A Study on Characterization and Challenges for Hand Gesture Recognition

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Abstract *- A computer works on the commands or inputs of the user, for giving inputs user need an interaction medium which is useful in passing user commands to the system, keyboard and mouse play a major role in giving inputs to majority of systems running at present. The system then interprets and performs accordingly. Due to advancement in computer technology new ways of interaction between user and computer have come up. One of them is Perceptual user interface in which a computer user interacts with the system without using simple keyboard or mouse but by giving voice commands or by body movements. In this report Hand Gesture Recognition which is one of the perceptual user interface method is explained. In this method the computer recognizes the different hand gestures and performs different operations based on each gesture.*

1.INTRODUCTION

We are living in a period where we come across new technology each day, every new technology try to overcome the drawbacks of older technology and try to give more user friendly environment. Presently we are using keyboard and mouse for interacting with computer system but it has a drawback that it requires physical connection between user and device. As the user may not always be present near the system it becomes a major drawback of keyboard and mouse. So, now we need more user friendly system which can recognize input from user without being in physical connection. One of the most appropriate and widely used method is Perceptual interface in which the system recognizes the gestures of the Human Computer Interaction. After recognising gestures it will be checked at different levels. If there is any discrepancy in the system it will be checked in the main database and will be corrected accordingly.The main focus is to improve the security system.

As we know that vision based technologygy is an important part of Human Computer interaction, new types Human computer interaction methods are required for smooth interaction between human and computer. Hand gesture recognition has various applications like computer games, sign language recognition, virtual reality, etc [1]. In the coming time it has much more scope of development as it is very effective mean for human computer interaction. Some newly manufactured laptops are coming with gesture recognition system which can be used for various purposes like sliding pictures in an album, sliding pages of a document, capturing photos and videos, etc. Gesture Recognition is the process of recognizing and predicting gestures used for communicating with computer system, a gesture may involve combining orientation and movements of hands, arms of the body and facial expressions which are mostly used for communication by deaf and dumb.This security system is very beneficial for these deaf and dumb people because they don't find any system to define their language in the society.

Hand gesture recognition technique is of two types Dynamic (the movement of hands and body convey some signs) and Static (the posture of body and hand conveys some message).

In this report we mainly focus on static hand gesture recognition technique. Hand should be in a specific position. Based upon that we recognise the gestures and store in our database.

2 . LITERATURE REVIEW

This section discusses the chronological order of some development in the Hand Gesture Recognition Systems which has significantly contributed to the knowledge in these systems. This paper based on computer vision would be never complete without discussing the Role of Glove based hand gesture recognition. The essence of glove based system lied in the wires and the sensory devices attached on the fingers and joints of the glove which produced sensation when there is any motion and to determine whether the hand is open closed or fingers bent. The sensory information is stored in the data system and is processed to take out the meaningful information from the hand gestures. The advantage of this system is that it required no pre-processing as the gestures can be identified directly by the sensory devices. Glove based technique is a very useful technique for blind person . They can't see but due to glove based technique they can touch it and estimate the type of object . There are plethora of techniques are available in this modern world . Artificial Intelligence uses are increasing day by day because it takes less efforts , less hardwork and required less labour .

Glove Based Analysis:

In this approach sensors are attached to the mechanical gloves and worn in hands, these sensors transduces flexion of fingers into electrical signals which records the hand posture and movement. These sensors are usually acoustic or magnetic which are attached to the gloves. When the recorded electrical signals are transmitted to system through wires the system recognizes the gestures and performs operations accordingly. Glove signals match the gestures with the defined signals in the database or according to the real time scenario.

Vision Based Analysis:

This is the most difficult approach to apply in Computer vision technology. Many different implementations have been tested so far. One is to deploy three dimensional model for the human hand [3]. Many cameras are attached to this hand which take pictures for different parameters like palm orientation and joint angles to perform hand gesture classification.Different angles of palm are tested and then verified accordingly.If not matched, they will be redirected to the first step of the system.

Analysis of Drawing Gesture:

As visual interaction between user and machine is a difficult task, also mechanically sensing hand gestures has many

problems like noise, reliability and accuracy. So, another approach is to use a Stylus which is used as an input device. These drawings are recognized by the system as written text.

Recognition

Object recognition is the process of identifying different objects from a mix of objects in an image or video, due to variable size, rotation, pose, and scale for the same object, recognition process becomes more difficult and is still a challenge for computer vision systems. In the project I have used Neural Network System to recognize hand gesture from the test image. A training dataset is prepared which contains set of images of different gestures of alphabet and the system is trained using neural network. When a image is captured for testing it is compared with each image of the dataset and the image which almost matches the image in dataset, is returned as correct alphabet gesture. Our computer system works on minute elements like pixels so there is a possibility of incorrect result if the test image is not accurate and not matching almost all pixels of the trained dataset. There are many frames of an image. If our camera detects the right image it will be good for us otherwise we will have to retake that image to recognise in a well mannered way. There are many steps where image verification and validation is checked to get clarification.

