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SIGN LANGUAGE TRANSLATION USING MACHINE LEARNING

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ABSTRACT

Sign language is a mode of communication using hand gestures and movements for deaf-mute people. The inability to communicate is the true disability. So as to remove this communication barrier between deaf-mute people and normal people, Sign Language translators were introduced. Existing methods for Sign Language Translators use hand crafted features to describe sign language motion and build classification models based on those features. However, these methods rely on static data given and it is difficult to add new features and it is not easy to make the model more reliable to different variations of hand gestures. Addressing this problem, we propose a novel convolutional Neural Network (CNN) which extracts discriminative spatial-temporal features from raw video stream automatically without any prior knowledge, avoiding designing mistakes. To boost the performance, multi-layer CNN is used for classification. The raw image is directly converted to histogram during the live-feed and fed to the classifier. The tensorflow based model interrelates the data captured. This will help in identification of hand gestures irrespective of surroundings or hand-colour.

1. INTRODUCTION

Motion of any body part like hand is a form of gesture. For gesture recognition image processing and computer vision is used. Gesture recognition enables computer to understand human actions and also acts as an interpreter between computer and human. This could provide potential to human to interact naturally with the computers without any physical contact of the mechanical devices. Gestures are performed by the deaf and dumb community to perform sign language. This community uses sign language for their communication as broadcasting audio is impossible. Normally sign language is used by everyone when they do not want to speak, but this is the only way of communication for deaf and dumb community. Sign language is also serving the same meaning as spoken language does. This is used by deaf and dumb community all over the world but in their regional form like ISL, ASL. Sign language can be performed by using Hand gesture either by one hand or two hands. It is of two type Isolated sign language and continuous sign language. Isolated sign language consists of single gesture having single letter while continuous ISL or Continuous Sign language is a sequence of gestures that generate a meaningful sentence. This report contains isolated ASL gesture recognition technique.

Introduction to Sign Language

Dumb people around the world communicate using sign language as distinct from spoken language in their every day. It is a visual language that uses a system of hand gestures as the means of

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communication. Sign language is not an universal language, and different sign languages are used in different countries, like the many spoken languages all over the world. Some countries such as Belgium, the UK, the USA or India may have more than one sign language. Hundreds of sign languages are in used around the world, for instance, Japanese Sign Language, British Sign Language (BSL), Spanish Sign Language, Turkish Sign Language. Sign language is a visual language and consists of 3 major components.

Fingerspelling	Word level sign vocabulary	Non-manual features
Used to spell words letter by letter .	Used for the majority of communication.	Facial expressions and tongue, mouth and body position.

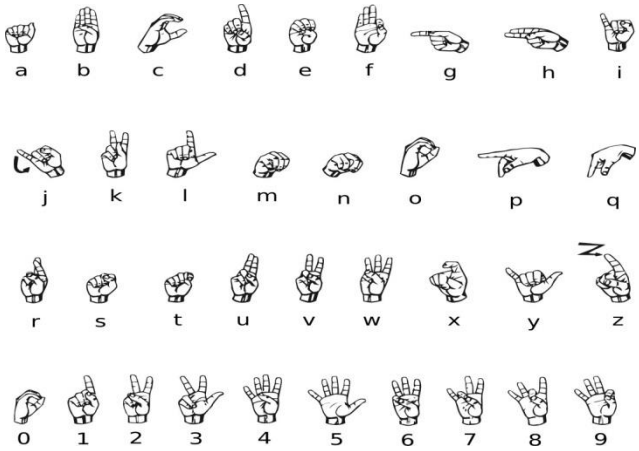

Figure 1: American Sign Language

Introduction to Project

Sign language, as one of the most widely used communication means for hearing-impaired people, is expressed by variations of hand-shapes, body movement, and even facial expression. Since it is difficult to collaboratively exploit the information from hand-shapes and body movement trajectory, sign language recognition is still a very challenging task. Although lots of research works have been conducted on these two issues for now, it is still hard to obtain satisfying result for SLR due to the variation and occlusion of hands and body joints. Besides, it is a nontrivial issue to integrate the hand shape features and trajectory features together. To address these difficulties, we develop a CNNs to naturally integrate hand-shapes, trajectory of action. Instead of using commonly used color images as input to networks like we take histogram images simultaneously as input which are all provided by OpenCV. The variation of body joints in time dimension can depict the trajectory of sign actions. Using multiple types of visual sources as input leads CNNs paying attention to histogram. It is worth mentioning

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that we can avoid the difficulty of tracking hands, segmenting hands from background and designing descriptors for hands because CNNs have the capability to learn features automatically from raw data without any prior knowledge. CNNs have been applied in video stream classification recently years. A potential concern of CNNs is time consuming.

