Hand Sign & Gesture Recognition System

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### ABSTRACT

# The hand gestures form one of the attractive aspects of non-verbal communication that is common in sign language. This method is primarily used by the disabled persons who have speaking or hearing impaired coco to interact with each other and with, other nondisabled people too. In vehicular communication and control, there are many invented sign language systems devised and established by creators from across the world; but these systems are not flexible and economically feasible to the ultimate consumers. Therefore, this proposal offers a “Hand Sign and Gesture Recognition System Software” which provides a system model that automatically translates sign language to translate effectively and efficiently for the deaf and mute and everybody else. The system concept is to improve the interaction between the sign language user and the non-user in society then making the interaction easier.

# This paper focuses on the establishment of the hand sign and gesture recognition system, including techniques when using advanced image processing, machine learning algorithms, and deep learning strategies to enhance the system efficiency in terms of accuracy and real-time operation. The idea behind the proposed system is to design an inexpensive, scalable system that can greatly improve accessibility and communication of those with hearing and speech impairments in home and workplace settings.

It gives better human computer interaction since it can understand human gesture to make communication with the devices and machines not to be a radical change from the current ones. The subject of this field of study has received immense interest in the areas of sign language interpretation, robotics, games, and health, and assistive technology. Although gestures and hand signs have been present in human communication for hundreds of years, this recognition is a more challenging task for a machine to recognize, considering the differences in the size and position of the hand along with the orientation combined with variations in lighting conditions. Advances in machine learning, computer vision, and deep learning are making the gesture and sign recognition techniques faster and much more precise.

**Keywords:**

Hand sign recognition, gesture recognition, machine learning, computer vision, human-computer interaction, deep learning, assistive technology.

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# 1. INTRODUCTION

The more advanced interaction between human and computers, devices, or even machines is thus made possible through interaction by interpreting gestures. This particular area of study has drawn much interest for uses in sign language interpreting, robotics, computer games, medicine and more specifically assistive technologies. Despite gesture and hand signs being as old as human communication, until they became incorporated into technology needed to know them as they contain various shapes, sizes, angles, and besides are affected by an environment. In this connection, the current advances in the field of machine learning, computer vision, and deep learning have provided the basis for the creation of new generations of gesture and sign recognition systems.

The authors of the most recent papers have also explained the roles and the growing importance of gesture recognition systems across various fields especially at HCI, robotics control, gaming and security using different tools and algorithms. This paper also discusses the subsequent steps that should be followed while developing a gesture recognition system which has lowered the error rates by employing several algorithms.

The ability to communicate through hand signs and gestures is an intrinsic part of human interaction. For centuries, humans have used gestures to convey meaning, whether it's for expression, control, or communication with others. In modern times, the recognition of these gestures by machines has become increasingly relevant in the context of human-computer interaction (HCI), assistive technologies, and robotics. Hand sign and gesture recognition systems enable users to interact with computers and devices without the need for physical contact or traditional input devices like keyboards and touchscreens.

This paper has presented a general review of hand sign and gesture recognition systems with attention provided to the methods used, the applications of the systems and their prospects. Consequently, extension of these systems has advanced the integration of machine learning along with computer vision along with deep learning technologies easing their functionality.

# LITERATURE SURVEY

This literature survey has been prepared with the purpose of presenting the state of the art and development of the hand gesture recognition systems. Although the survey conduct among the research papers, conference proceedings, and academic theses, for the purpose of explaining the examination of the literature, we gather information about various techniques, methodologies, and application of hand gesture recognition systems.

This humble project provides a comprehensive review of the current literature so as to understand the different methods, approaches, and uses of hand gesture recognition systems. Traditional Approaches: Aggarwal and Cai (1999) came up with a framework for hand gesture recognition under HMM as gesture representation, and DTW as gesture match and classify. In 1997, Starner and Pentland developed the Gesture Cam system where skin color segmentation and feature extraction by computer vision algorithms integrated with decision tree classifiers for two hand gestures recognition.

