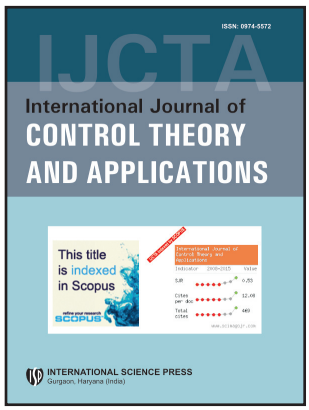

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Dynamic Hand Gesture Recognition System Using Real Time End Point Identification Method

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Abstract: Hand Gesture Recognition Systems are evolving day by day. Innovative technologies are providing new ways for interacting with computers and mobile devices. Due to the increasing demand of user friendly interfaces for communication with computers and mobile devices, hand gesture recognition systems are opening new ways to design and develop the user interfaces which are natural and easy to use.

When using hand gestures to develop new user computer interaction method it is necessary to identify the correct gesture from the hand gesture provided by user. In this paper, we have used Accurate End Point Identification (AEPI) method to identify hand gesture from the real time video input. The AEPI method is based on morphological operations. This paper outlines work carried out to dynamically identify the hand gesture and its possible applications for future use.

Keywords: Hand Gesture Recognition, Centroid Detection, Morphological Computations.

1. INTRODUCTION

Information and Communication Technology has impacted human life in such a way that the computing devices has become the unavoidable component in social, personal and business environment. Use of these devices ranges from updating status on social sites, shopping, surfing etc. to writing personal/business emails and so on. The recent advancements in technology introduced wide range of devices including wearable computing, touch based computing in not only portable devices but also in desktop environments. Each of these devices has various input and interaction mechanism that relies on traditional methods like using mouse, keyboards etc. and others are dependent upon touch based gestures.

To effectively utilize such devices and systems, more and more communication is required among the user and devices. Exploring new techniques of human computer interaction is becoming a popular area of research. Even though initial HCI systems based on keyboard and mouse has experienced a lot of innovation, still people

are demanding more and more. This led to the introduction of touch based interaction mechanisms and now touch less interaction methods are gaining attention of researchers. Utilizing human gestures in HCI has opened new doors for implementing innovative interaction techniques.

In this paper, we describe a hand gesture based interaction mechanism that can be used in real time for controlling various software applications not only on computers but also on mobile devices. The proposed system is based on our earlier work in which we have implemented Accurate End Point Identification method for recognizing static hand gestures in various lightning conditions, backgrounds, containing multiple objects and blur in the images which are captured through a webcam or laptop camera.

2. RELATED WORK

In our earlier work, we have described a system that captures static hand gesture images in real time and use them for gesture recognition. The implemented Accurate End Point Identification Method employs morphological operations, centroid detection, thinning process for gesture recognition. This section outlines the relevant work carried out in hand gesture recognition.

A.M. Raid, W.M. Khedr, and et. al., has written a program for user interface to perform six morphological operations through radio buttons. Slider & pop –up menu is used to change the size of structuring elements of shape diamond, square, and octagon [1].

To perform morphological operations on grayscale images more specific mathematical development are required [2, 3]. The main morphological operations are dilation and erosion [4]. In dilation the objects are expanded to fill the holes and thus disjoint objects are connected with each other. In erosion the objects are diminished towards boundaries. These operations if customized using a structuring element then several applications can be developed [5]. In morphological operations the rules corresponding to pixel and its neighbor pixels are applied to carry out the required operation on input image [6].

G.V. Tcheslavski has proposed Grayscale morphology using Morphological Image Processing [7]. Details on Morphological image operators are given in [8] by H.Heijmans. R. Haralick, S. Sternberg, and X. Zhuang, has given Image analysis using mathematical morphology in [9]. Detailed explanations on applications of mathematical morphology are given by Serra.J [10]. L.Vincent has thrown lights on morphological area opening and closing for grayscale image processing in [11].

Herve Lahamy and Derek Litchi has demonstrated real time gesture recognition using range camera and build a human machine interface. The authors developed two applications, first application recognizes the number of fingers raised in hand gestured and second application manipulates the moving objects based on 3D information provided by range camera [12].

