1. **Introduction**
   1. **Sign-Language**

Sign languages are a mode of communication that is mostly used by deaf or mute people. In sign language, hand gestures and movements, body language, or facial expressions are incorporated to convey meaning. Languages in this mode are not universal. People from different cultures and countries use different sign languages [1]. Around the world, there are more than 300 sign languages [2]. In sign language, gestures or symbols are organized linguistically. Sign language is a bridge between the deaf, mute and common people. Though many people think sign languages are not real languages, in linguistic terms, they are as rich and complex as any spoken language. Professional linguists have discovered that sign language exhibits the same characteristics as all languages [3].

* 1. **Sign Language Detection**

Together with the rapid advancements in information and technology, the interaction between humans and computers has also changed in the modern world.

There are more than 430 million people with speech and hearing disabilities worldwide, which is more than 5% of the world's population [4]. A sign language detection project provides assistance for these people. The sign language detection project uses a web camera to capture hand gestures, label those images, and then train those labeled images with the SSD Mobile Net algorithm. In order to get successful sign recognition three steps must be followed:

1. Capture the user's hand gestures or signs.
2. Classify each frame in real time.
3. Get the classification score and display the most likely sign [5].
   1. **Review of hand-gesture for sign-language recognition**

Human life is rendered easier by hand gesture recognition, which serves as a key to overcoming many difficulties. An extensive range of applications can be developed using the ability of machines to understand human activities and their meanings. Recognition of sign languages is one of the specific fields of interest [6]. Sign language recognition uses methods like identifying hand motions for different signs and segmenting hands from the background. This is done to forecast and string them into sentences that are both semantically correct and meaningful. The accuracy of a model is influenced by its background and environment. Gestures can be recognized in many ways, including vision-based and sensor-based systems. The vision-based approach is a prebuilt solution that is ready to configure and deploy using image and video footage of hand gestures. A sensor-based system, on the other hand, consists of multiple sensors that are aggregated as a single component that detects various parameters such as location, velocity, and trajectory [5]. There are a few steps to follow to develop a sign language recognizer:

* + 1. **Camera access and capturing image**

This sign language model is based on frames obtained by a web camera on a laptop. Different sign language symbols were captured from a variety of angles and in a variety of lighting conditions in order to improve their accuracy. The images were processed using the OpenCV python library.

* + 1. **Segmentation**

From these captured images, a specific region is selected that has the hand gesture of a sign language symbol. The goal is to predict that symbol. Images of the sign are surrounded by tight bounding boxes. With the LabelImg tool, all the different hand gestures were assigned specific names and labelled.

* + 1. **Classification**

When it comes to computer predictions, machine learning is used. There are four ways to approach machine learning: supervised, semi-supervised, unsupervised, and reinforcement learning. When it comes to supervised machine learning algorithms, training data is labeled and output data is specified. However, in unsupervised machine learning, the algorithm is trained on an unlabeled dataset and the outcome is predetermined [7].

The proposed model for sign language recognition utilizes supervised machine learning. This is because all of the images in the dataset have been labeled, and also because all results have been specified.

* 1. **Related works**
     1. **Real-time Sign Language detection**

Research on sign language detection has been done in New Delhi, India, to improve the communication between the deaf and general folk. They showcased their creation of a sign language recognition model based on Convolutional Neural network (CNN) technology. They created a dataset that has over 2000 images. Their dataset has a total of 5 classes and 400 images for each class. The symbols were Hello, Yes, No, I love you, and Thank you. They trained their dataset using SSD (Single Short Detection) Mobile net V2 architecture. It was a robust model that can consistently classify Sign language in the majority of cases. Since they used the Mobile net SSD model which is a single-shot multibox detection network, their model could scan the pixels of every image that were inside the bounding box coordinates and class probabilities to conduct detection. They used Tensor-flow object detection API that includes the SSD Mobile Net model. Their system was able to recognize selected sign language signs with an accuracy of 70 to 80% without a controlled background with a small light [5].

The accuracy table for the 5 classes:-

|  |  |
| --- | --- |
| Gesture Name | Accuracy (%) |
| Hello | 91.0 |
| Yes | 88.7 |
| No | 88.6 |
| Thank You | 84.1 |
| I love you | 82.4 |

* + 1. **Sign Language Recognition : State of the Art**

Karishma [8]

* + 1. **Sign Language Recognition with Tensor Flow**

Communication is the way to express or exchange information, ideas or feelings. To establish commutation between two or more people. However, it is slightly different among disable people; especially deaf and dumb people. They need different way to communication which we called Sign language. Being visual languages, they use the movements of hands, face, and body as communication movement. Sometimes it becomes hard to understand the meaning of sign language for normal people. To resolve this issue, one can build a model based on machine learning. A model can be trained to recognize different gestures of sign language and translate them into English. Author has created an Indian sign language dataset by using a webcam and then using transfer learning, train a TensorFlow model to create real-time Sign language recognition system. They have limited dataset. They used pre-trained COCO 2017 Dataset which was used in SSD Mobile Net v2 320X32.It has approximately 650 images in total, 25 images for each alphabet. For gesture translation, data gloves, motion capturing systems, or sensors have been used. Vision-based SLR systems have also been developed previously. Authors have worked on single-handed or Double-handed gestures. They used two algorithms to train the system, K-Nearest Neighbors Algorithm and Back Propagation Algorithm. Thus, this system has achieved 93-96% accuracy. The method that has been used for creating SLR systems are – Hidden Markov Model (HMM), The various HMM that have been used are Multi Stream HMM (MSHMM) which is based on two standard single streams HMM, light HMM and Tied Mixture Density-HMM. Models that have been used such as ANN, Naïve Bayes classifier, Multiplayer perceptron, Unsupervised neural network self-organizing map, self-organizing feature map, Simple Recurrent Network. Self-design methods have also been used such as the wavelet-based method and Eigen Value Euclidean distance.

|  |  |
| --- | --- |
| **Model** | **Accuracy** |
| The light-HMM | 83.6% |
| Multi stream HMM | 86.7% |
| SVM | 97.5% |
| Eigen Value | 97% |
| Wavelet Value | 100% |

The result of the system is based on confidence rate and the average confidence rate of the system is 85.45%. The state-of-the-art method of the Indian Sign language recognition system achieved 93-96% accuracy [9].

* + 1. **Sign Language Recognition using deep learning**

The IISL2020 dataset of diverse hand motions is used in the article to demonstrate Indian Sign Language recognition using LSTM and GRU. The suggested model performs better than any other ISL model that is currently available for terms like hello, good morning, and work. Furthermore, adding more LSTM and GRU layers and applying LSTM before GRU further improves the model's ability to determine the ISL. Future research can create various datasets under ideal circumstances, and model accuracy can be increased by rotating the camera or utilizing a portable device. As it is, the constructed model only considers the viewpoint of a single character. This strategy can be used in interpretation, particularly in the case of the ISL of continuous sign language leading to syntactic generation [10].

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