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# An Enhance Uniform & Robust ASL Recognition Approach Irrespective of Color & Shape

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*Abstract:* **American Sign Language (ASL) is a well developed and standard way of communication for hearing impaired people living in English speaking communities. Since the advent of modern technology, different intelligent computer-aided application have been developed that can recognize hand gesture and hence translates gestures into understandable forms. In this proposed system, Hand gestures images representing different English alphabets are used as an input to the system and then it is tested for a different set of images. The sign recognition accuracy obtained will be up to the mark.**

*Keywords:* **ASL character Hand gestures, Filtering Image, Edge Detection, and Image matching.**

## 1. INTRODUCTION

### 1.1 Image processing:

It is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or, a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. Image processing usually refers to digital image processing, but optical and analog image processing also are possible. The main requirement for gesture interface is the tracking technology used to capture gesture inputs and process them. Gesture-only interfaces with syntax of many gestures typically require precise pose tracking. A common technique for hand pose tracking is to instrument the hand with a glove which is equipped with a number of sensors which provide information about hand position, orientation, and flex of the fingers. The first commercially available hand tracker was the Data glove. Although instrumented gloves provide very accurate results they are expensive and encumbering. Computer vision and image based gesture recognition techniques can be used overcoming some of the limitations.

### 1.2 Gesture Recognition:

It is a topic in computer science and language technology with the goal of interpreting human gestures. Gestures can originate from any bodily motion or state but commonly originate from the face or hand. Current focuses in the field include emotion recognition from the face and hand gesture recognition. Many approaches have been made using cameras and computer vision algorithms to interpret sign language. However, the identification and recognition of posture, gait and human behaviours is also the subject of gesture recognition techniques. Gesture recognition can be seen as a way for computers to begin to understand human body language, thus building a richer bridge between machines and humans than primitive text user interfaces or even GUIs (graphical user interfaces), which still limit the majority of input to keyboard and mouse. Gesture recognition enables humans to communicate with the machine (HMI) and interact naturally without any mechanical devices. Using the concept of gesture recognition, it is possible to provide hand gesture as a input and accordingly alphabet will be displayed on the screen.Thiscould potentially make conventional input devices such as mouse, keyboards and even touch-screens redundant. Gesture recognition can be conducted with techniques from computer vision and image processing. The literature includes ongoing work in the computer vision field on capturing gestures or more general human pose and movements by cameras connected to a computer.

### 1.3 American Sign Language:

Sign languages are the most raw and natural form of languages could be dated back to as early as the advent of the human civilization, when the first theories of sign languages appeared in history. It has started even before the emergence of spoken languages. Since then the sign language has evolved and been adopted as an integral part of our day to day communication process. Now, sign languages are being used extensively in international sign use of deaf and dumb, in the world of sports, for religious practices and also at work places. The recognition of gestures representing words and sentences as they do in American and Danish sign language undoubtedly represents the most difficult recognition problem of those applications mentioned before. A functioning sign language recognition system could provide an opportunity for the deaf to communicate with non-signing people without the need for an interpreter. It could be used to generate speech or text making the deaf more independent. The Gestures associated with speech are referred to as gesticulation. Gestures, which function independently of speech, are referred to as autonomous gestures. Autonomous gestures can be organized into their own communicative language, such as American Sign Language (ASL).. The idea is to make computers understand human language and develop a user friendly human computer interfaces (HCI). In this project, I have use edge detection technique which will help to compare images. A new image is matched by individually comparing each feature from the new image to this previous database images.

