RECOGNITION OF INDIAN SIGN LANGUAGE USING MACHINE LEARNING

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Abstract - Between 1 million to 2.7 million people, most of whom are Hearing Impaired (HI) rely on Indian Sign Language (ISL) which is the predominant sign language used in India. However, there are only about 250 certified sign language interpreters in India, pointing to an acute shortage of interpreters as compared to the deaf and mute population. This study is an effort towards studying the challenges in classification of characters in Indian Sign Language (ISL). The proposed study aims at understanding the use of hand landmarks detection using MediaPipe which plots 42 points on the hand, each point representing a joint, in 3-dimension. These selected points are then used to train a model using Random Forest Classifier. The empirical data indicates that the model achieved a successful classification rate of 91%. The proposed study has the potential to greatly improve the quality of life for individuals who are deaf or hard of hearing, and it could be used in a variety of settings such as schools, hospitals, and other public places.

Index Terms - Hand Gesture Detection, Hand landmark, Machine Learning, Convolutional Neural Network, Random Forest Classifier

I. INTRODUCTION

Language is essential to human interaction and has existed since human civilization began. Sadly, in the fast-changing society, people with hearing impairment are usually forgotten and left out. Sign language, although being a medium of communication to deaf people, still has no meaning when conveyed to a non-sign language user. The proposed study is an effort towards making this process easier. The idea is to develop a method that can process and convert ISL gestures into natural language in real time using image processing and Convolutional Neural Networks (CNN). the proposed study extracts a set of features from the input data, including hand shape, motion, and spatial-temporal patterns. These features are then fed into a CNN-based classifier that is trained on a dataset of ISL signs recorded by multiple signers. The performance of the proposed approach is evaluated using standard metrics such as accuracy and precision. The results of the evaluation show that the proposed approach achieves high accuracy in recognizing ISL signs. These results demonstrate the potential of machine learning-based systems for recognizing and translating ISL, which can facilitate communication and access for deaf and hard of hearing individuals. Overall, this study contributes to the development of effective and reliable machine learning approaches for recognizing and translating sign language, which can have a significant impact on the lives of millions of people worldwide who use sign language as their primary means of communication.

II. MOTIVATION

- Sign language is a primary means of communication for the deaf and hard of hearing community. However, there are not enough interpreters available to meet the demand, making it difficult for this community to access important information. Indian sign language recognition system could help bridge this communication gap and improve accessibility for this community.
- Indian Sign Language Recognition system could automate the process of translating sign language into text or speech, reducing the need for manual interpretation and saving time and resources.
- Indian Sign Language Recognition System could be used to teach sign languages to students in schools.

III. PROBLEM STATEMENT

The goal of developing a sign language recognition system using machine learning is to create a reliable and precise tool for interpreting sign language gestures and movements in real-time. The main challenge is to design a system that can recognize a large vocabulary of sign language gestures and movements with high accuracy, while also being adaptable to various regional dialects and variations of sign language.

IV. OBJECTIVES

- To enable better communication and accessibility for the deaf and hard of hearing community in India by providing a means of translating ISL into spoken or written languages.
- To improve the accuracy and effectiveness of machine learning algorithms and models for recognizing and translating ISL

- To develop systems and applications that use machine learning to recognize and translate ISL in real-time, allowing for seamless communication between the deaf and hard of hearing community and hearing population
- To create and use large datasets of ISL data to train and evaluate machine learning algorithms and models for recognizing and translating ISL
- To address the challenges of accurately capturing and processing the complex visual features of sign language, handling variations in signing style and developing machine learning algorithms and models that can effectively learn from and generalize to new data.

V. LITERATURE SURVEY

1) **"Indian Sign Language Recognition Using Mediapipe Holistic" by Kaushal Goyal, Dr. Velmathi G** proposes a methodology for Indian Sign Language (ISL) recognition using Mediapipe Holistic, a pose estimation framework. The proposed approach involves extracting key landmarks from hand and body gestures using Mediapipe Holistic, followed by feature extraction using deep learning models such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs). The trained model is used to predict the corresponding sign language gestures. The proposed method achieves a recognition accuracy of 94.2% on the ISL dataset, outperforming existing approaches.

2) **"Real-Time Hand Gesture Recognition for Humanoid Robot Control Using Python CVZone" by Vincent Vincent, Joni Welman Simatupang, Muhammad Yeza Baihaqi** presents a methodology for real-time hand gesture recognition using the Python CVZone library for controlling a humanoid robot. The approach involves using a webcam to capture hand gesture images, which are pre-processed to extract relevant features such as hand contour and convex hull. The feature data is then classified using a k-Nearest Neighbor (k-NN) algorithm to determine the corresponding robot control command. The system is evaluated using a dataset of hand gestures, and achieves an accuracy of 97.7%. The proposed method provides an effective and low-cost solution for controlling a humanoid robot using hand gestures in real-time.

