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STUDY OF GESTURE BASED INTERACTION FOR INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) APPLICATIONS

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ABSTRACT

The advancement in technology has revolutionized the way of communication with computing devices. The conventional interaction technique consists of input devices such as mouse, keyboard and pointers which requires physical handling. A multimedia interaction approach provides a comfortable, touch-less, novel solution. Consequently, several approaches have been proposed as a mode of communication for the information and communication technology ICT applications. In recent years, the ubiquitous computing with conventional camera is progressing towards potential gesture based communication as a novel modality for human computer interaction HCI. Now, the gesture based technology is gaining popularity as it proves to be natural and intuitive mode of communication [1]. The target application of such hand gesture interactive system includes smart environments like training institutes, office, home, malls etc. In fact the modern work places and business environments which are equipped with dedicated conference room having computer assisted systems can be enhanced with gesture based technology. However, the gesture interface is a complex research problem as it involves image processing techniques for gesture recognition. The basic challenge in designing a gesture interface lies in dealing with various factors such as illumination, complex background, camera characteristics, and ethnicity. A typical gesture interface setup consists of computing system, camera and efficient algorithm [2]. It is required that the gesture interface should be simple, user friendly and respond in real time. Thus, the performance of interface depends on the hardware and efficient software techniques used. In present work a comprehensive study of multimedia interfaces for ICT applications is conducted. A review of various gesture recognition techniques is performed to identify optimum method for real time interaction. A preliminary study of implementing gesture interaction for computer system is done. Accordingly, a prototype is developed that recognizes hand gesture and converts it into actions to interact with various computer applications such as VLC, PPT etc.

Keywords: *ICT, Gesture Interaction, Image Processing, HCI, Multimedia Interaction.*

Introduction

The progression in technologies and ever-growing user demand for a natural and comfortable way of interaction with computing systems has always inspired the research in interface technology. The traditional way of interaction with the computing system requires handling some kind of input devices. The major disadvantages while dealing with such input devices includes operational skills, maintenance of devices and finally the user has to physically handle it. Thus, there is a wide scope for enhancing the features of interface devices for ICT systems. Aiming at further improvement for touch-less interaction a lot of research and development work is reported in ICT interface design.

In last two decades, attempts have been made to automate systems through human speech recognition. The speech recognition approaches can be classified into word recognition, continual speech recognition, speaker dependent, speaker independent recognition and small vocabulary to large vocabulary systems. The simplest method for speech recognition is to utilize speaker dependent isolated

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words on small vocabulary. This technique may not be feasible for many applications where a generalized interface is expected. It is required to design speaker independent, continuous speech recognition technique with large vocabulary. In any case, speech recognition is a complex technique requiring fast processing and large amount of memory.

In comparison with speech based system, gesture interface are getting wide popularity since they are most natural form of communication and their implementation is more feasible. A gesture is non-verbal communication made with a part of body. Using this process human can communicate with machine without using any mechanical device.

The recent progression in the gesture interaction methods and technologies in human computer interface HCI can be categorized into wearable, haptic, and touch-less interface systems. The wearable systems have hardware or micro system implemented for sensing gesture movements. The domain of haptics includes the study of human machine interface based on touch interaction. The touch-less system use computer vision methods to recognize gesture as input command. These systems are designed to recognize speech, facial expression and gesture interaction. The HCI design plays a significant role in deciding the usability of a product because it is evident that the multi-featured products may fail if they do not provide a user friendly interface.

The real challenge in implementing gesture technology is dealing with varying illumination conditions. Also, the raw input image, video or audio acquired as input may be noisy or degraded and requires to be processed before using it.

Gesture Interface Technology

A traditional gesture interface consists of camera interfaced to a computing system having control features. The performance of the system mainly depends on the image processing algorithm which is used to detect gesture. In such system the image acquisition is the first stage followed by pre-processing, segmentation, feature extraction and gesture classification stages. The flow of typical gesture interface system is shown in following figure.1.

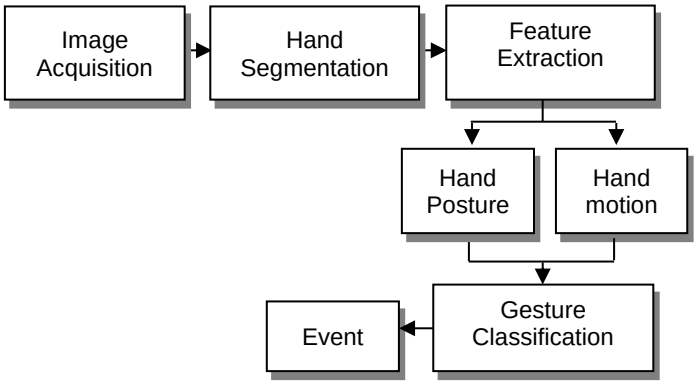

Figure 1: Typical Gesture Interface Setup

The image acquired from the camera is applied to the segmentation stage. It consists of skin classification algorithm for separating hand region from the image. Typically, skin classification involves transformation of RGB color space to another color space classifying skin by appropriate skin color model. There are many color spaces like RGB, HSV, YCbCr, YIQ, YUV, CIE lab and CIE LUV that are used for skin color segmentation [3,4].

The segmentation method can be classified into Pixel based, Edge based and Region based techniques. The classification of segmentation techniques is shown in the following table 1.

Table 1: Classification of Segmentation Techniques

Pixel Based	Edge Based	Region Based
Explicit Defined	Watershed Region	Region Splitting
Histogram Based	Canny Edge Detector	Region Merging
Gaussian model	Wavelets	
Neural Network	Laplacian of Gaussian	
Bayes Classifier		

The pixel-based technique is the simplest method. This method involves defining color space threshold value. The edge-based segmentation involves boundary identification between image regions. The major disadvantage in this method is that it provides comparatively inefficient information. The region base segmentation method involves identifying objects having similar characteristics. It is robust than edge segmentation method.

