GESTURE RECOGNITION: PROLOGUE

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Abstract—This paper discuss of basic of gesture recognition (GR) concept its various types, methods and approaches for recognizing a gesture as well as its application. Basically Gesture Recognition means identification and recognition of gestures of body motion, which can originate from face or hand. Gesture recognition it is also a topic in computer science engineering and language technology which interpret human gestures via mathematical algorithms. Recognition of human activity is an attractive goal for computer vision. The task of gesture recognition is made challenging due to complex background, presence of nongesture hand motions, and different illumination environments. Currently GR focuses in the field include emotion recognition from the face and hand gesture recognition .GR enables humans to interface with the machine **(**HMI**)** and interact naturally without any mechanical devices. The applications of gesture recognition are infinite, ranging from sign language through medical rehabilitation to virtual reality.

Index Terms— Image Processing and Pattern Recognition, HMI, Gesture recognition (GR) , neural network learning rules, static gesture, dynamic gesture, skin detection , edge detection

1 INTRODUCTION

THIS "Gesture" stating, "the notion of gesture is to embrace all kinds of instances where an individual engages in movements whose communicate intent is paramount, manifest and openly acknowledged". Gesture is a stochastic process.[1] it can be viewed as random trajectories in parameter spaces which describe hand or arm spatial states. It is also said to be a language technology with the goal of interpreting human gestures via some mathematical algorithms. Gestures can originate from any bodily motion or state but commonly originate from the face or hand. The identification and recognition of posture, gait, proxemics, and human behaviors is also the subject of gesture recognition techniques.[2] this paper deals with various gesture recognition techniques. Using this concept it is possible to point a finger at the computer screen so that the cursor will move accordingly. This could potentially make conventional input devices such as mouse, keyboards and even touch-screens redundant. The primary goal of gesture recognition research is to create a system which can identify specific human gestures and use them to convey information or for device control. Gesture Recognition is the act of interpreting motions to determine such intent.To identifies and recognize these gestures there are different ways such as:

- Hand Gesture Recognition
- Face or Emotion Gesture Recognition
- Body Gesture Recognition

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The meaning of gesture can be dependent on the following: [3]
(i) Spatial information
(ii) Pathic information
(iii) Symbolic information
(iv) Affective information

2 GESTURE TYPES

In computer interfaces, the two types of gestures are distinguished. When we consider online gestures, which can also be regarded as direct manipulations like scaling and rotating and in contrast offline gestures which usually processed after the interaction is finished. The main classification of gesture is

2.1 Static Gesture

It can be described in terms of hand shapes. Posture is the combination of hand position, orientation and flexion observed at some time instance. Static gestures are not time varying signals.eg. Facial information like a smile or angry face.*[4]*

2.2 Dynamic gesture

Dynamic Gesture is sequence of postures connected by motions over a short time span. In video signal the individual frames define the posture and the video sequence define the gesture. eg. Taking the recognized temporal to interact with computer.[4]

3 GESTURE RECOGNITION APPROACHES

For any system the first step is to collect the data necessary to accomplish a specific task. For hand posture and gesture recognition system different technologies are used for acquiring input data. Present technologies for recognizing gestures can be divided into vision based, instrumented (data) glove, and colored marker approaches. Figure 1 shows an example of these technologies.