## 2. LITERATURE REVIEW

### 2.1 Human Computer Interface System

Computer is used by many people either at their work or in their spare-time. Special input and output devices have been designed over the years with the purpose of easing the communication between computers and humans, the two most known are the keyboard and mouse. Every new device can be seen as an attempt to make the computer more intelligent and making humans able to perform more complicated communication with the computer. This has been possible due to the result oriented efforts made by computer professionals for creating successful human computer interfaces. As the complexities of human needs have turned into many folds and continues to grow so, the need for Complex programming ability and intuitiveness are critical attributes of computer programmers to survive in a competitive environment. The computer programmers have been incredibly successful in easing the communication between computers and human. With the emergence of every new product in the market; it attempts to ease the complexity of jobs performed. For instance, it has helped in facilitating tele-operating, robotic use, better human control over complex work systems like cars, planes and monitoring systems. Earlier, Computer programmers were avoiding such kind of complex programs as the focus was more on speed than other modifiable features. However, a shift towards a user friendly environment has driven them to revisit the focus area [1].

The idea is to make computers understand human language and develop a user friendly human computer interfaces (HCI). Making a computer understand speech, facial expressions and human gestures are some steps towards it. Gestures are the non-verbally exchanged information. A person can perform innumerable gestures at a time. Since human gestures are perceived through vision, it is a subject of great interest for computer vision researchers. The propose system aims to determine human gestures by creating an HCI. Coding of these gestures into machine language demands a complex programming algorithm. An overview of gesture recognition system is given to gain knowledge.

**Gestures:**

It is hard to settle on a specific useful definition of gestures due to its wide variety of applications and a statement can only specify a particular domain of gestures. Many researchers had tried to define gestures but their actual meaning is still arbitrary. Bobick and Wilson [1] have defined gestures as the motion of the body that is intended to communicate with other agents. For a successful communication, a sender and a receiver must have the same set of information for a particular gesture.

Gesture is defined as an expressive movement of body parts which has a particular message, to be communicated precisely between a sender and a receiver. A gesture is scientifically categorized into two distinctive categories: dynamic and static. A dynamic gesture is intended to change over a period of time whereas a static gesture is observed at the spurt of time. A waving hand means goodbye is an example of dynamic gesture and the stop sign is an example of static gesture. To understand a full message, it is necessary to interpret all the static and dynamic gestures over a period of time. This complex process is called gesture recognition. Gesture recognition is the process of recognizing and interpreting a stream continuous sequential gesture from the given set of input data.

## 2.2 Related Work

Christopher Lee and Yangsheng Xu developed a glove-based gesture recognition system that was able to recognize 14 of the letters from the hand alphabet, learn new gestures and able to update the model of each gesture in the system. Over the years advanced glove devices have been designed such as the Sayre Glove, Dexterous Hand Master and PowerGlove. The most successful commercially available glove is by far the VPL DataGlove as shown in figure 2. It was developed by Zimmerman during the 1970's. Star-ner and Pentland developed a glove-environment system capable of recognizing 40 signs from the American Sign Language (ASL). Hyeon-Kyu Lee and Jin H. Kim presented work on real-time hand-gesture recognition using HMM (Hidden Markov Model)

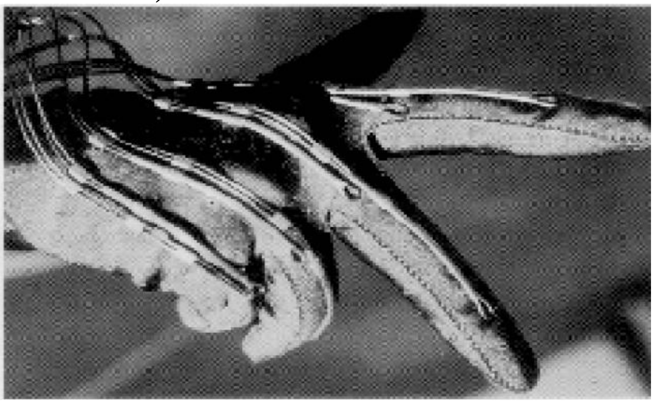

Fig 2.1 VPL data glove

doing skin-tone segmentation in HSV space, based on the premise that skin tone in images occupies a connected volume in HSV space. They further developed a system which used a back-propagation neural network to recognize gestures from the segmented hand images. Etsuko Ueda and Yoshio Matsumoto presented a novel technique a hand-pose estimation that can be used 7 for vision-based human interfaces, in this method, the hand regions are extracted from multiple images obtained by a multiviewpoint camera system, and constructing the "voxel Model." Hand pose is estimated. Chan Wah Ng, Surendra Ranganath presented a hand gesture recognition system. Claudia Nölker and Helge Ritter presented a hand gesture recognition modal based on recognition of finger tips, in their approach they find full identification of all finger joint angles and based on that a 3D modal of hand is prepared and using neural network [1].