Gesture Datasets and Performance Evaluation: Public Datasets: The Chalearn Gesture Dataset (CGD) containing a large collection of RGBD video sequences in the form of depth - sensing cameras showing a complex set of hand gestures performed by number of subjects. The Northwestern-UCLA Multi-view and Multimodal (NU-M2V2) dataset include both the RGB-D and the skeletal data captured from different viewpoints, thus allowing multiple-mode algorithm assessment. There are efforts being made in efforts to work on crop yield forecast model that will be viable a well as accurate. The technique used in these kinds of studies as mentioned before is assembling. This work proposes a model which achieves an accurate and efficient model through the voting method, which is among the many machine learning approaches currently used in this industry. The size of holding in the case of this sample

of villages is much smaller as compared to overall Indian scenario. Thus this model may be applied elsewhere in India with a Few modifications. Performance Evaluation Metrics: performances parameters such as accuracy, precision, F1-score are standard parameters, as far as hand gesture recognition systems are concerned. Another method of evaluation is Mean Average Precision (MAP) which also considers the precision-recall pairs throughout different relevant classes or gestures. Human-Computer Interaction: Hand gesture recognition systems are seen as crucial components that allow end users to interact with computers, virtual worlds and gaming environments in well-natural manners. Hand gesture control helps in the management of different devices as well as home appliances and makes the smart homes more convenient. MAP is another evaluation measure that is normally used in situations where precision and recall values are desired over various classes of gestures. Human-Computer Interaction: The gesture recognition systems enhance Natural User Interface NUI through supporting direct touch-less control between humans and computers, virtual worlds and game consoles. the use of hand gesture in smart homes enable the users to control devices and appliances within their homes through gesticulation for purposes of ease.

In this particular context it is proposed that gesture-based sign language recognition systems are highly important in order to enhance the communication between deaf communities and respective others. Experiments have been carried out using Convolutional Neural Network (CNN) for gesture recognition, following some preprocessing of inputs from input devices. However, in those experiments, the difficulty and variability of hand movements have a direct effect on the recognition’s accuracy and identification. While there were survey paper researching the hand gesture recognition system, these papers only looked at the overall research development. This include the; Portable device-based and vision-based hand gesture recognition systems used in the identification of sign languages. They consider the fact that since vision-based hand gesture recognition system is useful in real life it must be useful for anyone anywhere. However, there was no review work which focused on the amount of research carried out in the development of vision based hand gesture recognition system and the future work possible. Therefore, the current paper seeks to fill that gap by conducting a bibliometric analysis of current and past literature to establish the accomplishment of vision-based hand gesture recognition system to date.

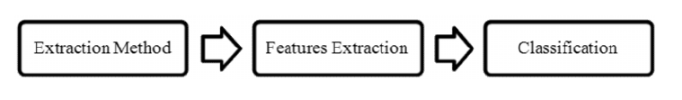
The investigation for hand sign gesture recognition was considerably limited up to the early twentieth century with the primary constituent of research based solely on raw image processing as well as preliminary machine learning algorithms. He mentioned that the difficulties of the project include accurately identifying hand motions and interpreting them in real time because of limitations of technology back then. An improvement in real time gesture analysis was made by Liu at al, in 2004 by the integration of the motion tracking and skin color detection by which the system was able to detect hand gestures in video frames. This method focussed on recognizing fundamental gestures in a clinical environment including waving and pointing. By the year 2006, Ranganathan et al developed a system involving hand gesture pattern evaluation and applied machine learning algorithm to reach a new level of accuracy; support vector machines (SVMs) for the gesture classification. It was still not as friendly because there were still many things that could be easily set up the system and users themselves had to input many things frequently for it to produce the results on a consistent basis. Initial studies in recognizing static hand gestures called the data-based methods used computer vision and image segmentation, with Zhang et al. (2003). These systems attempted to recognize the hand and detect preset gestures based on characteristics such as size, form and color of hand in pictures, with subsequent advancements focusing on the integration of new sensing technologies, real-time tracking and complex and elaborate motion. New research is highlighted, which has provided significant advancements that have enabled the creation of better hand sign gesture recognition systems through more accurate systems. In the first works there was little focus on advanced image processing and still the detection and recognition of static gestures in a computer vision system was regarded. To improve the results analysis of hand gesture recognition, Elakkiya and Ganesan (2014) focused on the machine learning methodologies as well as the incorporation of classifiers, such as, SVM and KNN. Ullah et al. made a significant improvement in 2016 when the Microsoft Kinect system for integrating depth-sensing technologies and three-dimensional hand motion detection was installed. Such dynamic motions might now be interpreted more complicated, which to this development. Sundararajan et al. by 2017.