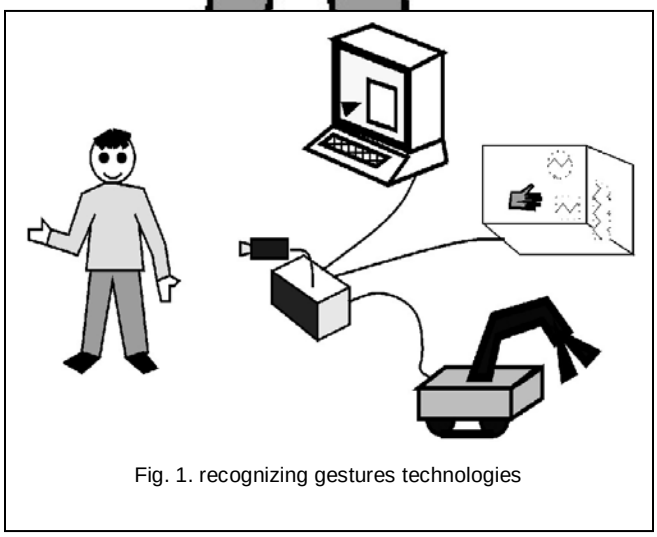

Fig. 1. recognizing gestures technologies

TABLE 1
BASIC GESTURE RECOGNITION APROACH

Parameters	Data-Glove based	Vision based
Computing Power	computational power not an issue(less)	more computing power
User Comfort	quite cumbersome(wear a tracking device, glove)	complete freedom
Hand Size	problem with glove-based solutions(due to different hand sizes)	not an issue
Calibration	more critical	Simple
Portability	Freely available (hand tracking is not involved)	difficult (due to camera placement issues and computing power requirements)
Cost	Expensive(tracking device)	Inexpensive
Noise	bounded with data	Minimal
Accuracy	high level	high level

3.1 Vision Based approaches

In vision based methods the system requires only camera(s) to capture the image required for the natural interaction between human and computers and no extra devices are needed. Although these approaches are simple but a lot of gesture challenges are raised such as the complex background, lighting variation, and other skin color objects with the hand object, besides system requirements such as velocity, recognition time, robustness, and computational efficiency .[6]

3.2 Instrumented Glove approaches

Instrumented data glove approaches use sensor devices for capturing hand position, and motion. These approaches can easily provide exact coordinates of palm and finger's location and orientation, and hand configurations .however these approaches require the user to be connected with the computer physically .which obstacle the ease of interaction between users and computers, besides the price of these devices are quite expensive it is inefficient for working in virtual reality .[7]

3.4Colored Markers approaches

Marked gloves or colored markers are gloves that worn by the human hand with some colors to direct the process of tracking the hand and locating the palm and fingers, which provide the ability to extract geometric features necessary to form hand shape .The color glove shape might consist of small regions with different colors or as applied in where three different colors are used to represent the fingers and palms, where a wool glove was used. The amenity of this technology is its simplicity in use, and cost low price comparing with instrumented data glove .However this technology still limits the naturalness level for human computer interaction to interact with the computer.[8]

4 GESTURE RECOGNITION SYSTEM COMPOSED OF SEVERAL STAGES

Most of the researchers classified gesture recognition system into mainly four steps after acquiring the input. These steps are: Extraction Method or modeling, features estimation and extraction, and classification or recognition as illustrated in Figure 2.

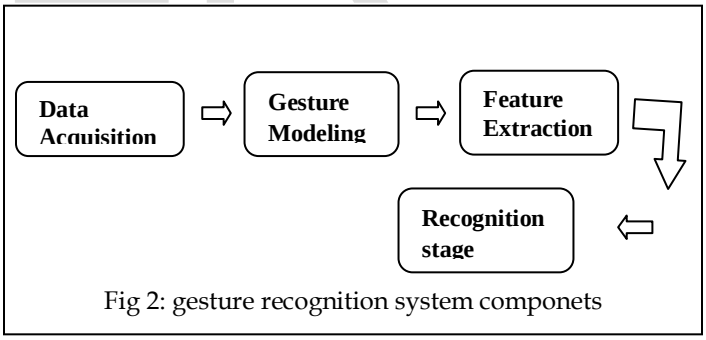

Fig 2: gesture recognition system componets

4.1 Data Acquisition: This step is responsible for collecting the input data which are the hand, Face or Body gestures and classifier classifies the input tested gesture into required one of classes.

4.2 Gesture Modeling: This employed the fitting and fusing the input gesture into the model used; this step may require some pre-processing steps to ensure the successful unification.

4.3 Feature Extraction: After successful modeling of input data or gesture, the feature extraction should be smooth since the fitting is considered the most difficult obstacles that may face; these features can be location of hand/palm/fingertips, joint angles, or any emotional expression or body movement. The extracted features might be stored in the system at train-

ing stage as templates or may be fused with some recognition devices such as neural network, HMM, or decision trees which have some limited memory should not be overtaken to remember the training data.

4.4 Recognition Stage: This stage is considered to be a final stage for gesture system and the command/meaning of the gesture should be declared and carried out, this stage usually has a classifier that can attach each input testing gesture matching class.

