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A Collaborative Augmented Reality System Based On Real Time Hand Gesture Recognition

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Abstract - Human computer interaction is a major issue in research industry. In order to offer a way to enable untrained users to interact with computer more easily and efficiently gesture based interface has been paid more attention. Gesture based interface provides the most effective means for non-verbal interaction. Various devices like head mounted display and hand glove could be used by the user but they may be cumbersome to use and they limits the user action and make them tired. This problem can be solved by the real time bare hand gesture recognition technique for human computer interaction using computer vision Computer vision is becoming very popular now a days since it can hold a lot of information at a very low cost. With this increasing popularity of computer vision there is a rapid development in the field of virtual reality as it provides an easy and efficient virtual interface between human and computer. At the same time much research is going on to provide more natural interface for human-computer interaction with the power of computer vision .The most powerful and natural interface for human-computer interaction is the hand gesture. In this project we focus our attention to vision based recognition of hand gesture for personal authentication where hand gesture is used as a password. Different hand gestures are used as password for different personals.

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A Collaborative Augmented Reality System Based On Real Time Hand Gesture Recognition

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Abstract - Human computer interaction is a major issue in research industry. In order to offer a way to enable untrained users to interact with computer more easily and efficiently gesture based interface has been paid more attention. Gesture based interface provides the most effective means for non-verbal interaction. Various devices like head mounted display and hand glove could be used by the user but they may be cumbersome to use and they limits the user action and make them tired. This problem can be solved by the real time bare hand gesture recognition technique for human computer interaction using computer vision Computer vision is becoming very popular now a days since it can hold a lot of information at a very low cost. With this increasing popularity of computer vision there is a rapid development in the field of virtual reality as it provides an easy and efficient virtual interface between human and computer. At the same time much research is going on to provide more natural interface for human-computer interaction with the power of computer vision .The most powerful and natural interface for human-computer interaction is the hand gesture. In this project we focus our attention to vision based recognition of hand gesture for personal authentication where hand gesture is used as a password. Different hand gestures are used as password for different personals.

I. Introduction

It is a topic in computer science and language technology with the goal of interpreting human gestures via mathematical algorithm. Gestures can originate from any bodily motion or state but commonly originate from the face or hand. Current focuses in the field include emotion recognition from the face and hand gesture recognition. Many approaches have been made using cameras and computer vision algorithms to interpret sign language. However, the identification and recognition of posture, gait, proxemic, and human behaviors is also the subject of gesture recognition techniques.

Gesture recognition can be seen as a way for computers to begin to understand human body language, this building a richer bridge between machines and humans than primitive text user interfaces or even GUI's (graphical user interfaces), which still limit the majority of input to keyboard and mouse.

Gesture recognition enables humans to interface with the machine (human-machine interaction) and interact naturally without any mechanical devices. Using the concept of gesture recognition, it is possible to point a finger at the computer screen so that the cursor will move accordingly. This could potentially make conventional input devices such as mouse, keyboards and even touch-screens redundant. Gesture recognition can be conducted with techniques from computer vision and image processing.

In computer interfaces, two types of gestures are distinguished:

I. *Offline gestures:* Those gestures that are processed after the user interaction with the object. An example is the gesture to activate a menu.
II. *Online gestures:* Direct manipulation gestures. They are used to scale or rotate a tangible object.

Gesture recognition is useful for processing information from humans which is not conveyed through speech or type. As well, there are various types of gestures which can be identified by computers.

a) *Sign language recognition.* Just as speech recognition can transcribe speech to text, certain types of gesture recognition software can transcribe the symbols represented through sign language into text.
b) *For socially assistive robotics.* By using proper sensors (accelerometers and gyros) worn on the body of a patient and by reading the values from those sensors, robots can assist in patient rehabilitation. The best example can be stroke rehabilitation.
c) *Directional indication through pointing.* Pointing has a very specific purpose in our society, to reference an object or location based on its position relative to ourselves. The use of gesture recognition to determine where a person is pointing is useful for identifying the context of statements or instructions. This application is of particular interest in the field of robotic.
d) *Control through facial gestures.* Controlling a computer through facial gestures is a useful application of gesture recognition for users who may not physically be able to use a mouse or keyboard. Eye tracking in particular may be of use

