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Hand Gestures - Virtual Mouse for Human Computer Interaction

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***Abstract* – In human computer interaction module, hand gesture plays an important role. Obtaining of accurate values in finger pointing with 3-D space value is difficult process. This research work focuses on the improvement of human computer interaction systems using hand gesture with 3-D space by using two camera in position. The hand pointing gesture is estimated and mapped to the screen coordinate system. Also we use other hand gestures to complete the action of virtual mouse. We use hand pointing to point to the screen and other gestures for other operations such as selection of a folder/an object.**

***Index terms* – Hand tracking, human-computer interaction (HCI), national user interface (NUI), active appearance model (AAM).**

I. INTRODUCTION

Computers and computerized devices have become an inevitable element in our society. They have affected us in a great deal. One of the major impacts of computer is communication. Although computers have made tremendous advancements, the common human-computer interaction (HCI) still relies on input devices such as keyboards and mouse. Vision based gesture recognition is an important technology for friendly HCI interface, and received more and more attention recently. Hand gesture is an efficient way for human-computer interaction[1]. Hand gestures can control many applications intuitively and also offer higher dimensionality. The use of hand as a National User Interface (NUI) has become more and more popular.

Today, hand is used as a direct input device[2]. For instance, we have touch screens embedded in smart phones. Now our main aim is to interact with the surrounding devices without direct contact. Hand pointing is the most basic and simplest gesture and perhaps the most intuitive interface for selection. However, the estimation of 3D [3] hand pointing direction automatically and accurately from videoinput is a challenging task because of the great variety and flexibility of hand movement and indistinguishable hand features of the joint parts.

In this paper [4], we not only focus on pointing gesture but also on some of other hand gestures. We set up two orthogonal

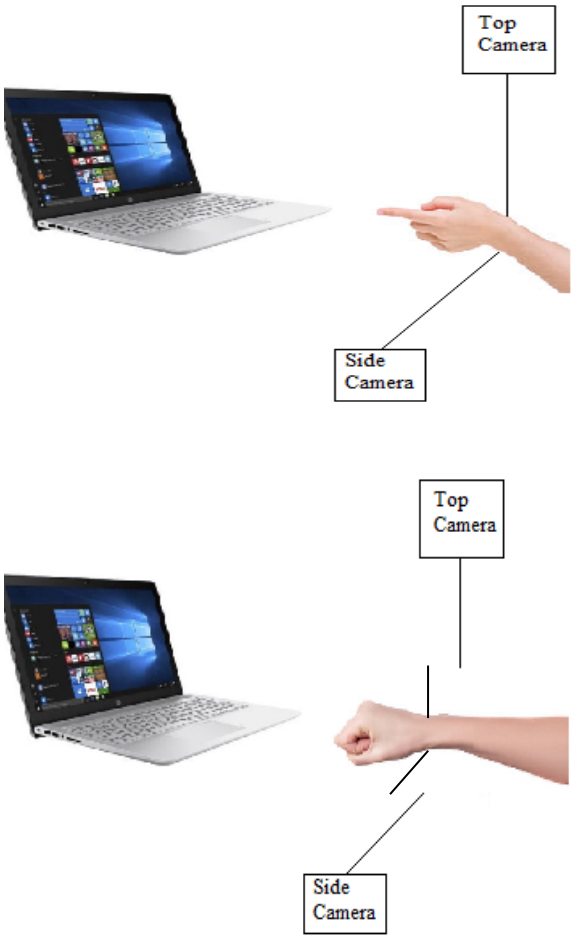

Fig. 1. System setup

Cameras, one on the top of the user's hand and the other on the left/right side of the user's hand.

II. RELATED WORK

Hand detection and recognition have been an active research area in computer vision based system for a long time. For an efficient means of human- computer interaction we use hand pointing. The previous works include hand detection and tracking using fingertips [6], multicolored gloves[7], depth-aware cameras[8], stereo-vision based approaches[9],[10],background subtraction[11], color based detection [8],[12] or binary pattern based hand feature detection[13]. Detection and tracking of hand accurately is a challenging task.

