Fingertip Detection Method in Hand Gesture Recognition

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Abstract - *Today, computers become more pervasive in society, having a positive impact on their use in terms of facilitating natural human-computer interaction (HCI). There has been increasing interest in building new approaches and technologies for bridging the human-computer barrier. The ultimate aim is to bring HCI to a regime where interactions with computers will be as natural as an interaction between humans, and to this end, incorporating gestures in HCI is an important research area. Fingertips detection has been used in several applications, and well accepted and frequently used in the area of Human-Computer Interaction these days. This paper gives a new time proficient method that will lead to fingertip detection.*

***Key Words*: Human Computer Interaction, Fingertip Detection, Skin Detection Process.**

1. INTRODUCTION

Earlier, computer programmers were avoiding complex programs as additional focus was on speed than other modifiable features. However, a shift in the direction of a user-friendly environment has driven to return the focus area. The idea is to build a language understand by the computer and develop a easy human-computer interface (HCI). Making a computer understand speech, facial expressions, and human gestures square measure some steps towards it. Gestures square measure the non-verbally exchanged information. An individual will do numerous gestures at a time. Since human gestures square measure perceived through vision, it's a subject of immense concern for computer vision researchers. The main aim of the given system is to find out human gestures by generating associate degree HCI.

The key component of vision primarily based HCI is tip tracking features application prospects. Previously, tip tracking has been realized exploitation associate degree infrared camera, multiple cameras and light-emitting diode lights for marking fingers. Although these methods did accomplish tip following to some extent, they suffer from a number of issues mentioned below:

i) The employment of expensive cameras.
ii) Strict restrictions on the positions of fingers.
iii) The need for auxiliary devices.

In this paper, we tend to focus on real-time tip tracking using a single low-cost optical camera and bare hands to improve the applicability and user experience.

The recognition of moving fingertips in the video wants a fast and robust implementation of the strategy. A lot of tip detection techniques based on hand Segmentation technique because it decreases pixel area that is going to process, by selecting only areas of interest.

2. RELATED WORK

Shreyasi et al. [1] propose a fast algorithm for recognition of a limited set of gestures from hand images of different skin tones. Our approach contains steps for applying pre-processing techniques, segmenting the hand region and finally classifying the gesture using MATLAB. The system is able to identify the skin regions depending on a set of skin detection criteria which helps to filter out the non-skin regions and extract the hand shape using morphological operations.

Jagdish Lal Raheja et al. [2] provide detection of moving fingertips in the video needs a fast and robust implementation of the method. Many fingertip detection methods are based on hand Segmentation technique because it decreases pixel area which is going to process, by selecting only areas of interest using HSV color space based skin filter.

Archana S. et al. [3], develops robust and efficient hand segmentation algorithm where three algorithms for hand segmentation using different color spaces with required morphological processing have were utilized. Hand tracking and segmentation algorithm (HTS) is most proficient to handle the challenges of vision based system such as skin color detection, complex background removal, and variable lighting condition. Noise may contain, sometime, in the segmented image due to the dynamic background. A applied on the segmented hand contour for removal of unwanted background noise.

Vincent Spruyt, et al. [4] gives, a real-time unsupervised hand segmentation method for video sequences. This algorithm is able to recover from failure and does not need an apparent initialization phase. The algorithm can also deal with varying lighting environments and moving or cluttered backgrounds and can be used in unconstrained environments.

Rayi Yanu town, et al. [5] offers a method for hand image segmentation from the depth image. Thresholding technique is used to get a human image apart from a depth image. The threshold level is obtained by analyzing the human posture dimension. By detecting the centroid of the human image, the left and right parts of the material body will be split. Hand segmentation is completed by exploitation Associate in Nursing measurement data of hand cause. This information is used to calculate the color value that gives the depth of hand in each image region. Thus, the attained values area unit used as a threshold for each image region. The thresholding operation resulted in fully metameric hand images. This technique features a small computation time.

Chunyang Wang et al.[6] offers Associate in Nursing approach to systematically pursuit numerous fingertips at the same time using a single optical camera. This technique uses the color model to extract the hand region and identifies fingertips via curvature detection. Different types of interfering points area unit removed by exploitation the vector of vectors and therefore the distance remodel. Associate in Nursing improved Kalman filter is employed to predict the locations of fingertips within the current image frame.

To notice fingertips from the contour of hand, the curvature-based algorithmic program is used. The curvature of a contour purpose is painted by the trigonometric function worth of θ, that is that the angle between Pi P i-N and Pi Pi+N:

$$\cos\theta = \frac{\overline{P_iP_{i-N}} \bullet \overline{P_iP_{i+N}}}{\left\|\overline{P_iP_{i-N}}\right\|\left\|\overline{P_iP_{i+N}}\right\|}$$

Where, P_i P_{i-N} and P_{i+N} are i^{th}, $(i\text{-}N)^{th}$ and $(i+N)^{th}$ points in the contour, respectively. Points with curvature values satisfying a predefined threshold value (close to 0) are selected as candidates for fingertips. In fingertip filtering method the points located at the valleys of the contour, are removed by interfering points located between fingers and the joint of arm. An improved Kalman filter is used to predict the locations X_{k+1} of fingertips in the $(k+1)^{th}$ image frame.