Dr. S.D.Lokhande and Vaishali S. Kulkarni [2] designed a system visually recognize all static signs of the American Sign Language (ASL), all signs of ASL alphabets using bare hands. But, since different signers vary their hand shape size, body size, operation habit and so on, which bring more difficulties in recognition. Therefore, it realizes the necessity for signer independent sign language recognition to improve the system robustness and practicability in the future. The system gives the comparison of the three feature extraction methods used for ASL recognition and suggest a method based on recognition rate. It relies on presenting the gesture as a feature vector that is translation, rotation and scale invariant. The combination of the feature extraction method with excellent image processing and neural networks capabilities has led to the successful development of ASL recognition system using MATLAB. The system has two phases: the feature extraction phase and the classification. Images were prepared using portable document format (PDF) form so the system will deal with the images that have a uniform background. The feature extraction applied an image processing technique which involves algorithms to detect and isolate various desired portions of the digitized sign. During this phase, each colored image is resized and then converted from RGB to grayscale one. This is followed by an edge detection technique. The goal of edge detection is to mark the points in an image at which the intensity changes sharply. Sharp changes in image properties usually reflect important invents and changes in world properties. The next important step is the application of proper feature extraction method and the next is the classification stage, a 3-layer, feed-forward back propagation neural network is constructed. The system is proved robust against changes in gesture. Using Histogram technique gets the misclassified results. Hence Histogram technique is applicable to only small set of ASL alphabets or gestures which are completely different from each other. It does not work well for the large or all 26 number of set of ASL signs. For more set of sign gestures segmentation method is suggested. The main problem with this technique is how good differentiation one can achieve. This is mainly dependent upon the images but it comes down to the algorithm as well. It may be enhanced using other image processing technique like edge detection.

Lalit Gupta and Suwei Ma [3] describes the design and implementation of a vision-based hand gesture classification (VHGC) system which can be used for novel human-computer-interaction (HCI) applications and for human alternative and augmentative communication (HAAC) applications. The main approaches for analyzing and classifying hand gestures for HCI and HAAC applications include glove-based techniques and vision-based techniques. The glove-based techniques use sensors to measure the positions of the fingers and the position of the hand in real-time. However, gloves tend to be quite expensive and the weight of the glove as well as the cables of the associated measuring equipment hinders free movement of the hand. The vision-based techniques are usually glove-free and can be divided into the three-dimensional (3-D) and the two-dimensional (2-D) approaches. In the 3-D approach, gesture classification is based upon the parameters of a 3-D model of the human hand. Gesture classification is based upon the parameters of an image of the gesture in the 2-D approach. Because 3-D hand models are quite complex, the classification of gestures from parameters derived from 3-D models is computationally extensive making real-time classification difficult. The 2-D models are relatively less complex than the 3-D models. However, 2-D models do not carry the finger movement and finger position information required for the classification of complex dynamic gestures. Therefore, the 2-D approach is restricted to the less complex problem of classifying well-defined static gestures. The goal of the paper was to develop a complete system capable of robustly classifying hand gestures for HCI and HAAC applications. From a visual analysis of hand gestures, it was determined that essential shape information for discriminating gestures was in the boundary of the gestures. Therefore, a contour and vision based classification approach was formulated. The relatively simple system consisted of a video camera, video capturing software, and a personal computer. For flexible operation, no constraint other than holding the gesture approximately parallel to the camera lens was imposed. The processing steps to classify a gesture included gesture acquisition, segmentation, morphological filtering, contour representation, and alignment based classification. Rather than forming an arbitrary set of gestures, the database for off-line evaluation consisted of the gestures for numbers 0 through 9 of the ASL. These gestures were selected because they are typical of the hand gestures that can be used for HCI and HAAC applications. The ten-class database consisted of ten example gestures for each class. The Otsu algorithm was selected to autonomously segment the gesture images and a morphological filtering approach was developed to remove background and object noise. The contour of a gesture was represented by the LCS and a linear alignment and a nonlinear alignment method were formulated to determine the similarity between two LCSs. The classification results showed that no misclassifications were obtained using nonlinear alignment even though the within-class variations were high because the gestures were formed by individuals not trained in ASL and with few constraints.