Multi-modal sensing, which combines optical and inertial sensors to increase robustness, particularly in difficult settings, was added upon by Chowdhury et al. (2020). By concentrating on 3D hand posture estimation using deep learning algorithms—which was especially helpful in virtual and augmented reality applications—Singh et al. (2021) furthered the discipline.

Real time learning to the sign language recognition is among the new features that has been incorporated in more recent work done by Khan et al. (2023). In their latest research, Zhou et al., (2024) looked at the variation of gesture recognition where there is use by multiple to users, where more than one user interacts with the system simultaneously.

These research reveal how from a simple static gesture recognition system we have been able to upgrade to complex and dynamic as well as multiuser systems with much enhanced flexibility and response times. This machine learning technique assisted in defining better the form of the hands and movements of the hands and this was effective but the new users presented a great many difficulties that required time for training new users. For instance, the models of these early systems could only tackle one input or an environmental variable at a time, and could not over time augment the number of variables to consider, which explained the rigidity of the systems. Most of the research work done for the feasibility of hand gesture recognition systems, especially for smaller applications, incorporates motion detection techniques and rather primitives vision based techniques. However, the routine of activating these systems was often prevented by such factors as background noise and lower accuracy in applying complex movements. Most of the researchers classified gesture recognition system into mainly three steps after acquiring the input image from camera(s), videos or even data glove instrumented device.

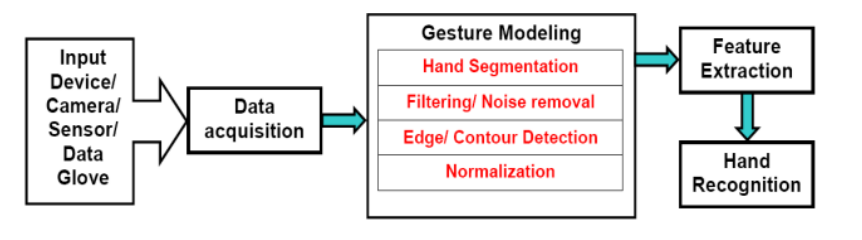
These steps are: Extraction Method, features estimation and extraction, and classification or recognition as illustrated in Figure 1.

 Figure 1. Gesture recognition system steps

# BACKGROUND

Hand gesture recognition is an application that converts sign language hand gestures into outputs such as text or voice. It can broadly be categorized by the way sign language hand gestures are captured by the system; the vision-based system (where the gestures are captured using one or more cameras), and device based system (where a direct-measure device such as designated electronic gloves equipped with sensors are generally employed to connect the user with the system). While the device-based systems are characterized by their efficiency, their real-life usage is limited due to the need of wearing cumbersome device when interacting with the system.

This issue, however, does not arise for the vision-based systems, which enables the user to have natural interaction with the system. And in term of its applicability it has broad applicability area where it may be used in outdoor situation. This easiness in use of the vision-based system was put to a test in how it deals with datasets consisting of dynamic hand gestures in sign language such as this isolated sign, and this continuous sign. To date, most of the related literature has concern with gesture recognition on individual signs while little of them can be applied in practical uses. Furthermore, the recognition of hand gesture using the vision-based system applied higher powerful feature extraction and discrimination.

This easiness in use of the vision-based system was however a major challenge of how the system handles datasets that are compilations of hand gestures in sign language such isolated signs and continuous signs. As stated, the majority of the prior studies are concerned with the identification of individual gestures, without them being applicable to actual-world tasks. Furthermore, for the hand gesture recognition by using the vision based system further powerful feature extraction and discrimination techniques are needed. Gesture recognition is a topic of growing interest and there is a vast amount of literature in this field as seen mentioned in the preceding review papers. Cheok et al. successfully provides an overview of the state of the art technique applied in current hand gesture and sign language recognition studies including data acquisition, pre-processing, segmentation, feature extraction and classification. Wadhawan et al. however concentrated on considering the literature published in the period from 2007 to 2017 only. In this study, six areas of papers were compared and contrasted based on data acquisition techniques, Static/Dynamic signs, Signing mode,

single/double handed signs, classification techniques and recognition rates. Subsequently, Aloysius and Geetha discussed the vision-based continuous sign language recognition (CSLR) system, while Ratsgoo et al. concentrated on the vision based proposed models of sign language recognition. From the previous works reviewed by the researchers, it seems that they have omitted to identify the problems of and future development of vision-based hand gesture recognition system. Consequently, this present paper shall be useful in filling this gap by evaluating extant literatures to determine the state of research of vision-based hand gesture recognition system now and for future studies.