Ankit Chaudhary et al. [7] gives Vision-Based Method to Find Fingertips in a Closed Hand using the corner detection method and an advanced edge detection algorithm like Gabor filter techniques. The main part of this method is that it includes noise reduction during edge detection in an image.

Yu Yu et al.[8] gives a new fingertip detection method based on a novel definition of fingers. This method firstly detects finger bases and estimated as prior information. Secondly, the finger regions and fingertips are located. The point cloud of hand is corresponding to all geodesic paths originated from palm center. If one path travels through a finger base, then its terminal point is defined as a finger point. The fingertips are determined inside these finger points by exploiting geodesic distances.

Georgiana Simion et al.[9] proposes a fingertip - based approach for hand gesture recognition with tracking principle. Tracking principle is the method where an improved version of the multi-scale mode filtering (MSMF) algorithm is used. In a classification step, the proposed set of geometric features provides high discriminative capabilities. This method can provide high accuracy with reduced computational costs for fingertips detection and tracking.

Hasan Sajid, Sen-ching S. Cheung [10] proposed “Hand Gestured Signature Recognition and Authentication with Wearable Camera”, Wearable camera is gaining popularity not only as a recording device for law enforcement and hobbyists, but also as a human-computer interface for the next generation wearable technology. It provides a more convenient and portable platform for gesture input than stationary camera, but poses unique paper, we describe a robust wearable camera based system called VSig for hand-gestured signature recognition and authentication. The proposed method asks the user to virtually sign within the field of the view of the wearable camera. Fingertip is segmented out and tracked to reconstruct the signature. This is followed by signature matching for authentication with the pre-stored signatures of the individual.

Haitham Hasan, S.Abdul Kareem [11] proposed “Human Computer Interaction for Vision Based Hand Gesture Recognition : A Survey”, The ultimate aim is to bring Human Computer Interaction to a regime where interactions with computers will be as natural as an interaction between humans, and to this end, incorporating gestures in HCI is an important research area. This paper provides a summary of previous surveys done in this area and focuses on the different application domain which employs hand gestures for efficient interaction. The use of hand gestures as a natural interface serves as a motivating force for research in gesture taxonomies, its representations and recognition techniques. The main goal of this survey is to provide researchers in the field with a summary of progress achieved to date and to help identify areas where further research is needed.

[12] Zhou Ren, Junsong Yuan, Jingjing Meng and Zhengyou Zhang proposed “Robust Part- Based Hand Gesture Recognition Using Kinect Sensor”, The recently developed depth sensors, e.g., the Kinect sensor, have provided new opportunities for human-computer interaction (HCI). It is thus a very challenging problem to recognize hand gestures. This paper focuses on building a robust part-based hand gesture recognition system using Kinect sensor. To handle the noisy hand shapes obtained from the Kinect sensor, we propose a novel distance metric, Finger-Earth Movers Distance (FEMD), to measure the dissimilarity between hand shapes. As it only matches the finger parts while not the

whole hand, it can better distinguish the hand gestures of slight differences. The extensive experiments demonstrate that our hand gesture recognition system is accurate distortions and orientation or scale changes, and can work in uncontrolled environments.

Archana S. Ghotka, Gajanan K. Kharate [13] proposed "Hand Segmentation Techniques to Hand Gesture Recognition for Natural Human Computer Interaction", The aim of this paper is to develop robust and efficient hand segmentation algorithm where three algorithms for hand segmentation using different color spaces with required morphological processing have were utilized. Hand tracking and segmentation algorithm (HTS) is found to be most efficient to handle the challenges of vision based system such as skin color detection, complex background removal and variable lighting condition. Noise may contain, sometime, in the segmented image due to dynamic background. An edge traversal algorithm was developed and applied on the segmented hand contour for removal of unwanted background noise.

III. FINGERTIP DETECTION PROCESS

Fingertip detection method has been shown in the following figure: It includes the following steps. Figure 1 shows the architecture of the fingertip detection system.

Step 1: First of all a camera capture a real-time video of moving hand in front of system and hand segmentation is done based on a skin filter.
Step 2: In this step wrist end is detected, based on the histogram of skin pixels and after this hand cropping is performed using different parameters.
Step 3: Finally fingertips will be detected in the cropped hand image.

Fingertip Detection Steps:
Skin Detection: Skin detection is the procedure of discovering skin-colored pixels and regions in an image or a video.