Md. Hasanuzzaman, S. M. Tareeq, M. A. Bhuiyan, Y. Shirai and H. Ueno [4] describes the Principal component analysis (PCA) method is a standard pattern recognition approach and many researchers use it for face and hand pose classification. The main idea of the principal component analysis (PCA) method is to find the vectors that best account for the distribution of target images within the entire image space. In the general PCA method, eigenvectors are calculated from training images that include all the poses or classes. But for classification a large number of hand poses for a large number of users, need large number of training datasets from which eigenvectors generation is tedious and may not be feasible for a personal computer. Considering these difficulties they have proposed person-specific subspace method that partitions the comparison area. In person-specific subspace method, ASL characters (hand poses) are grouped based on each person and for each person one PCA is used. They have described the algorithm of person-specific subspace method for ASL characters classification, which is very similar to general PCA based algorithm. To utilize person-centric knowledge, this system integrates person identification method with ASL recognition system. From the experimental results have concluded that, the classification accuracy of person-specific subspace method is better than general PCA method and person-specific subspace method is faster than the general PCA method. This system uses a skin-color based hand poses segmentation method, which is still suffering from the variation of lighting condition and background color or human sleeve's (shirt's) color. The system assumes that the background contains non-skin color and a user wears non-skin color sleeves. If we use infrared camera then it is possible to overcome this problem using minor modification in segmentation module other modules will remain the same. Since the skin reflects near IR light well, active IR sources placed in proximity to the camera in combination with IR pass filter on the lens makes it easy to locate hand those are within the range of light sources. Considering the reduction of processing time, so far eigenvectors calculations are performed separately in off-line. The eigenvectors do not change during dynamic learning process. The user has to initiate this calculation function to change the eigenvectors or principal components. In the future, if faster CPUs are available, these components are then possible to be integrated into on-line learning function. We could not claim that our system is more robust against new lighting condition and clutter background. Our hope is to make this sign language recognition system more robust and capable to recognize dynamic gestures for interaction with different intelligent machine.

## 3. ANALYSIS OF PROBLEM

There are many challenges associated with the accuracy and usefulness of gesture recognition software. For image-based gesture recognition there are limitations on the equipment used and image noise. Images or video must be under consistent lighting, or in the same location. Items in the background or distinct features of the users should not make recognition difficult. The variety of implementations for image-based gesture recognition may also cause issue for viability of the technology to general usage. For example, an algorithm calibrated for one camera may not work for a different camera. These criteria must be considered for viability of the technology. The amount of background noise which causes tracking and recognition difficulties, especially when occlusions (partial and full) occur must be minimized. Furthermore, the distance from the camera, and the camera's resolution and quality, which causes variations in recognition and accuracy, should be considered.

In order to capture human gestures by visual sensors, robust computer vision methods are also required, for example for hand tracking and hand posture recognition or for capturing movements of the head, facial expressions or gaze direction. Design and development of real time human to machine interactions by gesture recognition requires further improvement to detect hand motion information accurately and get efficient pattern matching of hand movement. It faces problems in gesture performed by different performers.

## 4. IMPLEMENTATION

### 4.1 Introduction

The system is designed to visually recognize all static signs of the American Sign Language (ASL), all signs of ASL alphabets using bare hands. The user/signers are not required to wear any gloves or to use any devices to interact with the system. But, since different signers vary their hand shape size, body size, operation habit and so on, which bring more difficulties in recognition. Therefore, it realizes the necessity for signer independent sign language recognition to improve the system robustness and practicability in the future.