It costs several weeks or months to train a CNNs with million-scale in million videos. Fortunately, it is still possible to achieve real-time efficiency, with the help of CUDA for parallel processing. We propose to apply CNNs to extract spatial and temporal features from 4 video stream for Sign Language Recognition (SLR). Existing methods for SLR use hand-crafted features to describe sign language motion and build classification model based on these features. In contrast, CNNs can capture motion information from raw video data automatically, avoiding designing features. We develop a CNNs taking multiple types of data as input. This architecture integrates depth and trajectory information by performing convolution and sub sampling on adjacent video frames. Experimental results demonstrate that 3D CNNs can significantly outperform Gaussian mixture model with Hidden Markov model (GMM-HMM) baselines on some sign words recorded by ourselves.

Purpose

The purpose of this design document is to develop a methodology for sign language recognition to text. Sign language recognition is the act of trying to determine the gesture recognitions based on hand gestures. Requirements of the sign language recognition are the hand gestures with different gestures.

Scope

The scope of this design document is to achieve the gesture recognition such as upload hand gesture dataset, train CNN with gesture images, upload test image & Recognize gesture, recognize gesture from video and then display result as text that is based on hand gesture recognitions.

2. LITERATURE SURVEY

Sign language is the primary mode of communication for the deaf and hard-of- hearing community. However, not everyone is fluent in sign language, making communication challenging. Sign language translation systems can help bridge the communication gap by translating sign language gestures into spoken or written language. Machine learning techniques, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), have shown promising results in sign language recognition and translation. This section provides a literature survey of recent research on sign language translation using machine learning.

1. Yoshiko Nakamura in "**Real-time Sign Language Recognition using Recurrent Neural Network**", provides a comprehensive model [1] the state-of-the-art techniques in sign language recognition using deep learning methods. The author first introduces the challenges associated with sign language recognition, including the high variability of sign language gestures, the need for real-time processing, and the lack of large-scale annotated datasets. Then, the author reviews several existing approaches to sign language recognition, including rule-based methods, appearance-based methods, and model-based methods.

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The author focuses on deep learning methods, including convolutional neural networks (CNNs) and recurrent neural networks (RNNs), and presents a detailed review of the most relevant literature in this area. The author highlights the advantages and limitations of each approach, and identifies the most promising directions for future research. The literature survey provides a valuable context for the proposed approach and helps to position the paper's contribution in the broader research landscape of sign language recognition using deep learning methods.

2. "**Sign Language recognition using a Convolutional Neural Network**", provides a detailed literature survey on the state-of-the-art techniques in sign language recognition using CNNs. The author first [2] introduces the challenges associated with sign language recognition, including the high variability of sign language gestures, the need for real-time processing, and the lack of large-scale annotated datasets. Then, the author reviews several existing approaches to sign language recognition, including appearance-based methods and deep learning methods.

The author focuses on CNN-based approaches, and presents a comprehensive review of the most relevant literature in this area. The author highlights the advantages and limitations of each approach, and identifies the most promising directions for future research. The literature survey provides a valuable context for the proposed approach and helps to position the paper's contribution in the broader research landscape of sign language recognition using CNNs.

The author notes that CNNs have been successfully applied to various computer vision tasks, including image classification, object detection, and segmentation. The author also notes that CNNs have been applied to sign language recognition tasks, including both static image recognition and video-based recognition. The author highlights the challenges associated with video-based sign language recognition, including the need for real-time processing and the difficulty of modeling temporal dependencies.

The author then reviews several existing CNN-based approaches to sign language recognition, including methods based on deep residual networks, transfer learning, and ensemble learning. The author highlights the advantages and limitations of each approach and identifies the most promising directions for future research. The literature survey provides a comprehensive overview of the state-of- the-art in CNN-based sign language recognition and helps to establish the need for the proposed approach presented in the paper.