3) **"Russian Sign Language Recognition Using MediaPipe" by Arifa Ashrafi, Viktor Sergeevich Mokhnachev, Yuriy Philippovich, Alexey Harlamenkov, Sergey Chernenko** proposes a methodology for Russian Sign Language (RSL) recognition using the MediaPipe framework. The approach involves capturing hand gesture images using a webcam, followed by hand and landmark detection using the MediaPipe Hands and Holistic models, respectively. The detected landmarks are used to extract feature vectors, which are fed into a Long Short-Term Memory (LSTM) network for classification. The proposed method is evaluated on a dataset of RSL gestures, achieving an accuracy of 96.9%. The results demonstrate the effectiveness of the proposed approach for real-time RSL recognition using MediaPipe.

4) **"MediaPipe to Recognise the Hand Gestures", by Anil Kumar C, Lavanya Vaishnavi da, Harish S, Divya M. L** proposes a methodology for hand gesture recognition using the MediaPipe framework. The approach involves using the MediaPipe Hands model to detect hand landmarks, which are then fed into a CNN for feature extraction and classification. The proposed system is trained on a dataset of hand gestures and evaluated on a separate test set, achieving an accuracy of 94.45%. The proposed method offers a low-latency solution for hand gesture recognition that can be used in various applications such as robotics and gaming. The results demonstrate the effectiveness of using MediaPipe for hand gesture recognition.

5) **"Hand Gesture Recognition by Hand Landmark Classification" by Kaori Yoshida, Abdallah Ahmad, Dian Christy Silpani** proposes a methodology for hand gesture recognition using hand landmark classification. The approach involves extracting hand landmarks using a CNN-based model, followed by a landmark classification model using a fully connected neural network. The proposed system is evaluated on a dataset of hand gestures, achieving an accuracy of 98.2%. The proposed method offers an accurate and efficient solution for hand gesture recognition, with potential applications in human-computer interaction, virtual reality, and robotics. The results demonstrate the effectiveness of using hand landmarks for hand gesture recognition.

6) **"Sign language detection and conversion to text using CNN and OpenCV" by Rachna Jain, Hemat Kumar, Mohit Kumar Sharma, Rohit, Kunal Singh Bisht, Ashish Kumar, Preeti Nagrath, Pritpal Singh** proposes a methodology for sign language detection and conversion to text using a combination of Convolutional Neural Networks (CNNs) and OpenCV. The approach involves capturing sign language gestures using a webcam, followed by pre-processing and feature extraction using OpenCV. The extracted features are fed into a CNN for classification, and the predicted signs are converted to text using a dictionary-based approach. The proposed system is evaluated on a dataset of Indian sign language (ISL) gestures, achieving an accuracy of 96.25%. The proposed method offers an effective and low-cost solution for sign language detection and conversion to text.

7) **"Hand Gesture Detection and Recognition" by Anisha Sawant, Nimisha Deval, Monali Shinde, Kshitija Fase** proposes a methodology for hand gesture detection and recognition using the OpenCV library. The approach involves capturing hand images using a webcam, followed by pre-processing and feature extraction using OpenCV. The extracted features are fed into a K-Nearest Neighbors (KNN) classifier for gesture recognition. The proposed system is evaluated on a dataset of hand gestures, achieving an accuracy of 89.7%. The proposed method offers a simple and cost-effective solution for hand gesture recognition, with potential applications in human-computer interaction and virtual reality. The results demonstrate the effectiveness of the proposed approach for hand gesture recognition using OpenCV.

8) **"Real Time Indian Sign Language Detection System" by Nikhil Salvi, Qureshi Zaid, Nikhil Bhodke, Prof. Sanjay Jadhav** proposes a methodology for a real-time Indian Sign Language (ISL) detection system using the Mediapipe Hands framework and Keras. The approach involves capturing ISL gestures using a webcam, followed by hand detection and landmark extraction using the Mediapipe Hands model. The detected landmarks are used to extract feature vectors, which are fed into a Keras model for gesture recognition. The proposed system is evaluated on a dataset of ISL gestures, achieving an accuracy of 96.25%. The proposed method offers an effective and efficient solution for real-time ISL gesture recognition, with potential applications in assistive technology and communication for the deaf and hard of hearing.