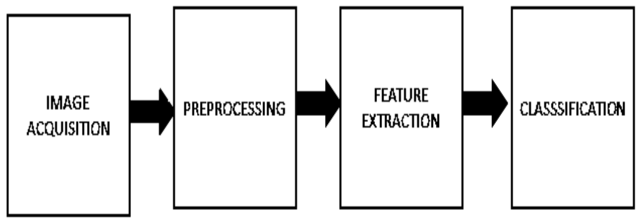


**Fig 4.1:** Block Diagram of hand gesture recognition system

There are mainly two approaches of hand gesture recognition

a) Device based (using instrumented gloves, position trackers etc.) which are very expensive.

b) Vision based required camera with natural interaction.

In Vision based approach challenging problem is as these system need to be background invariant, lightning insensitive, person and camera independent to achieve real time performance. So there is need for enhanced recognition algorithm to achieve better recognition rate for Static background and invariant lightning condition.

Several different approaches have been tested so far.

• One is to build a three-dimensional model of the human hand. The model is matched to images of the hand by one or more cameras, and parameters corresponding to palm orientation and joint angles are estimated. These parameters are then used to perform gesture classification.

• Second one to capture the image using a camera then extract some feature and those features are used as input in a swift algorithm for matching key points of image with the images available in the database.

In this proposed system, I have used second method for modeling the system; I have created a database according to the standard hand gesture database and taken the static or captured images as an input to the system. The overall design of system is shown in figure 4.2.

### 4.2 System Data Flow

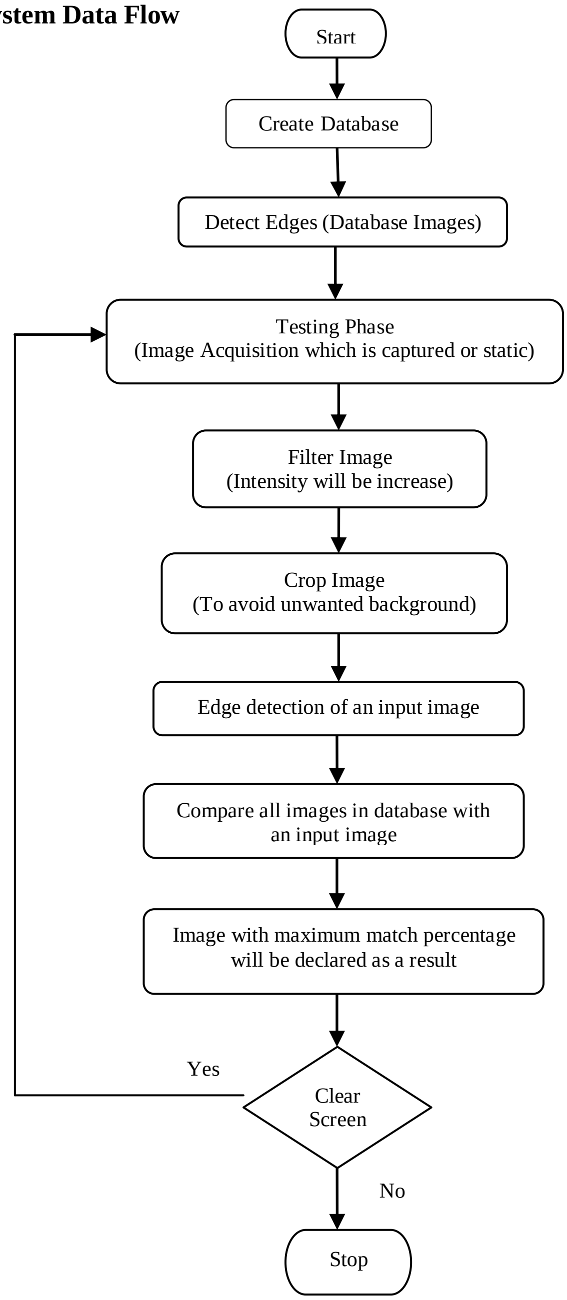


Fig. 4.2 System Data Flow

We will see the stepwise discussion of system data flow which shows in which manner my proposed system work:

The initial phase is to create the database for various alphabets according to the American Sign Language. There should various hand gesture images for each alphabet present in the database so that accuracy will be good. Then in the second phase thing to do is to detect edges of each image available in the database by using canny image technique for the gesture recognition purpose which will be use in the next phase. Final phase is the testing phase where image matching will be done. In this phase, image acquisition is the first thing that has to perform by browsing a file from disk or by capturing the image through web camera which will be input to the system. Then need to process on input image like filtering the image and cropping the image so that edges can be detected easily and input provided to the system avoid the unnecessary background. Another way to avoid unnecessary obstacle is to use plane background which is preferred by me in this system. In this way, the only hand gesture will be provided to the system for the recognition purpose. In the next step, have to detect edges of the input image which will be later compare with the edges of the images available in the database. After comparing with all the images available in the database the image with maximum matching points will be declared as a result which indicate alphabet of ASL language. In the next section, the detailed information of each step has given.

The system works in 3 phases:

1. Creating Database
2. Edge Detection of database images
3. Testing Phase (Image Recognition)

### 4.2.1 Creating Database

In the first step, we are going to create a database of various hand gestures which indicates character or alphabet for image recognition process. In this system, there are two ways to create database by either capturing the image through webcam or by browsing the static images from the disk.

After capturing the image, system is able to filter the image & crop the image and we can also able to perform some operation before adding to the database of an input image like resize image, enhance image, invert image and convert to gray scale which we will discuss later

### 4.2.2 Edge Detection

It is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. The points at which image brightness changes sharply are typically organized into a set of curved line segments termed edges. Edge detection is a fundamental tool in image processing, machine vision and computer vision, particularly in the areas of feature detection and feature extraction. The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world. It can be shown that under rather general assumptions for an image formation model, discontinuities in image brightness are likely to correspond to:

- Discontinuities in depth,
- Discontinuities in surface orientation,
- Changes in material properties and
- Variations in scene illumination.

In the ideal case, the result of applying an edge detector to an image may lead to a set of connected curves that indicate the boundaries of objects, the boundaries of surface markings as well as curves that correspond to discontinuities in surface orientation. Thus, applying an edge detection algorithm to an image may significantly reduce the amount of data to be processed and may therefore filter out information that may be regarded as less relevant, while preserving the important structural properties of an image. If the edge detection step is successful, the subsequent task of interpreting the information contents in the original image may therefore be substantially simplified. Edge detection is one of the fundamental steps in image processing, image analysis, image pattern recognition, and computer vision techniques. A typical edge might for instance be the border between a block of red color and a block of yellow. In contrast a line (as can be extracted by a ridge detector) can be a small number of pixels of a different color on an otherwise unchanging background.

In this process, Edge or border of a hand gesture can be detected using the canny image function. Image is nothing but the collection of pixels, for edge detection we are going to observe each and every pixel starting with the [0, 0] pixel. First pixel is set to 0 and then we compare next pixel with the first if it is same or not contrast with the first it is set to 0 and if the next i.e. second pixel is contrast to the previous then set forward to 1. After that we will compare second and third pixel if it is similar then forward set to 1 otherwise it will be set to 0 as shown in following expressions and this process will be repeated until we compare last pixel with their previous pixel. In this way, the matrix get formed which contain the value either 0 or 1 where value 1 represents the border of gesture which will be use in the gesture matching process. Following expression shows how value set in the matrix:

Initially forward set to 0;
If Dissimilar, pixel = Set forward to 1;
Else value will be same i.e. 0;
For next pixel:
Similar pixel = Set forward to 1;
Dissimilar pixel = Set forward to 0;
Above loop will execute for all the pixel in the image.