5 TOOLS FOR GESTURE RECOGNITION

5.1 Static gesture (pose) recognition: The user assumes a certain pose or configuration

- Template matching
- Neural networks
- Pattern recognition techniques

5.1 Dynamic gesture recognition : With prestrock , stroke and poststrock phases.

- Time compressing templates
- Dynamic time warping
- Hidden Markov Models
- Conditional random fields
- Time-delay neural networks
- Particle filtering and condensation algorithm
- Finite state machine

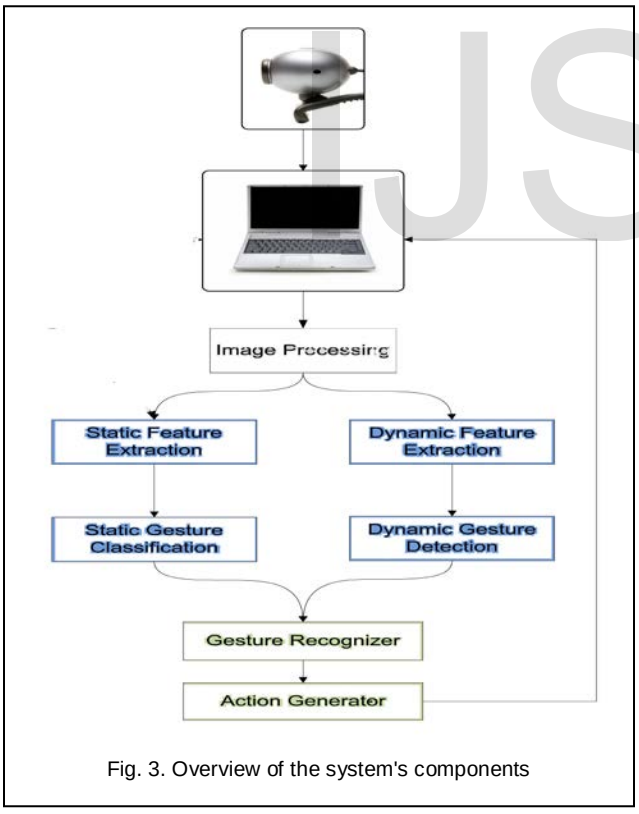

Fig. 3. Overview of the system's components

Fig 3 shows the Overview of the system's various components. The process begins with the computer system capturing a frame from the web camera, which is then processed to detect candidate regions of interest. After a hand is found in a region of interest it is tracked by the Hand Tracker all subsequent processing is done on this region. While being tracked static and dynamic features are collected, with the static features being passed to an Neural Network classifer and the dynamic features analyzed to obtain high level features. The static and dynamic information is then passed to the Gesture Recognizer, which communicates the type of gesture to the Action Generator. The action generator passes the necessary commands to the operating system to create the end result.

6 GESTURE RECOGNITION METHODS

Recently, several approaches have been proposed to implement hand-gesture to speech systems [9], [10], [11]. The three most popular models of sensing gloves are VPL Data Glove is Virtex Cyber Glove [12], and Matte1 Power Glove. They all have sensors that measure some or all of the finger joint angles. Each has its own advantages and disadvantages. The use of neural networks for the recognition of gestures has been examined by several researchers. Neural networks do not make any assumption regarding the underlying probability density functions or other probabilistic information about the pattern classes under consideration. They yield the required decision function directly via training a two layer backpropagation network with sufficient hidden nodes has been proven to be a universal approximator [13],[14]. Wibur has trained a neural network to recognize approximately 203 hand gestures derived from the American Sign Language [15]

in neural network The supervised decision-diected learning algorithm is used for generates a two-layer feedforward network in a sequential manner to add hidden nodes. Training patterns are divided into two types first is a "positive type" from which we want to extract the "concept" and second is a "negative type" which provides the counterexamples with respect to the "concept". A "seed" pattern is used as the base of the "initial concept.The seed pattern is arbitrarily chosen from the positive class. Then we try to generalize the initial concept to include next positive pattern. After this, we have to check whether there is any negative pattern in order to prevent the occurrence of "overgeneralization". The following step is to fetch next positive paittern and to generalize the initial concept to include the new positive pattern. This process involves growing the original hyperrectangle to make it larger to include the new positive pattern.A more detailed description of the training procedure is given in [15],[16].