American Sign Language

American Sign Language is not actually a spoken or written language but it a language of signs made up by using hand gestures. Each alphabet of English language has its own fixed standard gesture which is understandable by each individual having knowledge about this language. This language is very beneficial for person with disability like deaf and dumb, to communicate with these people it is quite easier if we use language of hands. Every country has its own sign language which is quite different from other languages. Due to the variation in the languages of different countries it is quite difficult to adapt a particular sign language.So at last analyst came at particular sign language known as the American sign language which we basically used for the people in the society to detect the security of the system .

3. PROJECT METHODOLOGY

Hand gestures recognition system can be divided into 4 major parts:

- Input
- Preprocessing
- Feature Extraction
- Real time classification
- Output

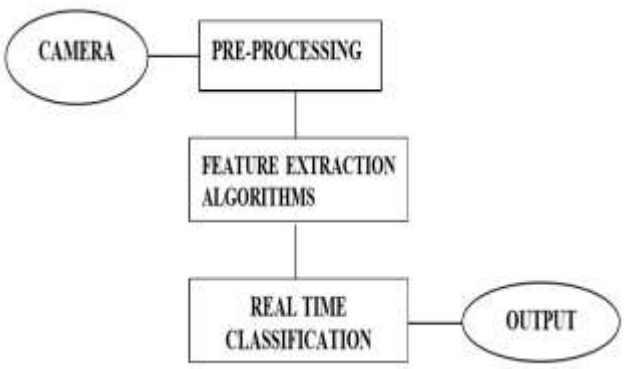


Fig : System Implementation

3.1.1 Preprocessing

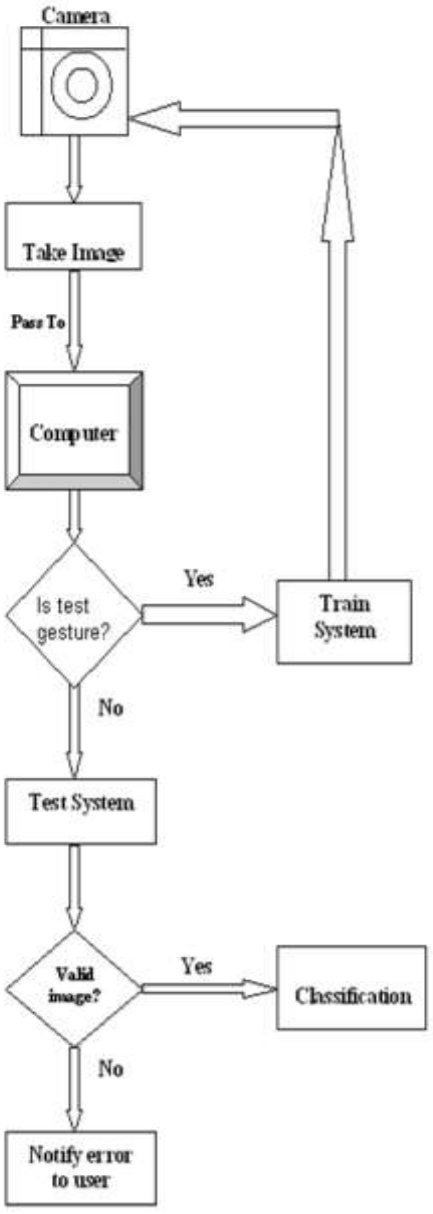
Preprocessing is the first step towards hand detection, it is required for pattern recognition and it increases the accuracy of hand detection process.

Preprocessing creates a sequence of processed images which help in recognition. Before applying any algorithm for further calculations preprocessing makes a perfect image for input in which algorithms can be applied more accurately. The main aim of reprocessing is to extract only hand from the whole image, as we require only hand for our further processes it becomes easier for the system to recognize correct posture of hand.

Preprocessing mainly consist of following steps:

- Skin modelling
- Removal of Background
- Conversion from RGB to binary
- Hand Detection

Accuracy plays an important role in any system. In our project accuracy will be somewhat high to improve the security of the system.The following gestures were recognized with an accuracy of 79%, Gestures were recorded with the help of inbuilt web camera. Various methods can be used for hand gesture recognition but the most simple one is carrying out the important features from hand and then recognizing the hand



gestures. Two steps which include recognition and detection will be done correctly for the accuracy point of view. Hand gesture will be matched with the gestures in the database of the

system and then verified accordingly to improve the security.