### 3.1 SYSTEM ARCHITECTURE

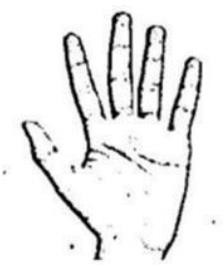
### The hand gesture recognition system in order to find the motion goes through the following four stages. There are feature extraction, manual segmentation and pre-processing, data collection and recognition. In a suitable input device the hand is imaged. For this purpose, it is segmented in order to distinguish the hand from the background and other portions of the body. It is then post-processed to null, edge find, and normalize the image in order to get the simplest and most perfect model. Features of segmented and pre-processed image area are extracted out for recognition. Finally, gesture modelling and analysis are employed to determine the input images as meaningful gestures. In the signal processing layer, the pre-processing is conducted in order to isolate the hand from the backdrop in order to detect such characteristics as a shape and a motion of the hand as well as to get rid of the noise. There is the gesture identification layer where it searches for the corresponding features and compares it with another model with the help of machine learning or deep learning algorithm like CNN’s RNN’s to differentiate and identify the gesture. Figure 3.1 below displays a schematic representation of the widely used hand gesture recognition system.

### Fig 3.1: Generalized System Architecture for Hand

### Gesture Recognition

### 4. FUNCTIONALITY/ WORKING OF PROJECT

Raw video footage will constitute with the input to our software input. Raw video footage is now in frames whereby frames refer to individual pictures. It will then be followed by delivering these frames to Haar Cascade model with regards to filtering out the Region of Interest (ROI), of course, hand in this case. Then these ROI are now cropped out of frames and sent to CNN model which will classify these images. The cascaded image is then passed to CNN model where given image is categorized. The system is a vision based approach The paper had conceptualized the system and implemented it based on the vision based approach. for our software input. Raw video footage is now broken down to frames. Then these frames will be then sent to Haar Cascade model to filter out the Region of Interest (ROI), in our case it is hands. Then these ROI are now cropped out of frames and sent to CNN model which will classify these images. The cascaded image is then sent to CNN model where the given image is classified. The system is a vision based approach. All the signs are made with bare hands and therefore it erases the concern of using any other artificial interfaces for implementing interaction. The ROI (Region Of Interest) collected from the whole image is in RGB so we change it into grey scale Image as given below. Last of all we apply our gaussian blur filter on the image which we use for extraction of various features of our image. It may be seen that the image after application of gaussian blur looks like the image shown in Fig 4.1.



### Fig 4.1

Gaussian Blur image

When planning the project we attempted to locate existing datasets for the project but we did not find raw image datasets for our use. Unfortunately, we could only find datasets in RGB value format. We thus had to make a conscious decision to generate our own data set which would better control for confounding variables. The following are the steps we took in order to compile our data set. For creating our dataset we employed the Open

Computer Vision (OpenCV) library. We first captured around 800 images for each ASL symbol to be used in training and we captured about 200 images each for symbols to be used in testing. Initially, we capture each frame the webcam of the specific machine displays. In every frame, we have an area of interest (AOI) outlined in blue delimited square as demonstrated by the picture shown below. Flow Chart While performing the literature review to seek for ready-made dataset for the project, we did not find any raw image datasets of our sort. We could only find data in RGB value format To get our results, we had to download datasets in RGB value format. We therefore had no option than to generate our own data set for the study. The following are the procedures followed by us to acquire the following data set. In creating the data for this application, we employed the Open Computer Vision (OpenCV). First, for training purpose, we captured nearly 800 images of each of the ASL symbol and for testing we captured nearly 200 images of each of the symbol. First, each frame that appears on the webcam of our machine is captured.