Manasa Srinivasa H S and Suresha H S has implemented a system to recognize the number of open fingers in a hand gesture. The authors implemented this system using codebook algorithm, contour and convex hull for subtracting the background of image and convexity defect calculations [13].

Reza Azad, Babak Azad and etl. has developed a real time HCI based on face and hand gesture recognition. The authors used face for verification and hand gesture for controlling the computer media player. The system first locates the hand gesture and face using the skin and cascade detector and then a threshold value is used in recognition process [14].

S.M. Hassan Ahmed and etl. has proposed a framework to control Microsoft Point Presentations base on real time gesture recognition. In this work the finger tips and region of interest is found using various techniques

such as Features from Accelerated Segment Test, Bresenham's algorithm, Adaptive Resonance Theory (ART) neural network etc[15].

A Kurakin and etl. has proposed a real time hand gesture recognition system which is automatic and robust using action graph that requires less training data. In this system authors developed new techniqes for segmentation and orientation normalization. The system is tested with twelve dynamic American Sign Language (ASL) gestures [16].

X. Zabulisy and etl has proposed an approach for Human-Robot Interaction based on Hand Gestures and given a detail study of various methods used in Vision-based Hand Gesture Recognition for Human-Computer Interaction in [17].

Quentin De Smedt and etl. has implemented a Skeleton-based Dynamic hand gesture recognition system that employed a multi-level representation of Fisher Vectors and skeleton-based geometric features which are classified by a linear SVM classifier. The authors evaluated the system using 14 gestures of 20 participants [18].

Cristina Manresa and et. al., has implemented a real time algorithm to control a videogame using hand gestures. The system is implemented using color cues from skin color and invariant properties with additional method to track hand using pixel labeling approach. The authors used finite state classifier to classify the gesture [19].

Hardy Francke and et. al., has implemented real time hand gesture detection and recognition system using boosted classifier and adaptive learning which is applicable in difficult environments [20].

M. Correa and et. al., has implemented a system using hand's position and velocities and cascade of boosted classifiers, Bayes Classifier to detect static and dynamic hand gesture for interaction with service robots[21].

Yikai Fang and et. al., has used a specific gesture to detect the hand gesture using motion and color cues by integrating the scale-space feature detection method for real time hand gesture recognition [22].

C. Keskin and et. al., has proposed a system based on wearable colored hand gloves that employees Hidden Morkov Model (HMM) to obtain hand coordinates via 3D reconstruction[23].

Varsha Dixit and Anupam Agarwal has defined a method for recognizing ten types of different hand gestures by taking the most interactive features of the hand. The authors were able to reduce the confusion problem among the gestures [24].

Kenji Oka and etl. has described a method for fingertip tracking which tracks the fingertips and hand gestures in complex backgrounds and in varying lighting conditions without using markers. The method is applied to develop augmented desk interface systems [25].

Robert Y. Wang and etl has proposed an easy to use and inexpensive method for hand gesture tracking developed using cloth glove of a custom color pattern. The method uses nearest neighbor approach to track hand gestures [26].

Tatiana Schmidt and etl. has presented a methodology for gesture recognition which deals with the sparse data provided by sensors. The angle between fingers is used to distinguish between the finger gestures and classifiers capable to deal with such data are used and compared with SVM and Random Forest Classifiers [27].

3. ACCURATE END POINT IDENTIFICATION METHOD

The AEPI method implements five different steps as shown in Figure 1. The acquired hand gesture image is preprocessed to generate the complement of binary image in this step. The true color RGB image is converted in

Grayscale intensity image using the Ostu's global threshold method. Grayscale intensity image is dilated using morphological operation in which the object boundaries are detected through defining a structuring element of circle shape. The dilated image is then converted into a binary image and its complement is obtained.

The important tasks carried out in step 1 includes conversion of RGB Image into Grayscale Image, Dilating the image and obtaining the binary complement of input image.