A real time hand tracking technique that tracked the front of the hand was proposed by GertGeebelen[7] but in different recordings the pixel values may vary and the borders for tracking the colors might have to change. Mathias Kolsch in [13]contributed a detailed analysis of Viola-Jones detectors for in plane rotations of hand appearances. However, only about 15˚ rotation can be efficiently detected from the method's performance on faces.

Although, different works have been done in this area, the degree of freedom of hand rotation still remains as a difficult task. Most of the previous work in the HCI with the help of hand gestures has been carried out in 2D space. Here we propose 3D hand pointing to solve the ambiguities springing from verbal communication[1]. Also we have incorporated other hand gestures into the system.

Here we use two orthogonal cameras to estimate pointing direction. Among the two cameras one is placed on the top of the user's hand and the other on the left side. We propose a hand image warping approach so that the original image in Cartesian coordinates is transformed to the polar coordinates. By doing so makes the hand detection invariant to orientation.

III. SYSTEM OVERVIEW

The human-computer interaction (HCI) system proposed consists of hand pointing detection. Figure 2 shows that the composition overview for the system and it has three different strategies for hand pointing gesture and it follows:

- Detection of hand region
- Tracking of hand features
- Making 3D pointing towards direction.

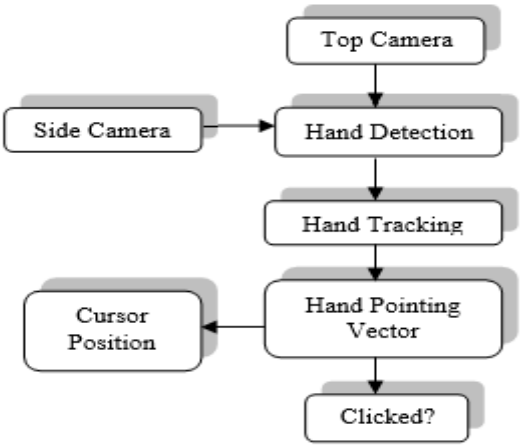

Fig. 2. System overview.

IV. HAND TRACKING AND POINTING ESTIMATION

1. Detection of Hand region

The primary step in approximating the pointing direction for the region of hand detection. Surprisingly, skin color [4] is almost uniform so color based hand detection is possible. Detection of hand without the help of skin color information and real time performance is not considered. Since the skin color has a much stouter red component, the image can be obtained by

$$I(xi, yi) = R(xi, yi) - max\,[G(xi, yi), B(xi, yi)]$$

Where *I* represent the image, *R, G, B* represents the red, green and blue components respectively. This process gives the skin area.

Figure 5 shows the position of the wrist comparison based on the Cartesian polar coordinates with the help of this position as 0˚ polar coordinate.

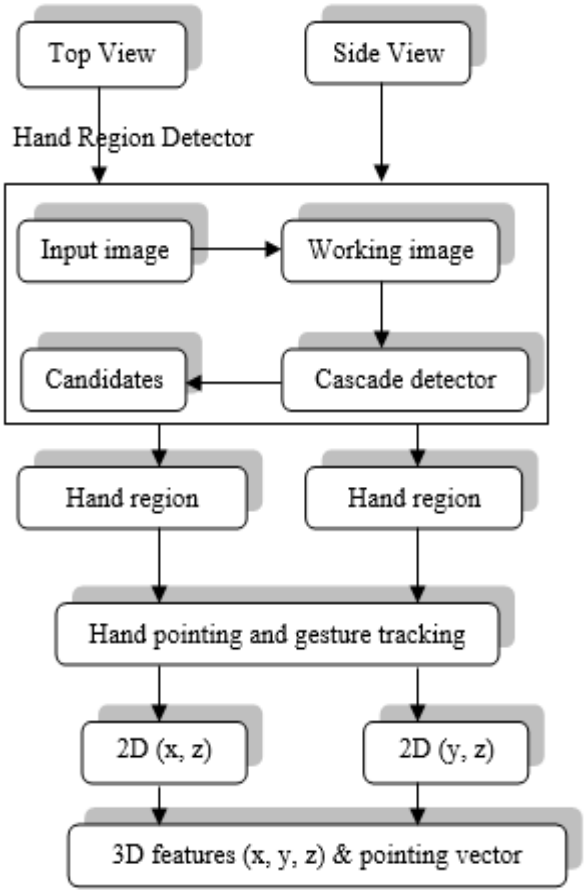

Fig. 3. Pointing approximation system including the hand region detector.