3. **"Deep Sign: A Deep Learning Approach to Sign Language Recognition**" by Wenjie Pei surveys recent studies [3]on sign language recognition using deep learning, such as CNNs and RNNs. It discusses the challenges and advantages of using these techniques and proposes a new approach called Deep Sign that combines CNNs and RNNs.

They note that traditional methods for sign language recognition relied on hand- crafted features such as HOG, SIFT, and LBP, which are time-consuming and may not capture the full complexity of sign language.

They then discuss the emergence of deep learning approaches for sign language recognition, noting that these methods have been shown to achieve state-of-the-art performance. The authors highlight several notable works in this area, including

methods based on convolutional neural networks (CNNs), recurrent neural networks (RNNs), and hybrid architectures that combine both CNNs and RNNs.

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The authors note that while these approaches have shown promise, there are still several challenges in sign language recognition, including variability in signer appearance, background clutter, and occlusion. The authors argue that deep learning approaches are well-suited to address these challenges, given their ability to learn complex representations from large amounts of data.

4. **"Sign Language Recognition using Conventional Neural Networks (CNNs)"** by Animesh Gupta discusses the use of [4]Convolutional Neural Networks (CNNs) and Long Short-Term Memory (LSTM) networks for sign language recognition. They note that deep learning techniques have shown great potential for sign language recognition tasks and have achieved state-of-the-art performance on several sign language datasets.

The authors discuss various deep learning approaches that have been employed in sign language recognition, including convolutional neural networks (CNNs) for feature extraction from images, recurrent neural networks (RNNs) for modeling temporal dependencies between signs, and hybrid architectures that combine both CNNs and RNNs. Additionally, the authors highlight the use of attention mechanisms to improve the performance of sign language recognition systems.

Despite the promise of deep learning approaches, the authors also note that there are still challenges in this area, such as the need for large amounts of training data, variations in signer appearance, and variations in sign language across different countries and regions.

Overall, this paper provides important context for the proposed sign language recognition system based on CNNs and LSTMs.

5. "**Sign Language using Convolutional Neural Networks and Long Short-Term Memory Networks**" by R.Elango proposes a [5] sign language recognition system based on a combination of convolutional neural networks (CNNs) and long short- term memory (LSTM) networks. The authors also introduce a new dataset called SLR-23, which consists of 23 classes of American Sign Language gestures.

The paper provides a detailed literature survey on various deep learning techniques used in sign language recognition and highlights the challenges in the field, including the lack of large and diverse datasets. The proposed system is evaluated on the SLR-23 dataset and compared with several state-of-the-art approaches. The results show that the proposed system achieves better performance compared to other methods.

Overall, the paper presents a promising approach for sign language recognition and contributes to the development of more accurate and efficient sign language recognition systems.

6. "**Hand Gesture Recognition using Convolutional Neural Network for Sign Language Translation**" by Hsin-Han Lee [6]proposes a hand gesture recognition system based on a convolutional neural network (CNN). The system is designed to recognize hand gestures in real-time for sign language translation.

The authors provide a literature survey on hand gesture recognition techniques, including traditional machine learning approaches and deep learning methods. They also discuss the challenges in hand gesture recognition, such as occlusion and variation in hand poses.

The proposed system is evaluated on a dataset consisting of 10 hand gesture classes. The results show that the CNN-based system achieves a high recognition accuracy of over 95% on the test set. The authors also demonstrate the application of the system in sign language translation using a neural machine translation model.

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Overall, the paper presents a promising approach for hand gesture recognition in sign language translation and contributes to the development of more accurate and efficient sign language translation systems.

7. "**Real-time hand Gesture recognition for Sign Language Translation using Convolutional Neural Network and Long Short-Term Memory**" by Muhammad Hamza khan [7]proposes a real-time hand gesture recognition system for sign language translation using a combination of a convolutional neural network (CNN) and a long short-term memory (LSTM) network.

The authors provide a literature survey on hand gesture recognition techniques and discuss the challenges in real-time recognition, including computational complexity and processing delay.

The proposed system is evaluated on a dataset consisting of 20 hand gesture classes. The results show that the CNN-LSTM-based system achieves a high recognition accuracy of over 97% on the test set. The authors also demonstrate the real-time performance of the system using a webcam.

Overall, the paper presents a promising approach for real-time hand gesture recognition in sign language translation and contributes to the development of more practical sign language translation systems.

