Dynamic Hand Gesture recognition from a complex background and finger identification using RGB colours

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***Abstract*—**Human-computer interaction is growing fast day by day for the use of mobile devices and virtual reality technology. Gesture recognition promotes human to interact with a machine without any mechanical instrument. The primary objective of gesture recognition scheme is to build a policy which understands human gesture and use them to control several devices. A real-time, quick and robust hand gesture recognition system is usually obstructed by the complexity of hand gesture modelling, particularly under complicated background. For removing these barriers, in this paper, we propose a method for hand gesture recognition in real environment and fingers detection using Red, Green and Blue colors. First cover up a little area of the top of the Thumb finger by Red, Middle finger by Green and Pinky finger by the Blue object. After Covering, a frame is taken from webcam and then apply the suggested procedure to recognize hand and fingers. As the experimental results, our method shows an excellent performance in the real-time test.

Keywords- Hand Gesture, Air Writing, finger identification, Smart Home.

I. INTRODUCTION

In recent years, the use of Computer is increased day by day. As a result, Human-computer Interaction or HCI is being more significant part of our daily life. There are two types of hand gesture recognition, Static and dynamic recognition. Static means, hand recognition on a still image and dynamic means, recognition on video.

For hand gesture recognition, many researchers applied machine learning algorithm, such as SVM multiclass classification algorithm to establish the universal hand gesture recognition systems for Portuguese sign language identification [1]. Gestures represent significant points of a body that can be observed as a kind of non-verbal interaction [2]. Various features were included in this topic. In many applications, statistical modelling was successfully used by applying Principal Component Analysis (PCA) [3], [4], Hidden Markov Models [5]. The hand gesture is done regarding hierarchies of multi-scale color image features at different scales and Blob, and ridge technique is used to find features of hand at various levels [6]. Hand taking through sequences of images is the most significant problem. The Bayesian algorithm is used for tracking the 3D position and orientation of hand movement [7].

Kinect sensor is used for hand gesture recognition, but it works well to track a large object than any small object, and it is a problem of the sensor. Therefore, a method named Finger-Earth Mover's Distance (FEMD) is used to measure the dissimilarities between different hand shapes which is proposed in [8]. In [9,10], Kinect sensor and a shape distance metric Finger-Earth Mover's Distance (FEMD) is applied for hand detection and gesture recognition which works robustly in free backgrounds. Kinect sensor and a shape distance metric Finger-Earth Mover's Distance (FEMD) is used for hand detection and gesture recognition which works robustly in free environment. Here, the depth map and color image are taken by the sensor to detect the hand shapes, and the segmented hand shapes are demonstrated as time series curves. Microsoft Kinect sensor provides a new type of

data in computer vision which is depth information. In human hand recognition field, the depth data help to reduce the noise and variance of background and illumination of the real world environment. The complex feature representation with extended feature vectors is used to minimize the complexity of the whole system. In [11], The Elliptical Density Shape (EDS) model which provide the simplified geometric shape feature of any complex shape object through time sequences to reduce complex feature demonstration.

The hand gesture is used in different applications. A quicker and smooth strategy with reasonable accuracy is more important concern to make smart device smarter and faster. Thinking this point, a novel procedure for hand gesture recognition using Principal Component Analysis (PCA) has been implemented in FPGA simulator [12]. Classification of hand gestures can also be received with neural networks (NN), which designated to be a helpful tool for such idea. A feed forward neural network with back propagation algorithm was used for recognition of hand patterns, taken from the raw data of a data glove with 18 sensors [13].

Convolutional neural networks (CNN) were also applied for designing of highly accurate hand tracker [14]. Also, such method enabled determination of hand's closeness in 99.1% images. For utilization of functional neural networks, unsupervised neural network approach for feature extraction is applied. Adding the number of neurons in hidden layers and their scarcity constraint, this multilayer NN can give a compressed illustration of given input images which can be taken for pattern recognition works [15].

