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Hand Gesture Recognition

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Abstract: ***Hand gesture recognition using visual photos with a variety of gestures and body parts movements can be used as a vital requirement to interact with a lot of potential applications in human-computer interaction, machine vision, games, and so on. Our analysis is one of the most challenges faced during the current time is providing separate and non-equally cumbersome services to the differently abled and handicapped. Most of the general approaches related to gesture recognition have utilized information gloves, except for a lot of natural interface. As a gesture could be a continuous motion or a static gesture or may be a change in facial expressions, the HMM (hidden markov model) should be used as a distinguished recognition tool.***

Keywords: Gesture Recognition, Hand Gestures, Pixel, Artificial Neural Network, Human–Computer Interaction, Computer Vision, Human-Computer Interaction (HCI), Hidden Markov Model (HMM), Principal Component Analysis (PCA), Feature Extraction Analysis.

I INTRODUCTION

In earlier days Electronic Devices were dependent on several hardware component to be operated by and such components were developed by humans to bridge a gap of communication between user and the system but to do so it requires certain amount of expertise in order to handle such equipment which is not possible for everyone to learn and operate those hardware. Thinking for solution of such problem HCI (Human Computer Interface) were derived, these HCI uses mathematical algorithms to recognise body movements as an input of action ,these input may include full body motion in an extent to increase its usability. Further enhancement may help in to create an interface with the help of which all appliances kept within a room can be manipulated with just one gesture as an input.

II LITERATURE REVIEW

A. Gesture

A gesture is a kind of body movement (hand, facial expression etc.) act as a way of communicate during which specific messages, either in situation of speech or along and in parallel with words. Gestures embody movement of the hands, face, or other parts of human body.

B. Hand Gesture

The great way of representation of what you want to say with the help of our different hand movements. For example *Thumbs Up* is widely recognised sign of approval or agreement.
It can be roughly divided into two categories:

1) *Static-Motionless.*
2) Dynamic-Hands in Motion

C. Applications

1) Home Automations: Creating smart homes means doors, windows and environmental devices that keeps you safe and comfortable.
2) Sign Language Interpretation: Provides interfaces for the people who are differently abled.
3) Safety Driving: Automobile industry has seen more sensor embedded car driving assistance, for blind spot recognition and parking assist.

D. General Architecture

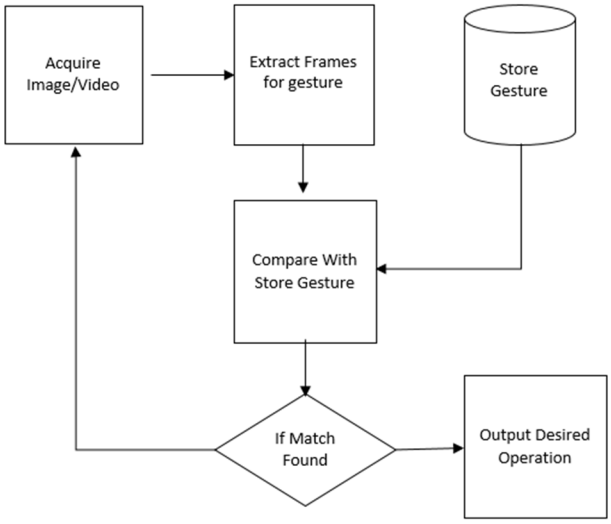

Fig. 1 shows certain steps that are described below.

1) *Acquire Image/Video:* - It is the first stage of the architecture where the image is taken via camera or any other media device.
2) *Extract frames of gesture:* -In this phase the acquired image is transformed into binary image with the help of certain methodologies so as to be processed for the next phase.
3) *Compared with sorted gesture data:* - Now the transformed image is compared through several samples of data set which is stored in devices so to get the desired meaning of the data and action to be performed.
4) *Results:* - If the processed data matches with the stored data then as a result certain defined action is performed related to that particular input in case if it fails to do so then again an input is taken and further steps are repeated.

