumar Gautam, Ajay Kaushik, "American Sign Language Recognition System Using Image Processing Method". *International Journal on Computer Science and Engineering (IJCSE)*. Vol.**9** No.07 Jul 2017. ISSN: 0975-3397.

[9]. Purva C. Badhe, Vaishali Kulkarni,2015" Indian Sign Language Translator Using the Gesture

Recognition Algorithm". 2015 *IEEE International Conference on Computer Graphics, Vision and Information Security* (CGVIS). 978-1-4673-7437-8/15/$31.00 ©2015 IEEE.

[10]. Md. Mohimiul Islam, Sarah Siddiqua, Jawata Afanan, "Real Time Hand Gesture Recognition Using Different Algorithms Based on American Sign Language".

[11]. R.Sakthi prabha,2015 " BIECC- an efficient cryptographic scheme for authenticate false data injection over wireless sensor networks" *International Journal of Applied Engineering Research* ISSN 0973-4562,**Vol**.10, Number 2 (2015) pp. 3557-3565

[12]. Vijay More, Sanket Sangamnerkar, Vaibhav Thakare and Dnyaneshwari Mane,2018 "Sign language recognition using image processing". *Proceedings of 1st Shri Chhatrapati Shivaji Maharaj QIP Conference on Engineering Innovations Organized by Shri. Chhatrapati Shivaji Maharaj College of Engineering*, Nepti, Ahmednagar, In. ISSN No: 2581-4230, 21st - 22nd February

[13]. Hadis Madani, Manoochehr Nahvi , "Isolated Dynamic Persian Sign Language Recognition Based On Camshift Algorithm and Radon Transform". 978-1-4673-6206-1/13/$31.00 ©2013 *IEEE.*

[14]. G.Anantha Rao, K.Syamala, P.V.V.Kishore and A.S.C.S.Sastry,2018 " Deep Convolutional Neural Networks for Sign Language Recognition". *SPACES-2018*, Dept. of ECE, K L Deemed to be UNIVERSITY.

[15]. R.Sakthi prabha, 2015 "BIECC- an efficient cryptographic scheme for authenticate false data injection over wireless sensor networks", *International Journal of Applied Engineering Research* ISSN 0973-4562 **Vol** 10, Number 2 (2015) pp. 3557-3565