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for controlling cursor motion or focusing on elements of a display.

e) *Alternative computer interfaces.* Foregoing the traditional keyboard and mouse setup to interact with a computer, strong gesture recognition could allow users to accomplish frequent or common tasks using hand or face gestures to a camera.

f) *Immersive game technology.* Gestures can be used to control interactions within video games to try and make the game player's experience more interactive or immersive.

g) *Virtual controllers.* For systems where the act of finding or acquiring a physical controller could require too much time, gestures can be used as an alternative control mechanism. Controlling secondary devices in a car or controlling a television set are examples of such usage.

h) *Affective computing.* In affective computing, gesture recognition is used in the process of identifying emotional expression through computer systems.

II. Literature Analysis

Wu Yueming, He Hanwu, Ru Tong, Zheng Detao have proposed a method for hand segmentation in their paper 'Hand Segmentation for Augmented Reality System'. This method uses Color-based and appearance-based skin detection technologies to separate the hand from the background. As compared with the traditional segmentation method this method has two benefits One is that it does not require a stationary camera or a static background; another is that it is not sensitive to intensity different, and requires no special object model with relative high performance. These two benefits make the system applicable to the augmented reality systems or other real-time systems. Hand segmentation is producing better quality results since appearance-based skin detection technology reduces the misjudged pixels along with the color based skin detection technique. The experimental result shows the accuracy, performance and robustness of this method.

The performance of the system is shown to be similar to state-of-the-art hand geometry authentication techniques but without sacrificing the convenience of the user. In the field of virtual reality and interactive graphics, communication between human and computer becomes more and more important. Wei Du and Hua Li presented a real-time system in "Vision based gesture recognition system with single camera" for human-computer interaction through gesture recognition and hand tracking [10]. Stable detection can be achieved by extracting two kinds of features: statistic-based feature and contour-based feature. Unlike most of previous works, our system recognizes hand gesture with just one camera, thus avoids the problem of matching image features between different views. This system can serve as a natural and convenient user input device, replacing mouse and trackball.

Hand gesture is a natural and intuitive interactive method. Shuying Zhao, Wenjun Tan, Chengdong Wu, Chunjiang Liu and Shiguang Wen presented in "A Novel Interactive Method of Virtual Reality System Based on Hand Gesture Recognition" [11] a novel interactive method of virtual reality system based on hand gesture recognition. The hand gesture segmentation method is proposed based on building complexion model by Gaussian distribution and the background model by automatically update the background parameters to improve the ability of adaptation environment. According to the good describing ability of Fourier Descriptor and the good self-learning ability of BP neural network, an improved algorithm of hand recognition is presented. Experiment result indicates that this method is flexible, realistic and exact, and fit for many virtual reality systems.

With the rapid emergence of 3D applications and virtual environments in computer systems; the need for a new type of interaction device arises. This is because the traditional devices such as mouse, keyboard, and joystick become inefficient and cumbersome within these virtual environments. In other words, evolution of user interfaces shapes the change in the Human-Computer Interaction (HCI). Intuitive and naturalness characteristics of "Hand Gestures" in the HCI have been the driving force and motivation to develop an interaction device which can replace current unwieldy tools. Considering this need Reza Hassanpour and Asadollah Shahbahrami have presented a survey on the methods A survey on the methods of analyzing, modeling and recognizing hand gestures in the context of the HCI in their paper 'Human computer interaction using vision based hand gesture recognition. This paper provides different methods for gesture taxonomy, gesture modeling, hand modeling and advantages and disadvantages of different methods.

III. Proposed System

a) Video Capturing

Video capture is the process of converting an analog video signal such as that produced by a video camera to digital form. The resulting digital data are referred to as a digital video stream, or more often, simply video stream. This is in contrast with screen casting, in which previously digitized video is captured while displayed on a digital monitor.