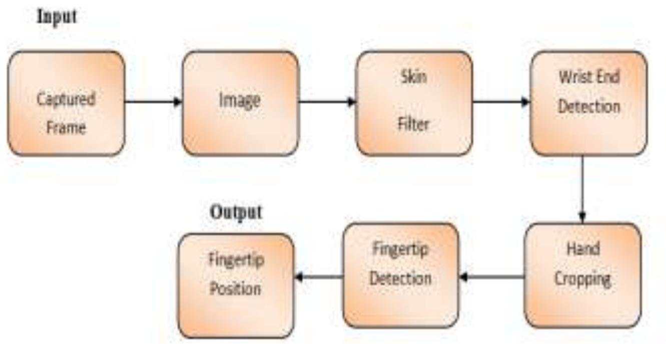

Figure 1: Fingertip Detection Architecture

Skin detection process has two stages: a training phase and a recognition phase. Training a skin detector involves three basic steps:

Figure 2: Fingertip Detection Steps

1. Gathering a database of skin patches from different images. Such a database, in general, encloses skin-colored patches from different people under different illumination conditions.

2. Choosing a suitable color space.

3. Learning the parameters of a skin classifier. Given a trained skin detector, identifying skin pixels in a given image or video frame involves:

   - Converting the image into the same color space that was used in the training phase.
   - Classifying each pixel using the skin classifier to either a skin or non-skin.
   - Typically post processing is needed using morphology to impose spatial homogeneity on the detected regions.

- **Hand Cropping:** Hand cropping minimizes the number of pixels to be taken into account for processing which leads to minimization of computation time. wrist ends a steeping inclination of the magnitude of the histogram starts, whose slope, m can be defined as:

$$m = \frac{y2 - y1}{x2 - x1}$$

  The first point of the image where the inclination is created, and then the point's matches to the first on pixel scanning from other three sides are found, which gives the coordinates where the image should be cropped.

- **Hand Segmentation:** A proficient hand tracking and segmentation is the key of success in the direction of any gesture recognition, because of challenges of vision-based methods, such as changing lighting condition, difficult background, and skin color find. The difference in human skin color complexion is necessary for the development of an algorithm for the natural interface. Color is a very powerful descriptor for object detection. The segmentation purpose is invariant to rotation and geometric variation of the hand. A human perceives characteristics of a color component such as brightness, saturation and hue component than the percentage of primary color red, green, and blue. Color models are useful to specify a particular color in a standard way. It is a space-coordinated system within which any specified color represented by a single point. Here, three techniques were introduced by means of different color spaces for correct hand recognition and segmentation. Hand tracking and segmentation (HTS) technique using HSV color space is identified for the pre-processing of HGR system.

- **Fingertip Detection:** Now in the cropped hand image, fingertips will be detected. Again scanning the cropped binary image and calculate the number of pixels for each row or column based on the hand direction in up-down or left right. The intensity values for each pixel are assigned from 1 to 255 in increasing order from wrist to finger end by proportionality. So, every one pixel on the boundaries of the fingers would be allocating a high-intensity value o55. The edge recognition of the fingers is completed by just detecting pixels having, the intensity of 255. This can be represented mathematically as:

$$pixel_{count}(y) = \sum_{X=Xmin}^{Xmax} imb(x,y)$$

$$modified_{image}(x,y) = round(\,x * 255 / pixel_{count}(y)\,)$$

$$Finger_{edge}(x,y) = \begin{cases} 1 & if\ modified_{image}(x,y) = 255 \\ 0 & otherwise \end{cases}$$

This work is the part of vision based fingertip detection system in the complex environment. Hand tracking and segmentation are the primary steps for any fingertip detection system. In the initialization step, our method was used to detect fingertips detection in a complex environment.

The different numbers, variant illumination and scales of fingertips, as well as the walking person in the background, have no effect on the performance of the given algorithm, indicating that our algorithm is effective and robust in complex environments and can be used for real-time fingertip detection.

- The original frames in the left panels, the segmentation results of the hand region in the middle panel, and the fingertip tracking results in the right panel.
- The scene shown in the first row contains many skin-colored regions and a hand with one fingertip.
- The scene in the second row includes many skin-colored regions and a man moving his fingertip.
- The scene in the third row is nearly the same as the first scene except with a different number and scale of fingers.

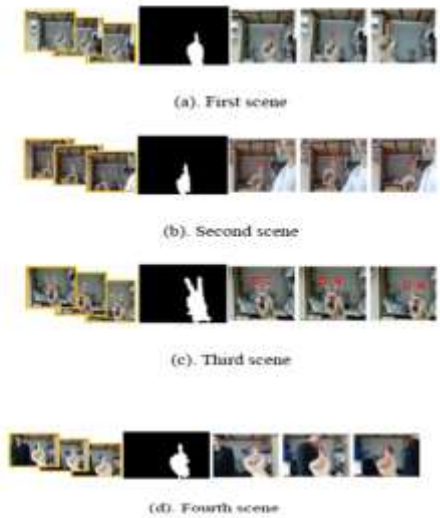

Figure 3: Fingertip Detection Result

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