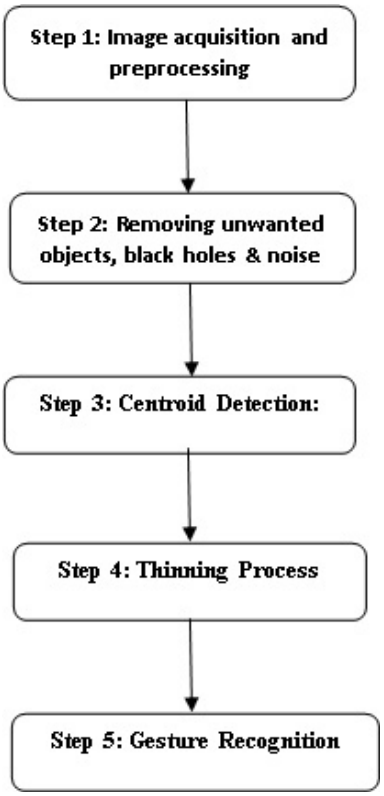

Figure 1: Steps in AEPI Method

The third step of AEPI method detects the centroid of the object remaining in the image. This object is mostly the hand gesture or sometimes it may include any of the connected object. After finding the centroid the thinning process is applied. In thinning process the object is shrinked to a thin lines. This is the fourth step of AEPI method.

Final step is gesture recognition in which the region of interest is extracted above the centroid point. The region of Interest contains the finger lines which are either separated ones or may have some branches. The end points are found first then out of total points branch points are found. To recognize the gesture following formula is used.

$$\text{Total count of fingers} = (ep\text{-}bp)/2.$$

where, "ep" is number of edge end points present in the cropped image.

"bp" is the number of branch points present in the cropped image.

Then the result is returned which identifies the gesture correctly. The AEPI method has been tested on images with uniform background, varying background, images containing multiple objects as well on blurred images. The AEPI Method provided promising results for the gesture recognition process.

4. REAL TIME END POINT IDENTIFICAITON METHOD (RTEPI)

The AEPI Method is applied to dynamic video input captured from web camera or laptop camera. To apply AEPI method a new method called RTEPI is used. The Figure 3 shows the block diagram of system.

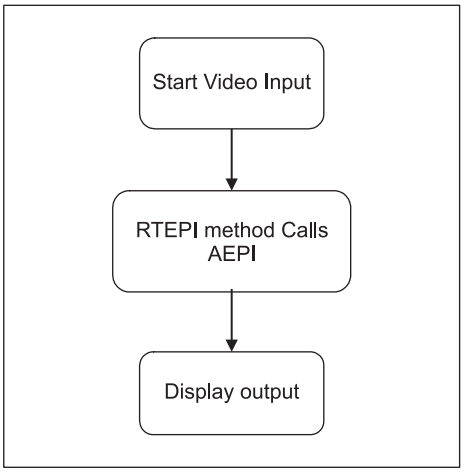

Figure 2: RTEPI Method

In RTEPI once the video input is started the program starts capturing the various input video frames. The RTEPI method captures the various frames of input video and out of these input video frames a sequence of five continuous frames is stored and then it identifies the best suitable image that has to be passed to AEPI method for further processing.

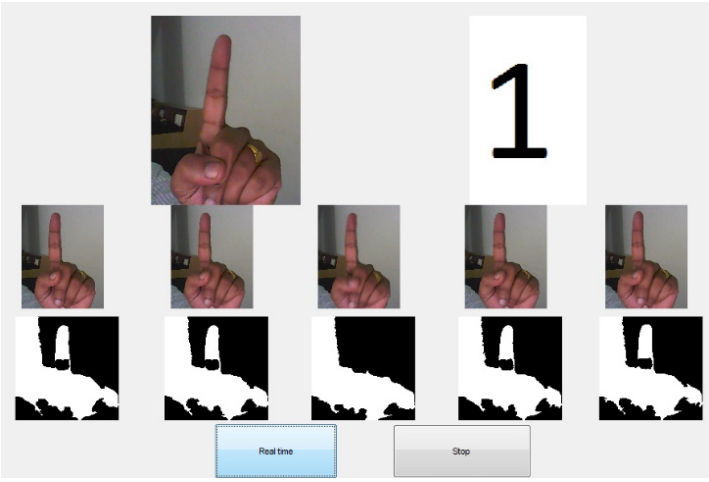

Figure 3: Dynamic Input1 & Result

As shown in Figure the input is passed to the AEPI method and the correct gesture is identified. The gestures from one to five are tested and the method correctly identifies the gesture from the video input. The RTEPI method employs various morphological operations and the input frame that is passed to AEPI is decided on the parameter such as number of objects present in the image, clarity of gesture in image, background of gesture in image. The frame which has less number of objects, clear gesture out of the five sequences and correct gesture is identified. The Figure 3, 4 & 5 are for correct gesture input sequences. In Figure 6, the input sequence contains two gestures hence RTEPI waits till the five continuous frames for the same gesture are obtained.