The video capture process involves several processing steps. First the analog video signal is digitized by an analog-to-digital converter to produce a raw, digital data stream. In the case of composite video, the luminance and chrominance are then separated; this is not necessary for S-Video sources. Next, the chrominance is demodulated to produce color difference video data. At this point, the data may be

modified so as to adjust brightness, contrast, saturation and hue. Finally, the data is transformed by a color space converter to generate data in conformance with any of several color space standards, such as RGB and YCbCr. Together, these steps constituted video decoding, because they "decode" an analog video format such as NTSC or PAL.Special electronic circuitry is required to capture video from analog video sources. At the system level this function is typically performed by a dedicated video capture card. Such cards often utilize video decoder integrated circuits to implement the video decoding process.

b) Image extraction from video

Here we have to select captured video as input. We are now ready to start extracting frames from the videos. After getting frame from video start to extract images from those frames. Store those extracted files in particular folder.

c) Image enhancement and Remove noise

Noise reduction is the process of removing noise from a signal. Noise reduction techniques are conceptually very similar regardless of the signal being processed, however a priori knowledge of the characteristics of an expected signal can mean the implementations of these techniques vary greatly depending on the type of signal. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because under certain conditions, it preserves edges while removing noise. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For 1D signal, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher-dimensional) signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns). Note that if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically.

d) Background suppress

An algorithm that detects and removes background shadows from images in which the pattern set occupies the upper-most intensity range of the image and the image is background dominant outside the pattern set is presented. The algorithm will remove background shadows and preserve any remaining texture left behind by the shadow function. A mathematical model of the histogram modification function of the shadow-removal algorithm is developed. An analysis of the sequential nature of the algorithm is included along with simulated results to verify the mathematical model developed and to show the effectiveness of the algorithm in removing background pattern shadows.

e) Hand region segmentation

The initial step of hand gesture recognition is the detection of hand region from the background This step is also known as hand detection. It involves detecting and extracting hand region from background and segmentation of hand image. Previous methods made use of following two approaches that is the color based model and statistical based model. This system uses the additional third approach i.e. haar like feature with adaboost technology. Different features such as skin color, shape, motion and anatomical models of hand are used in different methods. The output of this step is a binary image in which skin pixels have value 1 and non-skin pixels have value 0.

The characteristics of hand shape such as topological features could be used for hand detection. Hands can be found from their appearance and structure such as Adaboost algorithm. 3D model based detection. Using multiple 3D hand models multiple hand postures can be estimated.

f) Feature extraction and gesture recognition

The next important step is hand tracking and feature extraction. Tracking means finding frame to frame correspondence of the segmented hand image to understand the hand movement. Following are some of the techniques for hand tracking.

1. Template based tracking: If images are acquired frequently enough hand can be tracked. It uses correlation based template matching. by comparing and correlating hand in different pictures it could be tracked.
2. Optimal estimation technique: Hands are tracked from multiple cameras to obtain a 3D hand image.
3. Tracking based on mean shift algorithm: To characterize the object of interest it uses color distribution and spatial gradient. Mean shift algorithm is used to track skin color area of human hand.

Two types of features are there first one is global statistical features such as centre of gravity and second one is contour based feature that is local feature that includes fingertips and finger-roots. Both of these features are used to increase the robustness of the system. Hand posture can be distinguished using the number of fingers of the hand and if the number of fingers are same then the angle between two fingers can be measured to recognize the specific gesture.

The goal of hand gesture recognition is interpretation of the meaning gesture of the hands location and posture conveys. From the extracted features multiple hand gestures are recognized. Different methods for hand gesture recognition can be used such as template matching, method based on principle component analysis, Boosting contour and

silhouette matching, model based recognition methods, Hidden Markov Model (HMM). Hand gesture is movement of hands and arms used to express an idea or to convey some message or to instruct for an action. From psychological point of view hand gesture has three phases.

g) Register user

The Register User action registers the user information with the installer to identify the user of a product. it provides a unique user id for every user. a large set of postures and gestures is stored on the computer one for each individual.

h) Login

When a user wants to login he/she has to perform the desired hand gesture. This hand gesture can be performed using single hand. That gesture will be compared with the already recorded gesture that works as a password for that particular person, if that gesture matches with the performed gesture then only that person will be authenticated and will be allowed to access his/her account or product. Basic idea is that the number of fingers are counted and the password is created Ex, 123,432,531,23,4532,123451 etc. the password can be any combination of the numbers from 0,1,2,3,4,5. This password performed by the user is authenticated by the system and he/she will be allowed to access the application or is rejected the access.