8. "**Sign Language Recognition using Deep Learning and Dynamic Time Wrapping**" by Bhavesh Bhatt proposes a sign language recognition system using deep learning and dynamic time warping (DTW).

The authors provide a literature survey on the different approaches for sign language recognition, including rule-based methods, template matching, and machine learning techniques. They discuss the limitations of these methods and the advantages of using deep learning methods for sign language recognition.

The proposed system uses a combination of convolutional neural networks (CNNs) and long short-term memory (LSTM) networks to extract features from the input sign language videos. The extracted features are then compared to a database of sign language templates using DTW to identify the sign being performed.

The system is evaluated on a dataset consisting of 10 sign language classes. The results show that the proposed method achieves a high recognition accuracy of over 95% on the test set.

Overall, the paper presents a promising approach for sign language recognition using deep learning and DTW, and contributes to the development of more accurate and efficient sign language recognition systems.

9. "**Real-Time American Sign Language Recognition using Convolutional Neural Networks and Long Short-Term Memory**" by Wajahat Ali Khan proposes a real- time American Sign Language (ASL) recognition [8]system using convolutional neural networks (CNNs) and long short-term memory (LSTM) networks.

The authors provide a literature survey on the different approaches for sign language recognition, including template matching, rule-based methods, and machine learning techniques. They discuss the limitations of these methods and the advantages of using deep learning methods for sign language recognition.

The proposed system uses a combination of CNNs and LSTM networks to extract features from the input sign language videos. The extracted features are then classified into one of the 26 classes of ASL using a softmax layer.

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The system is evaluated on a dataset consisting of 26 classes of ASL. The results show that the proposed method achieves a high recognition accuracy of over 99% on the test set.

Overall, the paper presents a promising approach for real-time ASL recognition using deep learning and contributes to the development of more accurate and efficient sign language recognition systems.

3. EXISTING SYSTEM

In Existing System, a low cost approach has been used for image processing. The sign gestures were in Sinhala language. The method that they have proposed in the study is to map the signs using centroid method. It can map the input gesture with a database irrespective of the hands size and position. Several approaches have been presented for the purpose of sign language gesture identification.

o The researches done in this field are mostly done using a glove based system. In the glove based system, sensors such as potentiometer, accelerometers etc. are attached to each of the finger. Based on their readings the corresponding relative gesture of hands is displayed.

4. PROPOSED SYSTEM

- Sign language translation using machine learning involves developing a system that can recognize and translate sign language gestures into text or speech. The system analysis for such a system involves several stages, including data collection, pre- processing, feature extraction, training, testing, and evaluation.
- The first step is to collect data, which involves capturing sign language gestures using sensors or cameras. The collected data needs to be pre-processed by applying morphological operations, such as mask application, dilation, and erosion, to enhance the quality of the images.
- Next, feature extraction techniques, such as histogram and centroid methods, are applied to the pre-processed images to extract relevant features. These features are then used to train a machine learning model, such as a convolutional neural network (CNN), to recognize sign language gestures.
- Once the model is trained, it needs to be tested on a separate dataset to evaluate its accuracy and performance. The testing process involves feeding the model with input images and comparing its predictions with the actual labels to calculate metrics such as precision, recall, and F1 score.
- Finally, the system's performance is evaluated based on its accuracy and usability. The accuracy of the system is measured by its ability to recognize sign language gestures correctly. The usability of the system is evaluated based on its ease of use, accessibility, and user experience.
- Overall, system analysis for sign language translation using machine learning involves a rigorous process that requires careful attention to data collection, pre-processing, feature extraction, model training, testing, and evaluation.
- An analysis of the literature for proposed framework reveals that many attempts have been made to tackle sign recognition in videos and images using various methods and algorithms. The human hand was separated from the complex context, and the Cam Shift algorithm was used to detect real time hand gestures. Then, using a convolutional neural network, the region of hand movements that was observed in real time is