In computer vision, an early survey about studying image sequences is being given a new tradition [16]. In [17], This paper has described that at present, the focus of research is less on camera motion or the estimation of an image and the labelling of an action taking place in the picture. But, the primary interest is to use in real life application such as Human-Computer Interaction(HCI), Wireless interface and interactive environments [18,19]. What is happening which is the essential question in the age.

Two methods were implemented for dynamic hand gesture recognition in this paper. The effectiveness of planned system was tested for diverse backgrounds and hand orientations. In section II, the Proposed procedure has been given. In part III and IV, the finger detection technique and the hardware component and application has been introduced. Some experimental results have been shown in section V and the conclusion is given in section VI. Finally, the last part is a references section.

II. SUGGESTED PROCEDURE

The main purpose of the new system is not only to discover robust and rapid hand gestures recognition but also to detect the fingers from a complex environment. The Hand detection and the fingers identification from a complex background taken from moving hand gesture is shown in Fig-1. The algorithm for detecting a hand and classifying all fingers is mentioned below

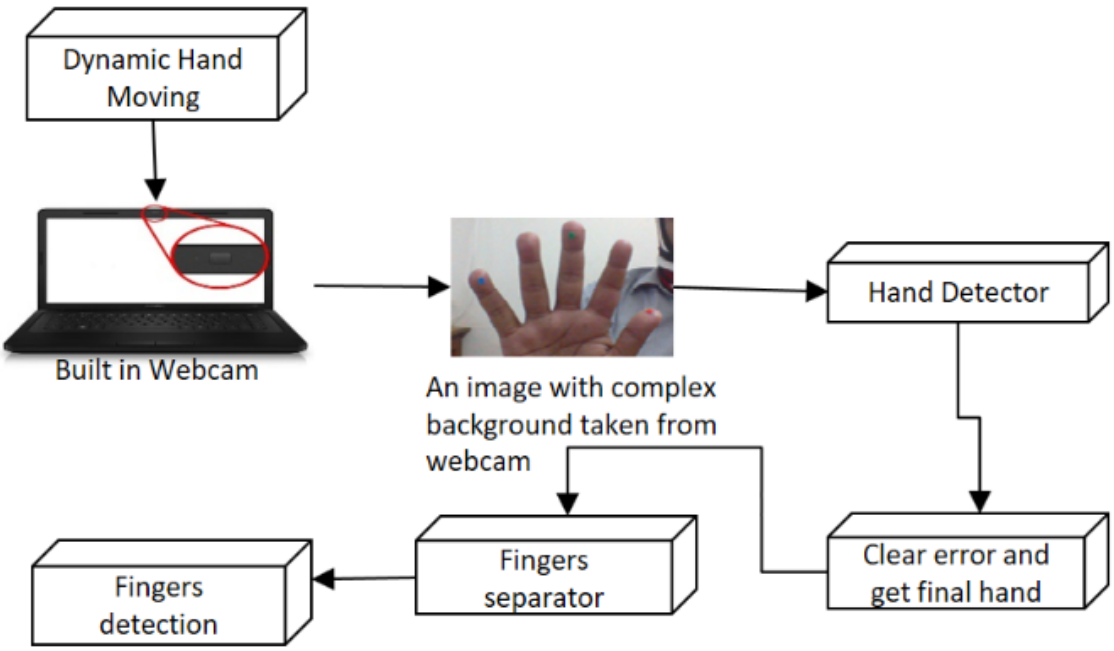

Fig-1: Hand Detection and Fingers Identification Procedure

A. *Hand Detection*

1. Set to a tiny region of the top of the Thumb finger by Red, Central finger by Green and Pinky finger by the Blue colored object.
2. Take a snapshot from a webcam camera.
3. Discover skin color area from the image of complex background using the equation 1,2 3, and 4.
4. Label all connected object and find the biggest connected object which is hand but not robust.
5. Reconstruct the hand to fill up all small area in hand data.