This proposed system could be used by any application to authenticate the authorized user. The major benefit of this system is that it could be used by blind users also, but the accuracy is the major concern, the system may not give accurate results in intricate background.

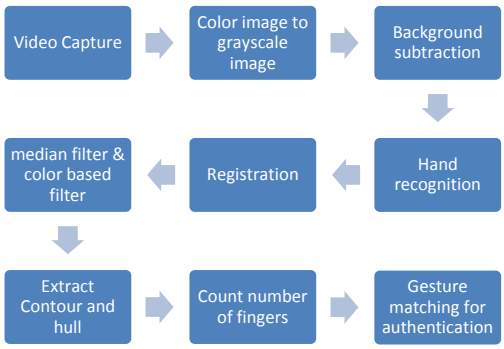

Figure 1 : System Architecture

IV. Result

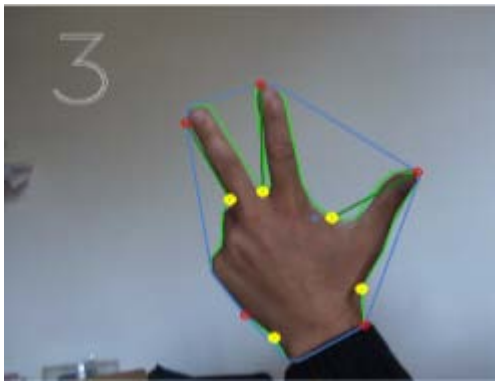

Fig 1(a)

Fig 1(b)

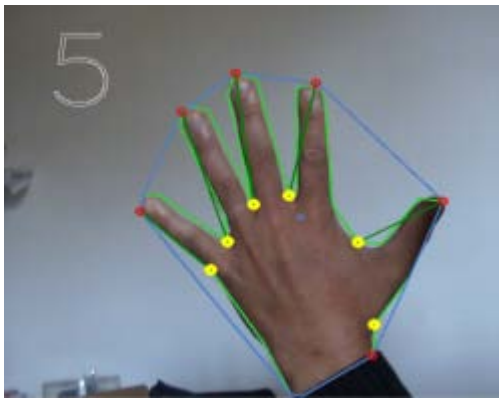

Fig 2(a)

Fig 2(b)

Fig 1 : (a) and 2(a) original picture and fig 1(b) and 2(b) segmentation result

IV. Conclusion

Vision based hand gesture recognition has major applications in human-computer interaction as well as in intelligent service robot. A lot of work has been done for hand gesture recognition such as color based method for hand region segmentation, contour based method, statistical analysis based method, some methods make use of A boosted classifier tree for hand shape detection. This project describes a collaborative vision based hand gesture recognition system where a hand gesture could be effectively used by a person as her password for the personal authentication. Initially the hand is segmented and separated from the background using haar-like features and topological features along with the color model so that the hand could be effectively separated from the background and the features could be easily extracted to recognize the hand gesture. This system accepts the password by the user through the hand gesture. For the password the user performs the required gesture to create a unique combination of the numbers 0,1,2,3,4,5 according to the number of fingers the users gesture has. If this number matches with the already recorded password for that user then the user will be authenticated and the login will be successful. This system provides an easy interface for human-computer interaction. This system will provide a more efficient system with greater accuracy that makes use of both the hands separately as well as the drawback of previous techniques have been tried to remove such as complexion problem could be effectively removed by using background model alongwith the complexion model. Using this method a rich set of possible combinations of the numbers could be made since there are no restrictions on the number, the only thing is that it should be the combination of 0,1,2,3,4,5 so the system will be more secure.

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