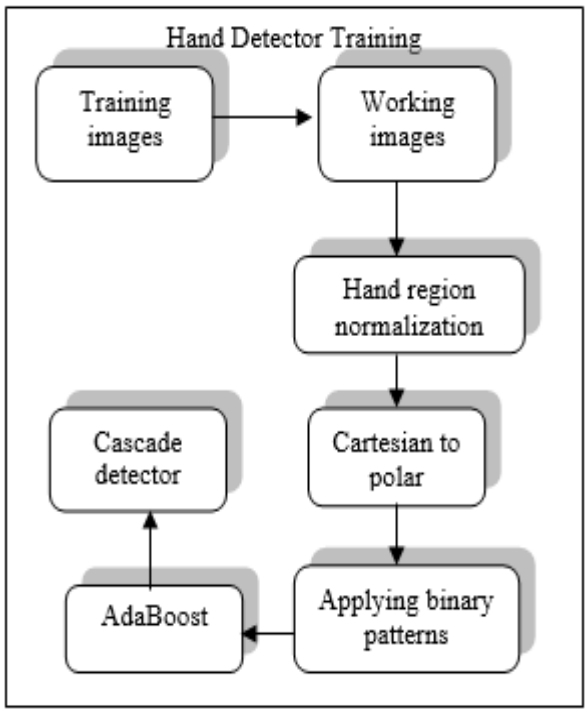

Fig. 4. Hand detector training process

2. Hand Feature Tracking

Hand feature tracking [14] is used to track the hand featured points by using active appearance model from the both top and side views. It will be more helpful in many applications for location tracking of deformable objects. This AMM model helps to capture the figures simultaneously in an orthogonal view. Creation of model is different than tracking of model.

3. Estimation of 3D Pointing Direction

Hand separation is used to create the frame and that can be viewed in both side and top using the camera. Top view use the (x,z) coordinate and (z,y) as side view and combining this both we will get the 3-D coordinates (x,y,z).

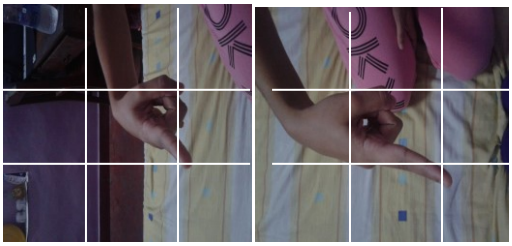

Fig. 5. Hand wrist estimation by 3 × 3 blocks division.

V. EXPERIMENTS AND EVALUATION

There are two USB cameras are placed which is used for the top view and side view. MATLAB software is used for it. For separate two views, we have to train the two detectors and choosing various image samples for various directions at the top & side view. The training samples of top and side view are shown in Fig 6.

At the training stage, binary patterns are applied for image conversation and feature generation for each sample. Then two cascade detectors were built which depends on AdaBoost feature selection. At the testing stage, the transformation of the input image to the working image, each and every detector monitors & scan the working image in each view separately.

When the comparison of detected hand regions with manually selected ones, we get 90% correct detection rate for both views under enough light conditions.

Fig. 6. Examples of hand training images

To validate the utility of the proposed system, we set up two USB cameras connected to the laptop. Using this setup as shown in Fig. 7, we are able to control the mouse action of the system. Here, we use the hand pointing gesture to point to a particular folder and the other gesture to select or open a particular folder. We are able to use our hand to point and select successfully provided sufficient lighting conditions.

Fig. 7. Orthogonal camera setup

VI. CONCLUSION

In this paper, we have proposed hand pointing gestures incorporated with other hand gestures in 3D space. We use two USB cameras which are placed orthogonal to each other to obtain top view and side view of different hand gestures.

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