B. *Finger Detection*

1. Separate all fingers from the hand using a polynomial fitting.
2. Detect the fingers according to RGB color following section (III).

Let, M be an RGB image taken from a webcam. M has three planes R, G, and B.

G1 =~ (I2B (G, Otsu's threshold)) -(1)

B1 = I2B (B, Otsu's threshold) - (2)

SkinArea = G1. ∗ B1 - (3)

$$RH = \begin{cases} M(i,j,1:3) = 0, & if\ SkinArea(i,j) = 0 \\ M(i,j,1:3), & Otherwise. \end{cases} \quad \text{- (4)}$$

Where I2B is a function used to convert an image into binary and RH indicates Reconstructed Hand.

III. FINGER DETECTION

Thumb Finger

I. The finger which contains the Red colored object.

Index Finger

I. Between the Thumb and the Middle Finger.
II. To the right side of the middle finger If the thumb finger is absent.

Middle finger

I. The finger which contains the Green colored object.

Ring Finger

I. To the left of the middle finger if the Pinkie finger is absent.
II. Between the Pinkie and the Middle finger.

Pinkie finger

I. The finger which contains the Blue colored object.

IV. THE HARDWARE COMPONENT AND APPLICATION

Kinect or any other sensor is not used here. Extra money is to spend for using any sensor. In this proposed system, a webcam adapter has been installed and used to take an image from video. As a result, we were not to waste additional money. Hand gesture recognition is implemented in virtual environment interaction, Sign language recognition, Medicine, Computer science, business, robot and many other fields. In the surgery, the doctor needs to observe the patient's clinical imaging data from the computer. However, the Human-computer interaction is not so convenient that a physician can use during surgery.

V. EXPERIMENTAL RESULTS

The proposed system was implemented using an optimized Matlab code. The experimental outcomes are demonstrated in Table 1 where NOI, HDR, TFIR, IFIR, MFIR, RFIR and PFIR stands for number of image, Hand detection rate, Thumb finger identification rate, Index finger identification rate, Middle finger identification rate, Ring finger identification rate and Pinkie finger identification rate respectively. Ten different hand gestures were taken and tested total 1000 images. Each gesture has experimented 300, 300 and 400 times with three distinct men. In our proposed system, there are two outstanding performances. One is hand finding from a complicated environment, and the other one is to identify fingers. We used three Red, Green and Blue object to identify Thumb, Middle and Pinky fingers. Polynomial fitting was used to separate all fingers. Fig-2 demonstrates an image with the difficult background taken from webcam video, extracted hand and Finger separation. There are some experimental results has been given in Fig-3. The average identification rate of hand, Thumb, Index, Middle, Ring and Pinkie finger is 98.353%, 99.913%, 96.25%, 99.977%, 96.617% and 99.95% respectively.

Fig-2: Webcam Image, Reconstructed Hand and Separated Fingers

Fig-3: Hand Recognition from a complex background

Table-1: Hand Recognition from a complex background

Persons	NOI	HDR	TFIR	IFIR	MFIR	RFIR	PFIR
First person	300	99.16%	99.95%	95.05%	99.99%	97.55%	99.97%
Second person	400	98.35%	99.90%	97.45%	99.96%	98.05%	99.96%
Third person	400	97.55%	99.89%	96.25%	99.98%	94.25%	99.92%
Average		98.353%	99.913%	96.25%	99.977%	96.617%	99.95%

VI. CONCLUSION

This paper demonstrates a more advanced and real-time hand gesture recognition. Two things have been implemented by this article. Firstly, Hand has been detected from a complex background. Secondly, every finger has been identified correctly. Those two points make the recognition and identification not only robust but also

accurate. There is a limitation of this system. It cannot recognize when the environment is darker. Otherwise, almost, 99% time this system can automatically recognize hand and finger from video quickly.

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