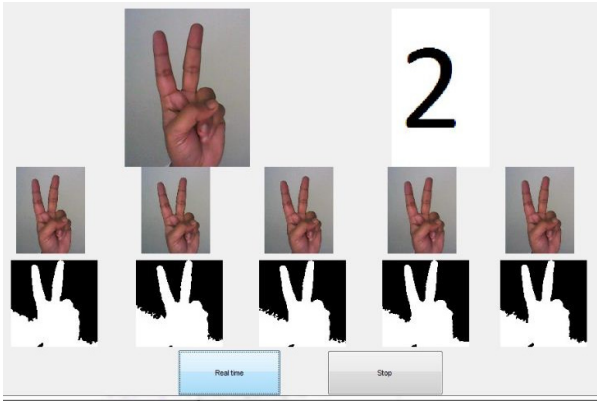

Figure 4: Dynamic Input 2 & Result

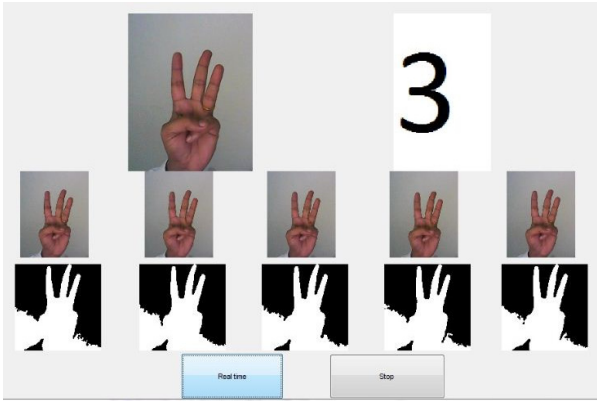

Figure 5: Dynamic Input 3 & Result

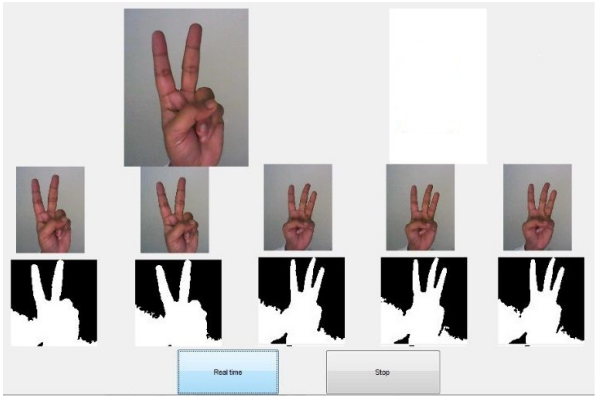

Figure 6: Dynamic Input with two different input sequence.

5. APPLICATIONS

The approach can be used in various applications like Hand Gesture recognition systems for Automatic Traffic monitoring, Communication systems for disabled people, controlling and communicating with computer applications, controlling functionalities of mobile phones etc.

6. CONCLUSION & FUTURE SCOPE

The real time end point identification method is based on Accurate End Point Identification, which enables the AEPI method to work on real time hand gestures captured through web camera or laptop camera. The input is a real time video. The RTEPI method provides the correct frame for processing to AEPI method which then detects the accurate method.

The Accurate End Point Identification method employs various morphological computations which are properly sequenced and modified to detect end points and branch points. The edge point detection formula accurately identifies the hand gesture from the static input image which contains varying background, multiple objects and blur. Currently the method is tested for the images taken with varying background and blurred images having multiple objects in it. The method achieved promising results with 99% accuracy as compare to available techniques for hand gesture recognition.

In future the combination of AEPI and RTEPI method will be used to control mobile applications through hand gestures.

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