### 4.2.3 Testing Phase (Image Matching)

After creating the database and detecting edges for all those images in the database. Need to move to our next phase i.e. Test phase where the image recognition for ASL will be done. For this purpose we need to follow certain steps:

Step 1: Image Acquisition

In the very first step, system needs a hand gesture as an input image which is either captured by web camera or a static image by browsing a file from the disk. System shows the four histogram for input image in which three of them represents the RGB component of an image and first one represents the intensity of an image.

Step 2: Filter Image

In this process, intensity of an image will get increase and entropy will be decrease which will help to make contrast in the color of the hand gesture with the background, So that we can easily detect the edges of the hand gesture.

Step 3: Crop the Image

In this step, to avoid the unnecessary background of the captured image we can easily crop the image by selecting only hand. Another way is to have plane background behind the gesture so that there will be no noise in the input image.

Step 4: Edge detection (Input image)

In the next step, after processing on the input image edges of hand gesture can be detected by using the canny method.

Step 5: Recognize Gesture

After detecting the edges of input image we will compare our input image with the images in the databases whose edges are already detected in the second phase which are now only black and white images in which pixels are represented by 0 and 1 respectively. Matching of image is done by comparing pixels matrix of the smaller image within the pixel matrix of the larger image as shown in fig. 3.1. Firstly we will compare the size of input image with the database images starting with the first image in database. If size of test or input image is smaller than individual database image then we search it in the database image or vice versa as shown in following expression:

[Height, Width] = Size (Test image);

[Height, Width] = Size (Individual database image);

If

Size(Test image)< Size (Individual database image);

Then search test or input image within the database image;

Else

Search database image within input or test image;

Sub-matrix size= [m , n] size of small image; which we will search in the matrix of greater size image Consider the following figure in which we will see how sub-matrix can be search in the matrix of bigger image. In this we consider matrix of size [10,10] which is of bigger image and matrix of size [4,4] which is of smaller image is compare with the bigger matrix.

| | | | |
|---|---|---|---|
| 1 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |

**Fig.4.3:** Shows how sub-matrix searches in the matrix

If, value (i,j)= = value ( $i_1$ , $j_1$ ); then match point=1;

Where, ( i , j ) is the (row, column) of sub-matrix &

( $i_1$, $j_1$) is the (row, column) of matrix of the bigger image.

Else, match point=0;

For the next comparison sub-matrix is shifted by one column until it reaches the last pixel in the row after that it will be shifted by one row. Image with the maximum match point will be declared as a result which represent some character and that character will be the output. Repeat above procedure for all available images in the database.

## 5. RESULT ANALYSIS

The performance of the recognition system is evaluated by testing its ability to classify signs for both training and testing set of data. The effect of the number of inputs is considered.

### 5.1 Data Set

The data set used for training and testing the recognition system consists of images for some ASL signs used in the experiments are shown in following figure. In this way a data set will be obtained with cases that have different sizes and orientations and hence can examine the capabilities of the feature extraction scheme. There is also provision of adding images to the database at runtime. The detailed descriptions of ASL alphabets are given below. All letters are signed using only the right hand which is raise with the palm facing the viewer so a straight finger is will normally point upwards. When fingers are folded they point down across the palm. When the thumb is folded it crosses the palm towards the little finger. In these descriptions left and right are from the position of the viewer. In the case where the hand is turned or tilted the positions of the fingers is described first for an upright hand and the turn or tilt is added. Following figure shows the hand gesture of alphabets in the American Sign Language (ASL).