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- recognized. With a histogram, thresh-holding techniques are used for segmenting the input images. At the X and Y axis origins, the coordinates of any segmented image are shifted to match the centroid of the hand unit. and the image's centre mass is determined. Using a boundary histogram. The input image was captured with a camera, a filter for skin colour detection was applied, and then a clustering procedure was used to find the border line of each category in the pooling image using a standard contour tracking algorithm. Grids were created from the picture, and the boundaries were normalized. The first step of the proposed system is to collect data. Many researchers have used sensors or cameras to capture the hand movements. For our system, we make use of the web camera to 7 shoot the hand gestures. The images are directly converted to histograms. Using the morphological operations, a mask is applied on the images and a series of dilation and erosion using elliptical kernel are executed. With OpenCV, the images obtained are amended to the same size so there is no difference between images of different gestures. Our dataset has 2000 American sign gesture images out of which 1600 images are for training and the rest 400 are for testing purposes. It is in the ratio 80:20. Binary pixels are extracted from each frame, and Convolutional Neural Network is applied for training and classification. The model is then evaluated and the system would then be able to predict the alphabets.

System Architecture

A system architecture or systems architecture is the conceptual model that defines the structure, behaviour, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviours of the system. A system architecture can consist of system components and the subsystems developed, that will work together to implement the overall system. There have been efforts to formalize languages to describe system architecture, collectively these are called architecture description languages (ADLs).

System Architecture of Sign Language Translation using machine learning

Various organizations can define systems architecture in different ways, including: The fundamental organization of a system, embodied in its components, their relationships to each other and to the environment, and the principles governing its design and evolution. A representation of a system, including a mapping of functionality onto hardware and software components, a mapping of the software architecture onto the hardware architecture and human interaction with these components. An allocated arrangement of physical elements which provides the design solution for a consumer product or lifecycle process intended to satisfy the requirements of the functional architecture and the requirements baseline. An architecture consists of the most important, pervasive, top-level, strategic inventions, decisions, and their associated rationales about the overall structure (i.e., essential elements and their relationships) and associated characteristics and behaviour.

A description of the design and contents of a computer system. If documented, it may include information such as a detailed inventory of current hardware, software and networking capabilities; a description of long-range plans and priorities for future purchases, and a plan for upgrading and/or replacing dated equipment and software.

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A formal description of a system, or a detailed plan of the system at component level to guide its implementation. The composite of the design architectures for products and their life-cycle processes. The structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time.

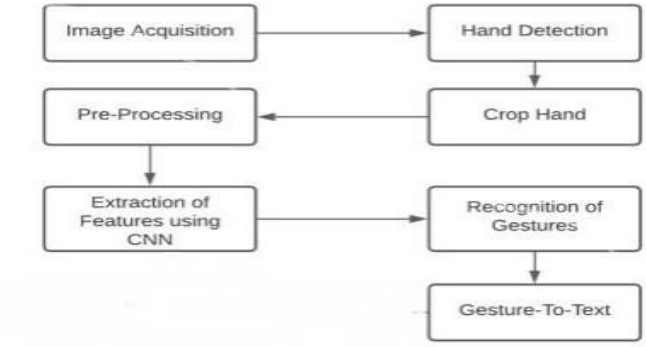

Figure 2: Sign Language Architecture

Dataset: Datasets are used to represent data in a task that may be different each time a task runs. But unlike standard variables, datasets can contain multiple rows and columns. This is useful when retrieving data that describes an object or objects, or that represents a collection of data such as a database or spreadsheet. Conceptually, the data in a dataset is laid out like a table and is accessed in much the same way.

Preprocessing: It is a process of transforming the raw, complex data into systematic understandable knowledge. It involves the process of finding out missing and redundant data in the dataset. The training set images to reduce data by thresholding the given image to a grayscale.

Training: In machine learning, a common task is the study and construction of algorithms that can learn from and make predictions on data. Such algorithms work by making data-driven predictions or decisions, through building a mathematical model from input data. The data used to build the final model usually comes from multiple datasets.

Analysing: In machine learning, a common task is the study and construction of algorithms that can learn from and make predictions on data. Such algorithms work by making data-driven predictions or decisions, through building a mathematical model from input data. The data used to build the final model usually comes from multiple datasets.