6.1 Learning Rules for neuran network

We will define a learning rule as a procedure for modifying the weights and biases of a network. The learning rule is applied to train the network to perform some particular task In supervised learning, the learning rule is provided with a set of examples of proper network behavior where is an input to the network, and is the corresponding correct output. As the inputs are applied to the network, the network outputs are compared to the targets. The learning rule is then used to adjust the weights and biases of the network in order to move the network outputs closer to the targets. The perceptron learning rule falls in this supervised learning category. Linear networks can be trained to perform linear classification with the function train. This function applies each vector of a set of

input vectors and calculates the network weight and bias increments due to each of the inputs. Then the network is adjusted with the sum of all these corrections. We will call each pass through the input vectors an epoch. This contrasts with adapt, which adjusts weights for each input vector as it is presented. Below in figure 4 we can see a flow chart of the perceptron algorithm. It is always operating on the same order. There is a graphical interface only for selecting the test set as it is the only user input

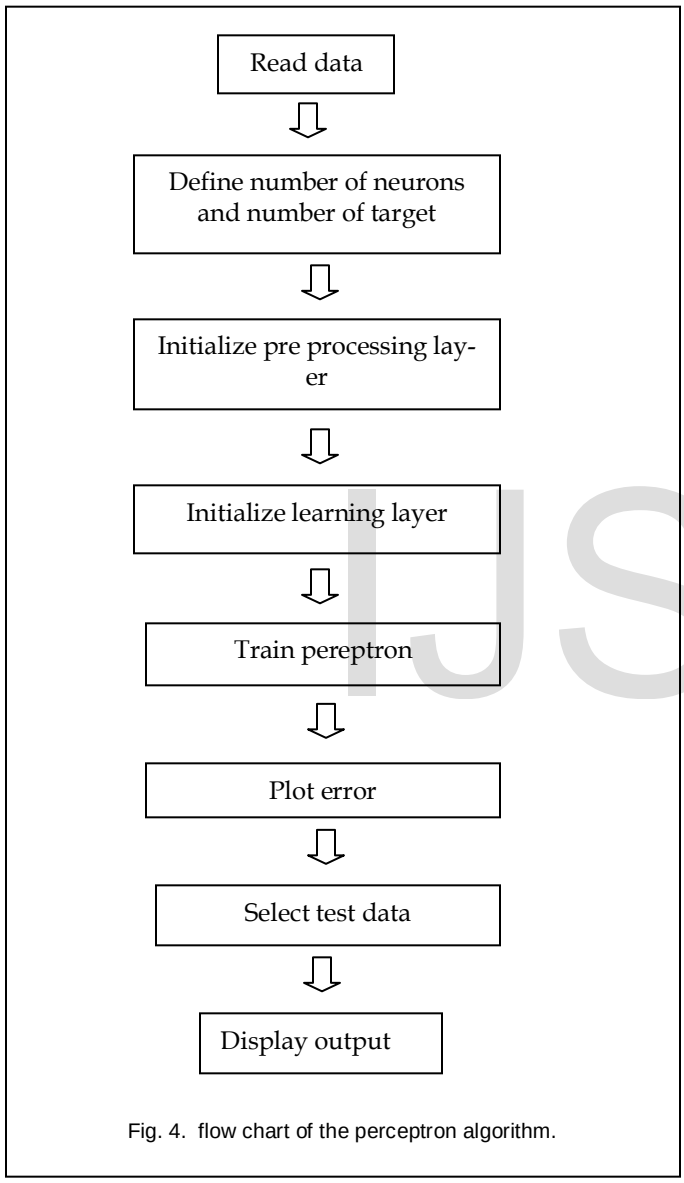

Fig. 4. flow chart of the perceptron algorithm.

6.2 HAND SEGMENTATION CLASSIFICATION ALGORITHM

The rapid growing and available compute power, with enabling faster processing of huge data sheets, has facilitated the use of elaborate and diverse methods for data analysis and classification. At the same time, demands on automatic pattern recognition systems are rising enormously due to the availability of large databases and stringent performance requirements. Here it is given a simplest algorithm used for pattern recognition. [17]

1. Convert the RGB image into gray scale image.
2. Segment the image into three equal parts
3. Take the right corner second level parte as left hand image
4. Take the left corner second level part as right hand image.
5. By considering threshold (120) and comparing with each pixel we count the number of pixels in the all parts.
6. Based on the pixel count specification we classify either left hand or right hand is raised or both.