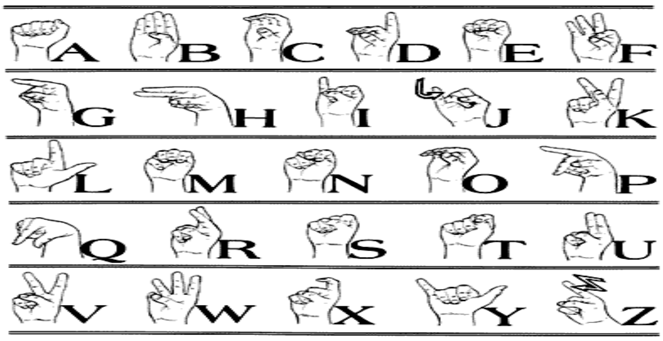


**Fig.1.2** ASL Signs (Actual)

### 5.2 Recognition Rate

The system performance can be evaluated based on its ability to correctly classify samples to their corresponding classes. The recognition rate can be defined as the ratio of the number of correctly classified samples to the total number of samples and can be given as:

$$\text{Recognition Rate} = \frac{\text{No. of correctly classified signs}}{\text{Total number of input signs}} \times 100\ \%$$

### 5.3 Experimental Results

The system is trained on some samples of ASL alphabets. The accuracy vary with the shape of ASL character for clear or simple shape it get the higher accuracy while for complex shape accuracy has been reduced. Table 5.1 shows the result analysis of these alphabets for various inputs:

Table no. 5.1

| Sr. No | ASL Char | No. of Input | Recognized character | Misclassified character | Accuracy |
|---|---|---|---|---|---|
| 1 | A | 10 | 08 | 02 | 80% |
| 2 | B | 10 | 09 | 01 | 90% |
| 3 | C | 10 | 07 | 03 | 70% |
| 4 | F | 10 | 07 | 03 | 70% |
| 5 | H | 10 | 08 | 08 | 80% |
| 6 | I | 10 | 09 | 01 | 90% |
| 7 | L | 10 | 09 | 01 | 90% |
| 8 | O | 10 | 07 | 03 | 70% |
| 9 | V | 10 | 08 | 02 | 80% |
| 10 | W | 10 | 07 | 03 | 70% |
| 11 | Y | 10 | 06 | 04 | 60% |

### 5.4 Operation on input image

I) Image resizing:

This system is able to change the size of input image to check the accuracy of the system and change in size of image had not affected my output result that much which indicates that problem of change in shape of hand gesture has been removed.

II) Enhance Image:

We can also enhance input image by providing enhance factor between 0 to 1 which increases the intensity of the input image so that the edges of hand gesture can be easily detected which will help to increases accuracy of the system.

III) Invert image:

If invert image operation is performed on the input image then it inverts the color of input image then also it will not affect the accuracy of image recognition which proves that change in color of an image will not affect the systems output

.

IV) Convert to Gray scale:

Conversion of image to gray scale will increase the PSNR of an input image which will help to increase the accuracy

## 6. APPLICATION

- Deaf or dumb people can able to interact with the computer system through sign language.
  A functioning sign language recognition system could provide an opportunity for the deaf to communicate with non-signing people without the need for an interpreter. It could be used to generate speech or text making the deaf more independent.

- A user friendly human computer interface (HCI) can be provided using gestures:
  • Replace mouse and keyboard
  • Pointing gestures
  •Navigate in a virtual environment
  • Pick up and manipulate virtual objects
  • Interact with the 3D world
  • No physical contact with computer
  • Communicate at a distance

## 7. CONCLUSION

This proposed system is able to recognize all static signs of the American Sign Language (ASL) using bare hands for hearing impaired people living in English speaking communities. The user/signers are not required to wear any gloves or to use any devices to interact with the system. In this system, I have used edge detection technique so that color of gesture will not affect the output. This system is not totally background independent for better result use of plane background will be good. System is still suffering from the variation of lighting condition and background color or human sleeve's (shirt's) color. The system assumes that the background contains non-skin color and a user wears non-skin color sleeves. My aim is to make this sign language recognition system more robust and capable to recognize dynamic gestures for interaction with different intelligent machine. System that understands human sign language and it is a user friendly human computer interfaces (HCI). The sign recognition accuracy obtained is up to the mark.

The work presented in this project recognizes ASL static signs only. The work can be extended to be able to recognize dynamic signs of ASL. The system deals with images with uniform background, but it can be made background independent. The network can be trained to the other types of images. It is important to consider increasing data size, so that it can have more accurate and highly performance system.

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