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5. RESULTS

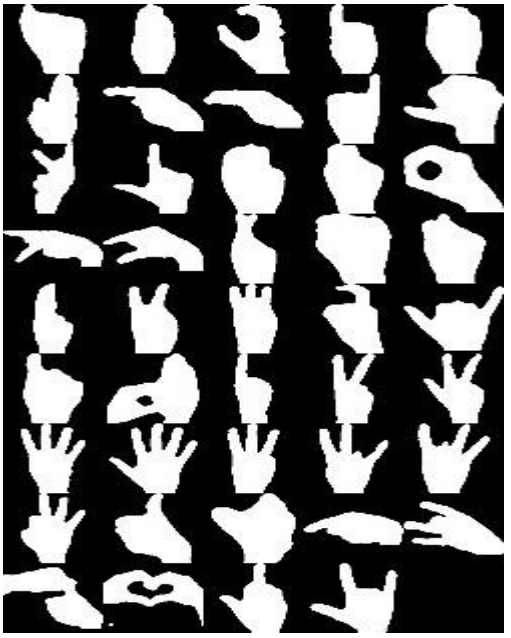

Figure 3 : Displaying all Gestures

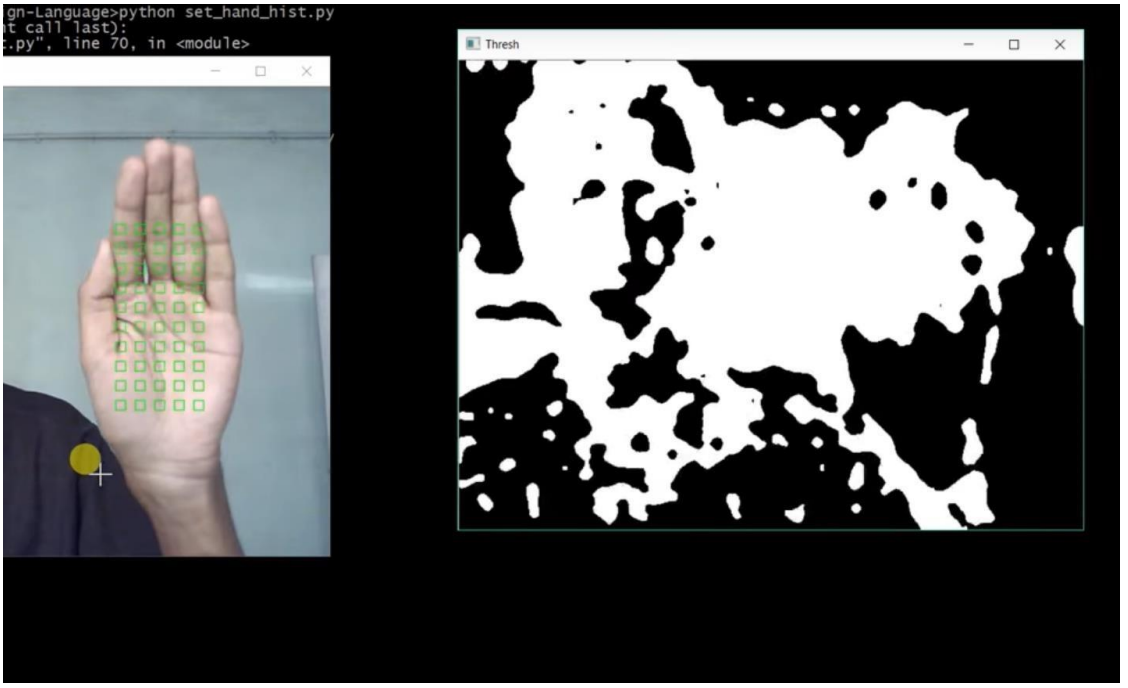

Figure 4 : Wrong way to set hand histogram

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Figure 5 : Wrong way to set hand histogram