E. Gesture Recognition Techniques

1) Principal Component Analysis PCA is a technique that allow to represent pictures as points during a low-dimensional space. If every image consists of 32x32 pixels whose values vary from zero to 255, then every image defines some points in 1024 dimensional space. If one tend to grab a sequence of pictures representing a gesture then this sequence can generate a sequence of points in space (see figure 2.). However, this set of points can sometimes lie on a low-dimensional sub-space inside the world 1024D space. The PCA algorithmic rule permits us to search out this sub space that sometimes consists of up to three dimensions. This enables us to examine the sequence of points representing the gesture as shown in Figure 2. We are able to represent this sequence of points by a graph. We are able to notice a unique sub-space and graph for every gesture within the vocabulary of our system.

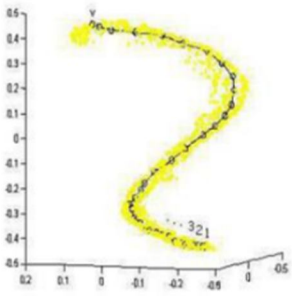

Figure 3: A graph representing a gesture in a subspace.

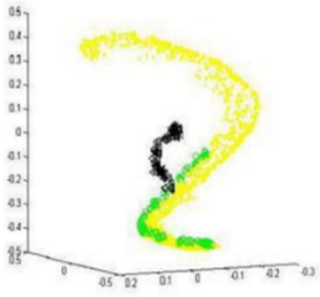

Figure 4: Projection of two different new gestures into a subspace. The green graph matches the known graph (yellow) but the black one is not.

Fig. 2 Points representing the gesture

2) OTSU Algorithm OTSU is a process in which the conversion of a RGB image into binary or grey scale image with the help of python and its predefined libraries of function to do so and once they are converted to binary image, a key image for detection of gesture will have only two values (Black-'0' which denotes background image and White-'1' denotes hand or body part). OTSU algorithm [8, 9] program is employed to convert RGB image into binary. An honest segmentation is the method by which we can create a vivid difference between background and hand gesture.

a) Evaluate the histogram statistics of the given image along with probabilities of each intensity level as shown in *fig. 3.*

b) Set up an initial value of $\omega_i(0)$ and $\mu_i(0)$.

c) Proceed ahead through all possible thresholds t = 1…… maximum intensity.

i. Update and ω_i and μ_i .

ii. Compute $\sigma_b^2(t)$.

d) Required threshold corresponding to the maximum value of $\sigma_b^2(t)$.

e) You can compute two maxima's (and two related threshold). $\sigma_{b1}^2(t)$ is the value of greater max and $\sigma_{b2}^2(t)$ is the value which can be greater or equal maximum.

f) Required threshold= (threshold1+threshold2) /2.

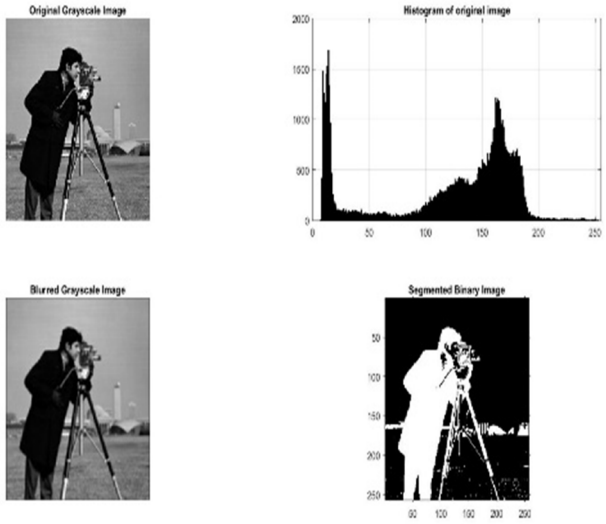

Fig. 3 Segmentation technique

To get best result optimal threshold to be chosen and segmentation (see figure 3) will be done in line with the selected value. The choice of the segmentation technique primarily depends on the kind of image on that we've got to try and do process and OTSU algorithms had been tested and performed expeditiously regarding hand gestures information. It's an unsupervised and nonparametric technique of segmentation which may choose threshold automatically and do segmentation.