HAND GESTURE RECOGNITION FLOW CHART

The 3D model approach can use volumetric or skeletal models, even a combination of the two.
Volumetric approaches have been heavily used in computer animation industry and for computer vision purposes. The models are generally created from complicated 3D surfaces(for ex NURBS).

The drawback of this thing is that this method is very computational and cpu's for real time analysis are going to be developed. For the moment, a good approach would be to map simple primitive objects to the person's most important body parts (for example cylinders for the arms and neck, sphere for the head) and analyse the way these interact with each other. Furthermore, some abstract structures like super-quadrics and generalised cylinders may be even more suitable for approximating the body parts. The exciting thing about this approach is that the parameters for these objects are quite simple.

4. Results and Discussion

The following tables show means of various hand gesture recognition systems. For Table 1 a comparison between recognition method in hand gesture recognition methods used. For Table 2 provides a summary of application and invariant vector of hand gesture recognition systems. Table 3 shows the Summary of extraction method, features representation, and recognition of hand gesture recognition systems which are; hand extraction technique, features vector representation, and recognition used in the selected hand gesture recognition systems.

Table 1. Comparison between recognition methods in hand gesture recognition methods used.

Sr. No.	Recognized Gestures	Total Gestures used For Training nd Testing	Recognition Percentage	Database used
1.	26	1040	DP 98.8% MLP 98.7 %	American Sign Language (ASL)
2.	6	60	normal method 84% Scaling normalization method 95%	Own Database
3.	26	208	92.78%	American Sign Language (ASL)
4.	0-9 Numbers	298 video sequence for isolate dgestures/ 270 video sequence for continuous gestures	90.45%	Recognize Arabic numbers from 0 to 9.
5.	5 static/ 12 dynamic Gestures	Totally 240 data are trained and then the trained are tested	98.3%	5 static gestures and 12 dynamic gestures.
6.	31	130 for testing	90.45%	Own Database
7.	6	60	100% for more than 4 gestures	Own Database
8.	20	200	100% for 14 gestures, and >90 for 15-20 gestures	Own Database

Table 2. Summary of application areas and invariant vector of some hand gesture recognition systems.

Sr. No.	Application Area	Invariant factor
1.	Real time system / control a computer graphic crane by hand gestures/ play games such as scissors/paper/stone	Lighting conditions / Translation
2.	Sign Recognition	Lighting conditions / Translation
3.	Sign Recognition	Rotation
4.	Sign language	Rotation / Translation / Scaling
5.	Robot control application	Translation / Rotation / Scaling
6.	Real-time system/ moderate computational resources devices e.g. netbooks	Rotation / Translation
7.	Sign Recognition	Rotation /Translation / Scaling
8.	Sign Recognition	Rotation /Translation / Scaling
9.	Drawing graphical elements such as triangle, rectangular/ Editing graphical elements such as copy, paste, undo/ Mobile robot control/ Virtual	-

	Reality.	

Table 3. Summary of extraction method, features representation, and recognition of hand gesture recognition systems

Sr. No.	Extraction method	Features Vector Representation	Classifier
1.	HSV color space	13 parameters as a feature vector , the first parameters represents the ratio aspect of the bounding hand box and the rest 12 parameters are the mean values of brightness pixels in the image	Fuzzy C-Means (FCM) algorithm
2.	Color space	From Self-Organized Neural and Self-Growing hand shape, then, 3 angles of hand shape is calculated; TC Angle, Distance from the palm center , RC Angle.	Gaussian distribution
3.	Colored glove/ HSV and threshold based method	9 numerical features formed by distances from palm to all fingers and four angles between the distances	Learning Vector Quantization (LVQ)
4.	GMM for skin color Detection and color space	Orientation quantization	HMM
6.	Thresholding	Divide the scaled normalized hand image into Blocks of intensity features.	Euclidean Distance Metric.
7.	HSV color space/thresholding	178 features, for local and global features using moments	Euclidean Distance Metric.

4. Conclusion

The successful completion of this project was a result of extensive research work. At the starting I had no knowledge and idea about computer vision but while searching for topics for the In-house training I found it quite interesting and started working on it. As to fully understand a topic we require research work and this research helped me to understand and work on the project. And now finally the project is completed.

During the project I faced some difficulties which required my full concentration and were time consuming. First difficulty was to choose a perfect platform to build the whole project, as hand gesture recognition can be built on several platforms so selection of any one was difficult as each platform had its own benefits and drawbacks, in some computation speed was more in another the code was complex. But finally I chose MATLAB as it was quite simple and with good computation speed. Another difficulty was loading images through webcam, Matlab required some adapters for loading video input from the webcam, as a solution adapters were installed as add-ons and were used to get images from the webcam.

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