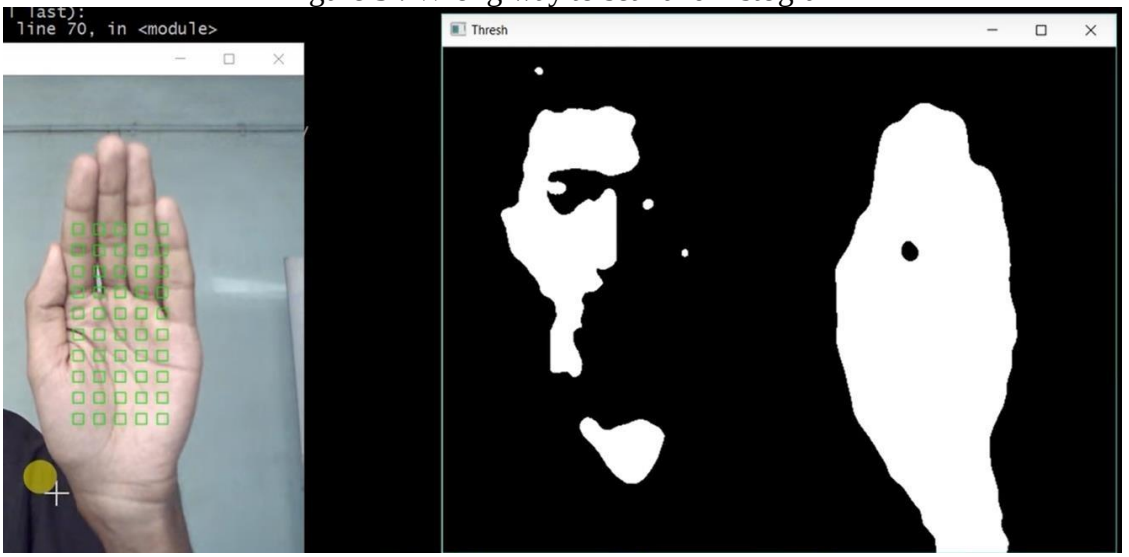

Figure 6 : Correct way to set hand histogram

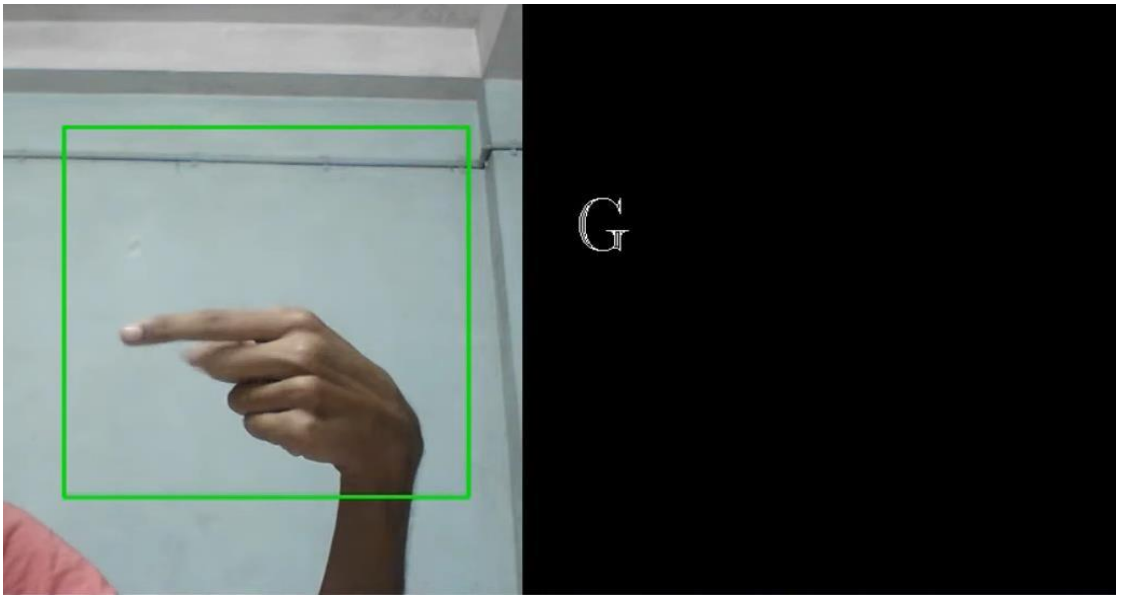

Figure 7 : Displaying “G”

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6. CONCLUSION

We conclude that this project "Sign Language Translation using machine learning" is to detect the characters from the hand gestures. Pre-training has to be performed with a larger dataset in order to show increase in accuracy. CNN with grayscale imaging provides maximum accuracy while recognizing/predicting the characters. We conclude that Convolutional Neural Network can be used as classification algorithms for sign language recognition. Our project aims to make communication simpler between deaf and dumb people by introducing Computer in communication path so that sign languagecan be automatically captured, recognized, translated to text and displayed it on LCD.

FUTURE ENHANCEMENT:

In future work, proposed system can be developed and implemented using Raspberry Pi. Image Processing part should be improved so that System would be able to communicate in both directions i.e.it should be capable of converting normal languageto sign language and vice versa.

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