3) Hidden Markov Model (HMM) Hidden Markov Models (HMM) model is meant to deal with the dynamic forms of gestures [10]. Gestures area unit collected through a sequence of video or picture streams. The goal is to acknowledge two categories of gestures one is deictic and other is symbolic. The image is refined by employing a quick look–up over the classification method [11].

Hidden Markov Model can be characterized by:

a) P is a set of states, contains a starting state P_a and ending state P_b.

b) Q is the transition probability matrix, define by $Q=\{q_{ab}\}$, where q_{ab} is the transition probability of taking the transition from state a to state b.

c) R is the output probability matrix, $R= \{r_b(S_n)\}$ for distinct HMM, $R= \{R_b(x)\}$ for a continuous HMM, where S_n derived a discrete analysis symbol, and x stands for continuous analysis of n-dimensional random vectors**.**

In the observation the point of consideration is only a distinct HMM. For a distinct HMM, q_{ab} and $r_b(S_n)$ have the following properties-

$$q_{ij} \geq 0 , r_j(S_n) \geq 0 , \quad \forall a,b,n, \qquad (1)$$

$$\sum_b (q_{ab}) = 1 \quad \forall a, \qquad (2)$$

$\sum_r r_b(S_n) = 1 \quad \forall b, \quad (3)$

In the event that the underlying state is of circulation $\pi = \{\pi a\}$, a HMM can be composed in a reduced documentation $\lambda = (Q, R, \pi)$ to speak to the total parameter set of the model. For a more nitty gritty reference on hypothesis, calculation, and utilization of HMM, the users are alluded to [14]**.** In order to cut down the training process, first order is the main concern. HMM, that primarily based on the subsequent presumptions: (1) Markov presumptions- a recently created state is entered construct exclusively in light of the present state (2) Output presumptions- the yield likelihood appropriation work depends entirely on the state at the real time without certain parameters such as when and how the state is entered being taken into consideration.

In the investigation space of demonstrating and characterizing dynamic gesture, the recognition based on HMM has been an awfully well-liked technique, and principally employed in classification method as a result of them offer dynamic time deformation, a coaching algorithmic rule, and a transparent theorem semantics.

The primary approach for the acknowledgment of human movements bolstered by HMMs was presented in Yamato et al. (1992). It recognizes six inside and outside totally unique court games strokes by Rigoll et al. They require enhanced their framework from Distinct HMM to Continuous HMM by extracting new applied mathematics decisions, that results to a change inside the HMM results. The augmentation of the framework planned by Rigoll et al. (1998) could recognize dynamic motions no holds barred and independent mode. Looking on the sort of the component extricated from gesture, numerous HMM topologies are reached out from the ordinary HMM approach like distinct HMM, Continuous HMM, and Partial HMM to deal with further issues.

From above mentioned techniques recapitulation is done in the comparative study table 1-

Table 1 Comparative Study

S N	Methodology	Description	Objective	Advantages	Limitation
1	Principal Component Analysis(PCA) [1]	Method for compressing a lot of data into something that captures the essence of the original data.	Static	Robust to the noise in representation of images	Transition speed of hand gestures
2	OTSU Algorithm [8,9]	This algorithm perform the reduction of grey level image to binary image.	Dynamic	Commonly used because of simple calculations and high stability	Small sized object, background with less details
3	Hidden Markov Model [2,3,4,5,7]	A Statistical Markov Model .It's a simplest dynamic Bayesian network along with a Markov Process with unobserved states.	Dynamic	Have a good accuracy rate over several attempt of recognitions	Fails as the distance varies for image extraction

III. CONCLUSIONS

In the conclusion if one has to compare the power among these three stated techniques it's the best option to collectively use PCA along with HMM .HMM has a high rate of accuracy in gesture recognition and sign language up to 99.8% recognition rate while in other hand PCA by fellow researcher [2] proved that it is also a reliable technique to be fit for this work. In case of OTSU algorithm

its usefulness reliable within brightness domain for background-foreground extraction are plausible only with certain special cases with good light and contrast or conclusion states that OTSU is fast and easy method with less reliability.

