Study of Hand Gesture Recognition System

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Abstract: In today's life Human-computer interaction plays an important role in daily communication as the devices with computational capabilities are growing in number and hence forming an ecosystem of their own, convenience of interacting with such ecosystems has emerged as a potential topic for study. Human posture especially the hand is most effective since it is a natural way of interacting making it a convenient and intuitive interface therefore it is being extensively studied and being widely adopted. This is generally achieved by using various sensors which are commonly present in most devices and then applying image processing and various computer vision system techniques to identify and detect the gestures. This paper mainly focuses to present recent technologies that use both static and dynamic hand gesture control system.

Keywords - Human Computer Interaction (HCI), Hand Gesture, Hand Posture, Features Extraction, Segmentation.

I. INTRODUCTION

Body language is one of the key way of interaction among humans. It adds emphasis on the complete message itself. Gesture is a form of non-verbal communication using various body parts, mostly hand and face [1]. We can inherit gesture recognition into system to enhance human-machine interaction. This would enable us to control a wide variety of devices remotely through hand postures.

We live in a world where essentially all the devices are interconnected in a closed ecosystem. With increasing need to maintain communication within a system, we have to come up with a centralized method for communication. With advent of IOT, more and more devices are getting interconnected, we cannot add more devices for controlling them. The complexity of system must be controlled as devices are getting compact and portable. Gesture system provides a novel method to facilitate the requirement of centralized technique for communication. Hand gesture best suits this way of interaction as it is the most convenient method for humans to interact.

Gesture eliminates the need of peripherals or external devices to be added to the ecosystem for interaction. Hand Gesture can be categorized in two types such as Dynamic and Static Gestures. Static gesture [2] are the postures which refers only a single image to a single command. A Static gesture is simple and need less computational power. Dynamic gesture change over a period of time and it is complex. simple example of static gesture is stopping signal. A waving hand means goodbye is an example of dynamic gesture. Nowadays, visual sensors are used in the domain of robotics, visual surveillance, manufacturing and health care.

II. LITERATURE REVIEW

In the article "real time Hand gesture Recognition using finger segmentation," achieved the task of gesture recognition by first isolating the image of a hand from the background and then converting the image to grayscale or a binary image. This methodology of gesture recognition was based on essential identification of the fingers, so the palm was separated by drawing a maximal inner circle on the palm region and the erect fingers in the binary image were identified by the labelling algorithm which uses image processing techniques like edge detection. Similar approach followed by Ma, Xuhong; Peng, Jinzhu [5] who used Kinect sensor to sense the hand gesture and get various readings of the distance and depth of the hand from the source, then manipulating the gathered information by performing hand segmentation, fingertip detection and palm point detection. Focusing at the limitation of distance of gesture recognition, their article proposed an improved threshold segmentation method with depth information of the gesture by the Kinect sensor and also presents the cosine curvature algorithm for detection of fingertips.

In 2010, the skin pigment parameters such as hue, saturation and value of RGB along with Laplacian filter was used to extract the hand postures. Similarly, some others used YCbCr color model, input gestures such as hand gloves and HSI indexing models to detect edges of hand postures.

The most promising way of implementation of hand gesture recognition system are by using Vision systems. Vision systems leverage the power of machine learning to help the system recognize gestures on basis of what it has previously learnt. Computer vision attempts to replicate a human's cognitive ability of interpretation of what he/she sees. Computer Vision systems basically are intelligent enough to make sense out of an image, identify objects, context of the image. Vision systems are mostly based upon neural networks which are just a bio-mimicry of a human brain's network of neurons. One of the implementation used Convolutional neural networks to detect and recognize the hand gestures and the also use the error back propagation algorithm for training their model. A research implements Max Pool Convolutional neural networks or MPCNN along with morphological image processing to remove the noise which increases the accuracy of the model.

A team of Ayanava Sarkar [3] implemented hand gesture control for a drone by using Leap motion controller which is different from a Microsoft Kinect sensor [6]. To Track hand motion up to range about 1 meter or 3 feet directly, the Leap motion controller uses three infrared LED's and two monochromatic infrared (IR) cameras. It recognizes any hand motion occurring in that plotted volume by forming a hemispherical area above its radius of about 1 meter.

III. 3.1. ANALYSIS OF HAND GESTURE

From all the papers the modelled hand gestures are sent for analysis phase [7]. In this phase it is aimed to estimate the parameters [7] necessary for hand gesture control. Firstly, the task is to extract the essential feature from the raw captured image, and secondly the calculation of model with the given parameters.

During the process of feature detection, it is required to localize the hand to extract he necessary input as per the required parameter. It includes the segmentation of hand i.e. separation of hand from foreground and background objects. It also eliminates the unwanted objects. Localization [8] of hand includes generally two methods: motion tracking characteristics and color tracking.

An effective and efficient method for the localization of hand is skin colour [8]. Skin segmentation based on color is the most popular method applied to locate hand posture. This uses adaptive background. However best method is to control the lightening conditions manually to get the best localizations.

There involves a sequence of image frames to locate the actual posture of the hand having ambient background environment. Analysis to estimate the appearance of the moving hand becomes difficult when the background environment is noisy i.e. there may be presence of unwanted objects. This can be eliminated by the use of deformable 2D template models [7]. In case of 3D model there involves dynamic parameters [7] of kinematic shapes i.e. both angular and linear.