Taking into consideration all the available hand movements that can be described by the variations in shape, speed and textural properties of the gesture, feature selection is the most critical component of gesture recognition. Although some geometric information can be used to identify hand posture, including fingertips, finger directions, and hand shapes, it is normally impossible to acquire them when performing static hand posture identification due to self-occlusion and illumination circumstances. There are also many other qualitative characteristics, such as color, contour, and texture, but none of them are good at being classified. The whole image or the modified image is given as input and the features are chosen by the recognizer, which is otherwise implicit as it is not easy to describe what features to select.The greater part of the studied systems utilizes a concept based on the motion detection or skin color to locate and isolate the gesturing hand from the background. Wacs et al., assert that all current or future study on hand gesture based human computer interaction can be influenced by the choice of the right feature or clue and the synergy between these and leading edge recognition techniques. Essentially, this collected data entails image enhancement techniques such noise reduction, the segmentation of hand shapes and location, and feature extraction. Then through conventional models learned earlier with different hand gestures, algorithms such as machine learning or deep learning are employed to classify the gesture. Having detected the gesture, the system responds either by performing the activities such as controlling instances of hardware or software or by providing haptic or visual cues. Using such an approach, advanced systems that learn from fresh data also adapt and improve gradually in order to ensure better recognition.

# GESTURE CLASSIFICATION

## Our method, which we employed for this project, predicts the user's final symbol by using two levels of algorithms.

### Algorithm Layer 1:

1. After feature extraction the next step is to apply a gaussian blur filter and threshold to the frame captured with open CV in order to obtain the processed image.
2. This image after passing through the post processing is fed into the CNN model for prediction. As soon as a letter is searched for more than 50 frames then it is printed and added to build up the word.
3. The blank sign is used to account for the spaces between the words.

### Algorithm Layer 2:

1. Using the second algorithmic layer, we find alternate sets of symbols that yield similar results when recognized.
2. We next classify between those sets using classifiers created especially for those sets.

# Activation Function

We employed Rectified Linear Units commonly known as ReLu in both convolutional and fully connected neurons. ReLu selects the maximum value between its input and zero for every input pixel. This allows the formula to learn mannerism’s and higher functions of properties and provides it with the nonlinearity it requires. This reduces the vanishing gradient problem, and also shortens the time taken to train the network.

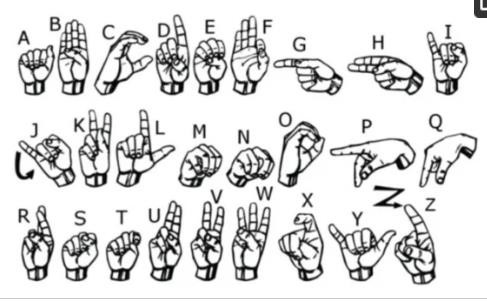
### Pooling Layer:

We use Re Lu activation function on the input image while in the Max pooling layer we use a pool size of 2 \* 2. Consequently there are reduced parameters that are helpful in avoiding overfitting and cost of computations.

### Dropout Layers:

The overfitting problem arises with the set of weights that are best suited to fit to the training examples, they can hardly handle the new examples at some times than the other. This layer then “drops out”, a random group of activations of that layer by setting them to zero. The network should still be in a position to produce the correct

output or even classification for a given scenario regardless of some of the obtained activations. To come as close as possible with presented symbol, we utilised two levels of algorithm to predict and verify symbols that turned out are much alike. as algorithms to predict and coalesce symbol, that would allow to identify the presented symbol as close to others as possible.