The present system despite the fact that gives off an impression of being possible and easy to use when contrasted with the typical order based system or gadget based system where input modes is less strong as far as recognition part. An endeavor to make the input modes less requirements subordinate for the user hand motions has been most appropriate. However quality of such systems are likewise broadened by applying some extra flexible algorithm that will encourage to diminish noise and blurry movements so as to own a lot of correct translation of gestures into commands.

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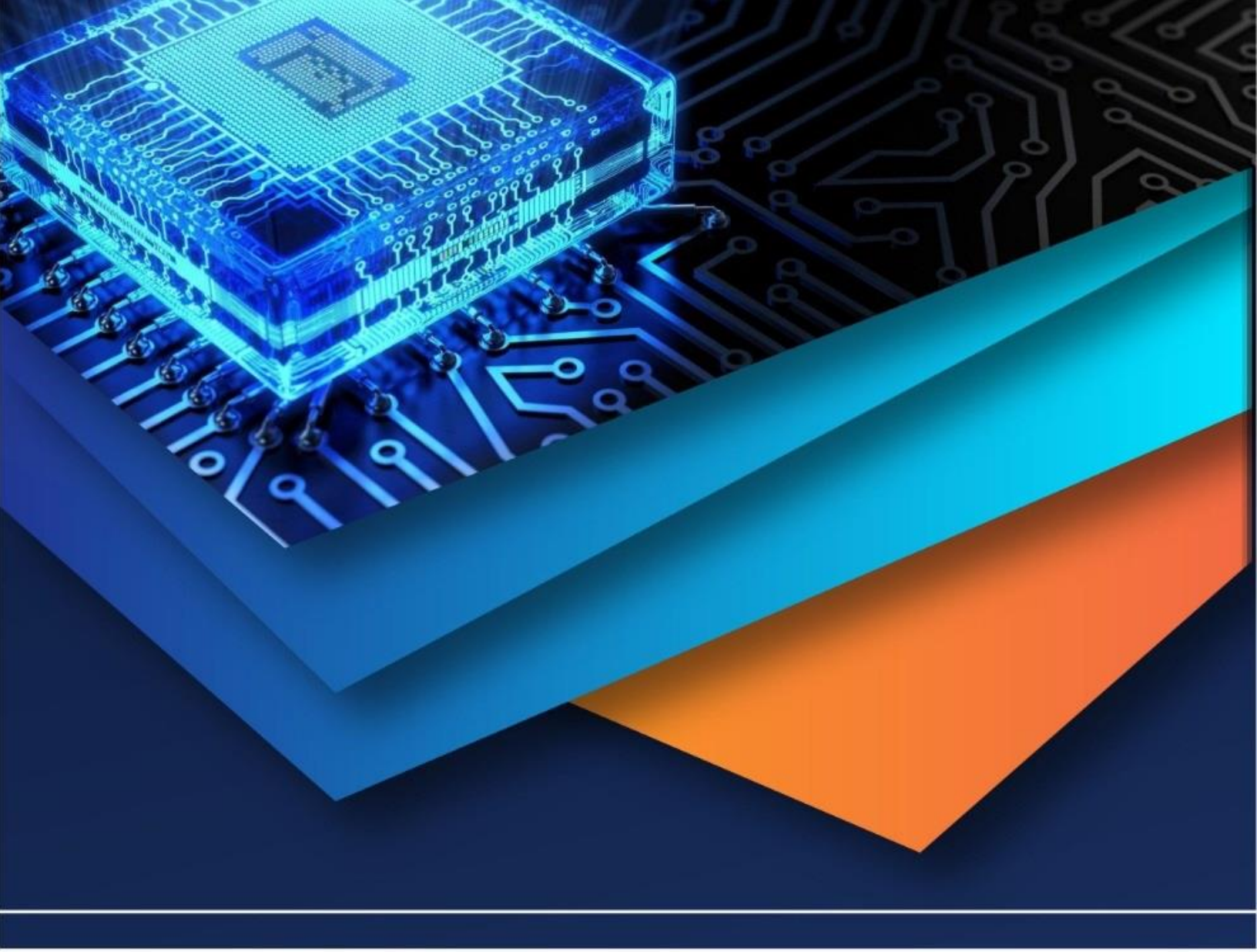

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