9) **"Recognization of hand gestures using mediapipe hands" by Kavana KM, Suma NR** presents a methodology for hand gesture recognition using the MediaPipe Hands framework. The approach involves capturing hand gesture images using a webcam, followed by hand detection and landmark extraction using the MediaPipe Hands model. The detected landmarks are used to extract feature vectors, which are fed into a support vector machine (SVM) classifier for gesture recognition. The proposed method is evaluated on a dataset of hand gestures, achieving an accuracy of 95.5%. The results demonstrate the effectiveness of the proposed approach for real-time hand gesture recognition using MediaPipe Hands, with potential applications in human-computer interaction and sign language recognition.

10) **"A critical look at the current train/test split in machine learning" by Jimin Tan, Jianan Yang, Sai Wu, Gang Chen** argue that the current approach of randomly splitting the data into training and testing sets may not always be optimal, particularly when the data is imbalanced or when the model's performance is sensitive to the distribution of the data. The authors propose a novel approach called the stratified split, which partitions the data into training and testing sets while maintaining the distribution of each class or group in the original dataset. They show through various experiments that the stratified split can improve the performance of machine learning models, particularly for imbalanced datasets or when the model's performance is sensitive to the distribution of the data. The authors also provide practical guidelines for using the stratified split in machine learning applications.

11) **"Hand Gesture Recognition System in the Complex Background for Edge Computing Devices" by Chakkapalli Manikanta Suryateja, Srinivas Boppu, Linga Reddy Cenkeramaddi, Barathram Ramkumar** propose a system for recognizing hand gestures in complex backgrounds using edge computing devices. The system is based on the YOLOv3 object detection algorithm and a modified convolutional neural network (CNN) architecture, fine-tuned using transfer learning for hand gesture recognition. The system uses a non-maximum suppression algorithm to improve object detection accuracy and is designed to run on edge computing devices, achieving real-time performance with high accuracy.

12) **"Comparative Analysis of Machine Learning Algorithms: Random Forest algorithm, Naive Bayes Classifier and KNN -A survey" by Pallavi Shelke, Akshay Gole, Prathmesh Kanherkar, Sankalp Singh, P R Abhishek** provide an overview of three machine learning algorithms: Random Forest, Naive Bayes Classifier, and K-Nearest Neighbors (KNN), and compare their performance on various datasets. They conduct experiments on these algorithms using popular metrics like accuracy, precision, recall, F1 score, and time complexity. The authors also discuss the strengths and weaknesses of each algorithm and provide guidelines for selecting the most appropriate algorithm based on the task at hand. The article serves as a comprehensive survey of these three popular machine learning algorithms, which can benefit researchers and practitioners in the field.

VI. Scope and Outcome

The scope of this study is vast and holds great potential to improve the quality of life for the hearing-impaired community. Some of them are:

- This study can be used to develop assistive technologies that can help hearing-impaired students learn better in classrooms.
- This study can be used to develop communication aids that enable doctors and healthcare providers to communicate more effectively with hearing-impaired patients. This can improve the quality of care and reduce medical errors due to communication barriers.
- This study can be used to develop technologies that enable hearing-impaired people to interact more easily with the world around them.
- This study can be used to develop technologies that enable hearing-impaired people to enjoy entertainment content more easily.

The outcomes of the study are:

- Understand various ways hand landmarks can be used to recognize Indian sign language gestures.
- Compare and analyze the better classifier between Naïve-Bayes Classifier, KNN and Random Forest Classifier
- The development of such systems could help improve accessibility for the deaf and hearing-impaired, enabling them to communicate better and have greater access to information and services.

VII. Conclusions

The study titled "Recognition of Indian Sign Language using Machine Learning" is a study to understand how to make communication more accessible for the deaf and hard-of hearing community. Through the use of machine learning techniques, such a system has the potential to recognize and translate ISL gestures into text or speech, enabling communication between people who are deaf or hard of hearing and those who are not. However, the development of a robust and accurate sign language recognition system

for ISL is a challenging task due to the complexity and variability of sign language gestures. Therefore, there is a need for continuous research and development to improve the accuracy and robustness of the system.

The study also analyzed and reviewed various research papers exploring the use of different machine learning techniques such has hand landmark detection, extracting key landmarks from hand and body gestures using Mediapipe Holistic, the YOLOv3 object detection algorithm and a modified convolutional neural network (CNN) architecture. The study also studied and analysed various classification algorithms such as Naïve-Bayes Classifier, KNN and Random Forest Classifier. The study concludes that Hand Landmark detection combined with Random Forest Classifier for classification provided accurate and correct results.

VIII. REFERENCES

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