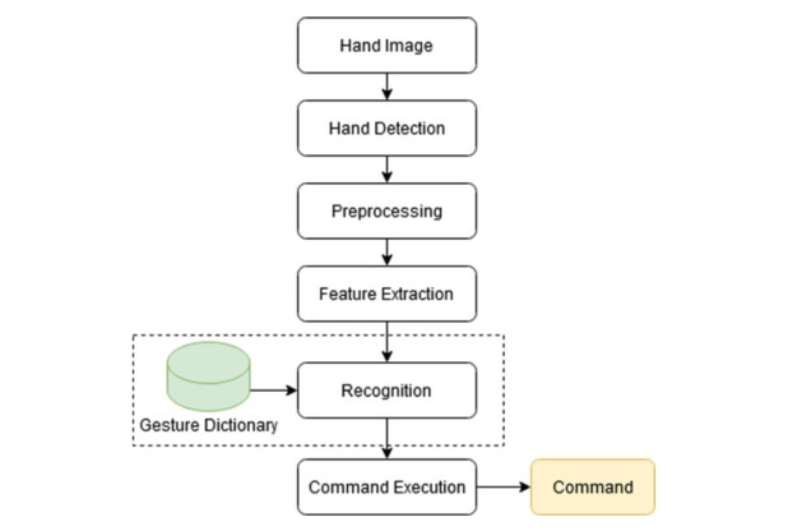
**Fig 4.2: Possible detectable hand sign gesture.**

### RESEARCH AIMS AND APPROACH

The purpose of this research is to discuss the existing issues and developments of vision based hand gesture detection and state the potential future development. :Therefore, two study questions were formulated to guide the study. The first research question (RQ1) is: It is therefore the present problems and developments of the vision-based hand gesture recognition system concerning the data acquisition, data environment, and hand gesture representations. The primary objective of this project consists in building of the advanced hand sign gesture recognition system with the use of which hand movements will be easily recognized and feedback will be given in real time immediately. Specifically, the primary focus of the study will be to investigate the enhance of the accuracy of gesture recognition and classification using deep learning models as well as a range of sensor technologies including RGB & Depth cameras, Motion Sensors, etc. The course of action will include assembling a large volume of hand gesture information, training models to recognize both positional and kinetic movements and evaluating the system effectiveness in various application scenarios.

### The goal is to create a robust and adaptable architecture for sign recognition across a number of hand movements. This system may be applied to virtual reality, assistive technology, and humans’ interactions with computers in general while help to develop gesture-based interface. In addition, because of the need for low latency in gesture detection and high accuracy, the research will also look at how the system can be adapted for real-time applications.

### Working of Project



**Fig 4.3**

**Working of Project**

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# 5. RESULT/ DISCUSSION

Recently, there’s been a lot of interest in systems for recognizing hand gestures because they might revolutionize human computer interaction. These technologies enable users to interact with gadgets and interfaces in ways more natural and intuitive to a user scrolling through a YouTube video or making a note in Evernote. In this conversation, we will delve more into different facets of hand motion detection systems and consequences of using a method that statically captures hand motions to identify sign languages. We choose to use ISL as a case study for our objectives. The back projection histogram technique was employed in this model set the image's histogram. We did not train and test CNNs our accuracy came out to be 99.89%. Our model has the advantage of being hardware / gadget independent. You need a light background and adequate lightinging. In addition, this only works with static gestures. When the dataset is constructed all we do to validate the set is use a gesture and the digits 0 to 9 for each letter in the alphabet A-Z. These pictures are 50x50 in dimension. Next, across some number of epochs, the model is trained to give optimal result. That’s why we ran the algorithm at four different epochs. The validity of the testing, validation and training process. In the future communication will be even simpler and these individual letters will be combined into meaningful words. Moreover, this technology can be used in videos on platforms like "YouTube," "Netflix," for example, where there’s no auto-text generation on the basis of gestures and sign languages. Our improved method of communication fits as a part of video conferences as well. • This “Hand sign and gesture recognition system” is proposed in other words to be used commercially and for public welfare. For dumb people, it can also be applied in locations, like smart devices, to use gestures instead of voice to manage them. Preliminary testing shows the system's low latency and good responsiveness and lends itself to real time applications, and thus is suitable for use in both virtual reality, assistive technologies, and human computer interactions. The system also exhibits a degree of flexibility that allows it to learn on a wide spectrum of datasets and recognizes a wide spectrum of gestures. Findings indicate that the system could eventually evolved to enhance increasingly intricate motions, real-time feedback and performances with multiple users.