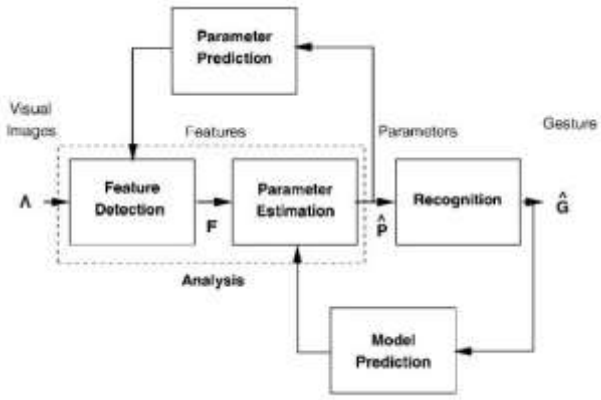

Figure. Hand Gesture Analysis and Steps for Recognition. [9]

3.2. RECOGNITION OF HAND GESTURE

The image has to be recognized a meaningful gesture during recognition phase. There has to be proper selection of gesture parameters. This determines the accuracy of the classification [9]. For this purpose, the neural networks have been widely used in the field of extraction of features such as shape, skin pigment, color etc. Many models such as Hidden Markov Model (HMM) turns out be a good tool as recognition system [10], others clustering algorithms involved. For controlling robotic motion, fuzzy c- mean clustering algorithm is applied.

3.3 CHALLENGES FACED BY HAND GESTURE SYSTEMS

Hand Gesture Recognition system faces many difficult challenging situations. [11], some of which are discussed now. First is the extracted hand region get affected due to change in Variety of illumination conditions. [11]. Then comes the Rotation problem, which arises when the hand region is rotated in any direction in the view. Next is the background problem, which refers to the complex background which houses multiple objects. Objects similar to the hand are more likely to produce a misclassification problem. Fourthly, the scaling problem, it is produced if there is a difference in the sizes of hand [11]. Finally, the fifth issue is the translation problem, which arises with the interpretation of the variation of hand positions in various photos. This also leads to an erroneous representation of the features.

3.4. REVIEW OF GESTURE RECOGNITION SYSTEMS

The hand gesture recognition system involves the use of several techniques and tools. In this part, couple of methods are hereafter established. [3] Recognition of hand gesture using the fuzzy c-means clustering algorithm for remote mobile application. The image taken as input is converted into HSV color space [3] and segmented using the thresholding technique. After removing the noise from the picture, as many as 13 elements were extracted as the feature vector. The Aspect ratio of bounding box is represented by the Vector feature of the hand and other 12 parameters constitute the grid cells of the given image. The gray level in ¾ block partition is represented by the mean of each cell. The system is implemented under intricate background and invariant light conditions. A total of 120 samples, which are 20 samples for 6 gestures, are used for training the system. The system implemented showed up with recognition accuracy of 84.83% and a recognition time of 2-4 seconds. The input image has been partitioned into different blocks of 23x23 pixels each, and each of these blocks is used as a feature vector. The system consists of a training phase, and a running phase. In the training phase, a database is used to store several feature vectors of input gestures. In testing phase the stored image in database is compared with input image for classifying using Euclidean distance. Since the segmentation operation is imperfect, filling the inner region of hand gesture, the hand saturation algorithm was used. The filling algorithm has been altered and enhanced to produce Speed Border Image Algorithm [12]. Different Morphological-operations by good quality and time with modified reconstruction is achieved. For dilation operation, dynamic structuring elements are employed [2] to resolve the problem of empty objects in the previous algorithms.

Stergiopoulou [13] suggested a networked neural that was self-sorted as well as self-growing. Here skin color filter in YCbCr color space is being used for detecting different regions of the hand. The procedure of finger identification that describes the number of fingers raised and attributes of hand shape. Wysocki et al. [4] boundary histogram is represented using rotation invariant poses. Skin color recognition filtering and clustering operation by ordinary counter tracking algorithm used for segmentation. The boundary illustrated as chords side chain was used as a histogram. For classification, DP matching and MLP Neural Networks were used. A posture recognition system using a neural network to recognize 42 alphabet finger symbols were presented, along with gesture detection system for recognition of 12 words. For gesture recognition, Backpropagation Neural Network is used and Elman Recurrent Neural Network was utilized for gesture recognition. After the raw data has been recieved, the posture system sets the sampling starting time of the given image and if it was determined that it is a gesture, then sent to gesture system. [4] Elmenzian suggested a system that identifies meaningful and isolated gestures for (0 – 9) Arabic numbers. (GMM) Gaussian Mixture Model was used for skin color detection. The direction between the center point of current frame and previous frame. To recognize the hand motion path, couple of algorithms such as HMM topology and BW algorithm are used. The system does not need code word model recognition.

Trigonometric and geometric shapes are identifiers for gesture identification. A webcam was used to collect database images, which were then segmentation is done manually by performing many experiments that test contains one or more group of three features defined, angle in middle of two fingers and relation of distance radius, geometrical shape descriptor groups with features, aspect ratio, circularity and solidity. (MLP) Multiple Layer Perceptron are used for classifying. The geometrical shapes descriptor computed local inclination histogram for every image. The system goes through a training phase. For the training phase, a feature vector was stored in the computer hosting the several histograms, and in the runaway phase, the attributes vector of the given postures extract and compared with all attribute vectors store in the computer.

IV. SUMMARY AND CONCLUSIONS

For a smooth interaction between humans and machines, constructing an efficient and hand gesture recognition system is an integral aspect. Here in this work, a comparative study has been provided on various hand gesture recognition systems, with stress and significance on feature identification, segmentation and extraction phase, which are compulsory requirements for posture designing and analysis. The identification rate of several recognition systems have been analysed, along with the three main steps for hand gesture recognition system, i.e., segmentation, features representation, and recognition and techniques used for each of these phases.

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