6.3 ALGORITHMS FOR HAND GESTURE RECOGNITION

There we have two algorithms for hand gesture recognition using MATLAB for Edge detection and Skin detection algorithms.

EDGE DETECTION

Following steps are used for detecting the edges:

1. Image capturing using a webcam or any camera.
2. Converting the captured image into frames.
3. Image pre-processing using Histogram Equalization.
4. Edge detection of the hand by using an algorithm like Canny Edge Detection.
5. Enlargement of the edges of regions of foreground pixels by using Dilation to get a continuous edge.
6. Filling of the object enclosed by the edge.
7. Storing the boundary of the object in a linear array.
8. Vectorization operation performed for every pixel on the boundary.
9. Detection of the fingertips.
10. Tracking of the fingertips in frames to determine the motion.
11. Identification of the gesture based the motion.
12. Insertion of the input stream into the normal input path of the computing device.

In this the images is first captured using a webcam, separated into frames and converted into grayscale format. The contrast is then improved using Histogram Equalization. After the edges are detected, the images are dilated to fill up the broken edges. The images are then filled up using boundaries function in MATLAB, and the boundary pixels are detected and stored sequentially in a linear array. The fingertips are then detected using vectorization technique and the gesture is recognized by the system depending on the relative movement of the fingertips in the different frames.

SKIN DETECTION

Following steps are used for skin detection [19]

1. Image capturing using a webcam or any camera.
2. Converting the captured image into frames.
3. Skin color detection using hue and saturation values of various possible skin tones.
4. Storing the boundary of the object in a linear array.
5. Vectorization operation performed for every pixel on the boundary.
6. Detection of the fingertips.
7. Tracking of the fingertips in consecutive frames to determine the motion.
8. Identification of the gesture based the motion.

9. Insertion of the input stream into the normal input path of the computing device.

In Skin Detection Algorithm after the images are separated into frames, the skin detection algorithm is applied. The closed contour of the fingers is identified in this technique even in the presence of a noisy background and hence eliminates then the vectorization technique is used to detect the fingertips and the gesture is recognized by the system depending on the relative movement of the fingertips in the different frames [18]

There is a limited amount of studies in literature for the hand gesture recognition. Recognition methods, like in the detection procedure, are mainly realy on algorithms which need training or diferent environmental constraints. A clear summary of such algorithms are shown in table

Reference	Primary Method of Recognition	Number of Gestures Recog-nized	Background to Gesture Images	Additional Markers Required	Number of Training Images
39	Hidden Markov Models	97	General	Multi-colored gloves	400
5	Entropy Analysis	6	No	No	400
41	Linear ap-proximation to non-linear point dis-tribution models	26	Blue Screen	No	7441
42	Finite State machine modeling	7	Static	Markers on glove	10 se-quences of 200 frames each
43	Fast Template Matching	46	Static	Wrist band	100 exam-ples per gesture

7 CONCLUSIONS

This survey summarizes the techniques that have been used for hand localization and gesture classification in the gesture recognition literature, but shows that very little variety has been seen in the real-world applications used to test these techniques these techniques can be used in various of real time nature for ease of humanbeing. Applications that take advantage of depth information in challenging environments (such as hand detection and gesture recognition low lighting, or gesture recognition with occlusions) are still missing,and work on this is ongoing and applications that test the limitations of depth sensors (such as tolerance to noise in depth images, and detecting hands with limited range of motion or in close contact with objects).

8 FUTURE SCOPE

Gestures are destined to play an increasingly important role in human-computer interaction in the future. Facial Gesture Recognition Method could be used in vehicles to alert drivers who are about to fall asleep. Area of Hand gesture based computer human interaction is very vast. Hand recognition system can be useful in many fields like robotics, computer human interaction and so make hand gesture recognition offline system for real time will be future work to do. Support Vector Machine can be modified for reduction of complexity. Reduced complexity provides us less computation time so we can make system to work real time.

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