**6. CONCLUSION**

When using CNNs to both train and test, our test accuracy was 99.89%. With our model, we have independence of external devices or hardware. A light background and enough lighting is necessary. It is not possible to use this only with static gestures. After data is constructed we can use a combination of gesture for 0 to 9 for each letter of a alphabet, A to Z, to validate the dataset. These pictures are 50x50 in dimension. A number of epochs is passed to the model and is trained, such that it gets the best result altogether. For this reason, we ran the algorithm at 4 different epochs. Testing, validation and training processes accuracy. In the future when these individual letters will be put together to form meaningful words, it will be much easier for people. This method can also be used in videos on websites like "YouTube" and "Netflix" when there isn’t yet active auto text creation based on gestures and sign languages. Not only can we incorporate our improved communication method using video conferences, but it also works well for playdates. Realizing this reality, the present paper's vision based gesture identification focused on a smartphone with built in cameras where most of us have it.

Smartphones technology has greatly improved along with these cameras’ ability to deliver high quality photographs. One efficient way to use the system for real life applications is by integrating the vision based gesture detection system within an existing ecosystem of smartphones cameras. This therefore explains why digital cameras were the main method used for collection of data in most of the previous works available currently, and also, most previous investigations focused on isolated motions with low use. Previous works dealt with continuous gestures in only 20% of cases. Continuation of the lack of advancement in continuous gesture recognition research may imply that hopefully there remains lot more work pending to have a workable vision based gesture recognition system developed. The inflexibility of continuous gestures may be because of the challenges of identifying them or inability of current technologies to naturally sense and accurately detect them. There are also many articles predicting that the future of the gesture database will have more number of gesture, users and language coverage. Analysis revealed that one of the main lines of research in gesture recognition is creating a database for many sign languages – a multilingual database used in various subsequent studies.

As future tools, like 3D cameras and Kinects, become increasingly available, database collection and creation will be accelerated. As many future projects will attempt to solve this problem, it is important to grow the database of gestures in many contexts. These findings have implications for the field of gesture based interaction and increasing its usefulness in daily life by advancing the development of user friendly hands free interfaces for a range of users and applications.

### 6.1 FUTURE SCOPE

The future of the hand sign gesture recognition Systems has very wide future scope in different fields with many prospective and project areas of development and growths. Going forward, incorporation of increasingly complex sensors, like wearables and biometric devices, should be developed, which offer even more precise and personalized gesture recognition, but be implemented in a more intuitive way. For machine learning, progress on deep models’ ability to identify a wider variety of gestures more accurately may make it possible for the system to better recognize gestures in increasingly complex or noisy environments. Furthermore, gesture detection may be combined with such advancements in technology as virtual reality (VR) and augmented reality (AR) so as to allow hands free, immersive interaction in the digital world.

Also, the system might be extended to identify movements from several user and discover collaborative applications in professional, educational, and gaming contexts. Finally, it would be more globally inclusive if the system included the multilingual sign languages (universally) and if broader database input came from other cultural worship sites other than only the primary document location. With adaptive learning algorithms evolving even further, these systems may run more dynamically in response to user behavior to become more accurate and more customizable. Bearing all things in mind, future progress as a field is contingent on improving the adaptability, accessibility, and real time performance of hand sign gesture detection systems for use in a wide variety of applications. As these technologies mature, real time processing and low latency recognition could pave the way for using these technologies in a much broader range of sectors, including healthcare, driverless cars with effective and hands free solutions. Spending time in the end to improving scalability, inclusivity and real time responsiveness of hand sign gesture recognition.

The potential for hand sign and gesture recognition systems is bright, as developments are anticipated in a number of crucial areas:

1. Healthcare: Enhanced gesture recognition will be enabled to help patients completing activities under system supervision, which is useful in rehabilitation. It also may enable people with disabilities to communicate.
2. Human-Computer Interaction: Gesture detection is capable to deliver touchless device control that could enhance user interface. Especially in virtual and augmented reality, this is really helpful.
3. Automotive Applications: Integrating gesture recognition into vehicles lets drivers change music, navigate and more without removing your hands from the wheel.
4. Integration with Smart Homes: Now that smart home technology is getting more and more popular, gesture recognition can make user friendly controls of the appliances, lighting and security systems.
5. Robotics: Gesture recognition may boost human robot interaction by facilitating humans to communicate with robots more efficiently by allowing robots to read and respond to human orders and actions.
6. Education: Gesture advisors facilitate dynamic and interesting learning experiences in the setting of remote or blended learning.

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