The feature extraction is the next stage and can be implemented through static or dynamic gesture recognition techniques. The static gesture recognition technique involves extracting information from stable hand postures. The popular static hand gestures comprise of finger count or hand gestures without moving the hand. In dynamic gesture technique the hand movements are classified as input commands. Accordingly, various hand gestures are classified through algorithm. Further, each gesture is associated with a particular command to trigger an event.

In the present work study of gesture-based technology is conducted to identify optimum method for interaction. Further, design of gesture based system to interact and control ICT tools is discussed.

Literature Review

In this section a brief review of the gesture detection techniques is discussed. In gesture based system image acquisition can be done using leap sensor, kinect sensors or camera. The leap sensor is used to recognize finger and hand movements, they are high precision in millimetre but are costly. The kinect sensors are used to recognize body movements, facial expressions and voice, they are precision in cm but are costly. In comparison the digital cameras are used to recognize body movements, facial expressions, they provide better resolution 30Megapixel and are very cheap and are popular in gesture design.

The acquired image is processed for skin detection in segmentation stage. The skin detection is the process of finding skin-colored pixels and regions in an image. The skin detection techniques can be classified into explicitly defining skin region, non-parametric method, parametric method and software computing techniques. In the explicit technique selecting good color space determines the performance of the system. The explicit skin detection technique is simple approach, requires less memory and does not require training. However, in explicit technique selection of appropriate color space plays significant role in overall solution.

The Non-parametric methods are not affected by color space representation while the explicit methods and parametric modelling techniques are affected by the choice of color space. It is also reported that parametric models are also affected by amount and quality of training data available. The software techniques involve mathematical algorithms for skin classification. These techniques should provide good reliable performance with complex background. The disadvantage of this system is requirement of learning which time consuming. The review of skin color classification techniques is presented in the below table-2.

Skin Color Classification			
Explicitly Define Skin Region	**Non-Parametric Method**	**Parametric Method**	**Software Computing**
Basic color RGB, normalized RGB	Standard lookup table	Single Gaussian	Neural networks
Perceptual color spaces HSI, HSV, HSL, TSL	Bayes Classifier	Mixture of Gaussian	Fuzzy systems
Orthogonal color spaces YCBCR, YIQ, YUV, YES	Self-organizing Map	Elliptical boundary Model	Generic algorithm for recognition
Perceptual uniform color spaces CIE lab and CIE LUV			

The gesture based interface has wide range of application. Presently, there is a lot of research reported in gesture technology [5]. In the following section a brief review of gesture technology and its use in ICT is discussed.

Khamar Basha Shaik et.al presented a comparative study of human skin color detection using HSV and YCbCr color space [6]. The result of HSV and YCBCR color space for skin color detection is based on the selection of threshold value. These approaches discriminate color and intensity information even under uneven illumination conditions. The RGB to HSV transformation is a time consuming process.

The HSV based detection is best suited for simple images with uniform background. Moreover, if there is a lot variation in the value of the color information then it becomes difficult. In the case of YCBCR color space, transformation and separation of color and intensity information is easy as compared to HSI or HSV.

Stoo Sepp et. al presented a comprehensive review of gesture based learning with ICT[7]. The gestures such as pointing and tracing have proved to be beneficial to learners by gathering attention or physically expressing learned concepts. They proposed a novel paradigm for ICT to be used for both purposes to interact with learning material as well as to provide information. With the continual advancement in technology there will be more apps and devices for all ages of leaners and more ways to learn about how gestures and technologies will boost learning.

Zixun Hua suggested that using gesture based technology (GBT) in classroom teaching will improve teachers ICT pedagogical practices [8]. This technique will improve ICT literacy, instructional design, instructional organization, instructional evaluation, and professional development. He proposed Leap motion based system to communicate with ICT.

Lakshmi T.G et.al suggested geometry via gestures [9]. Studying geometry requires understanding and integration of theorems, proofs, coordinates, shapes, properties and formulae. Student find it difficult to manipulate 3D objects, they focus on formulas and theorem and not on visualization of 3D objects. The authors proposed Geometry-via-Gestures" (GvG), this technique enables the learners to construct objects like circular cylinder using gestures and derive its volume.

Hui Liang et.al suggested hand gesture interface for puppetry system to assist story telling [10]. The system is implemented with depth motion sensing providing hand gesture interaction. The hand gestures are uses to manipulate virtual puppet to perform story and interact with virtual environment to assist narration. The pilot system developed by the author is a novel digital storytelling system that helps children's to improve narrating ability as well as the cognitive coordination. The preliminary test showed that children can benefit from playing with puppet narrator.

Mina C. Johnson Glenberg proposed gesture in 3D for learning. The setup allows for creative kinestheic manipulation of content. It is seen that the gestures interaction show positive effects on learning. The author proposed a new graphic cube to help visualize the immersive educational lessons. Further, mapping full body movement can provide creative gestures for learning 3D.

System Description

The present work is focused on designing a gesture interface system for ICT applications. The important factors that are considered here are camera placement, the ability to recognise gestures and implementation for controlling attributes of media player. The proposed system is real time video processing system consisting of webcam interfaced to computer system.

The camera is placed on the screen of computer system to provide a better field view. The pixel based explicit skin color model is used here as it is simple technique and provides fast computations.

Amongst, the color spaces the popular color spaces used for skin detection with static background are RGB, YCBCR and HSV. The RGB color space is simple technique and is widely used for detecting skin region from an image. The RGB color space is default color space and any other color space can be obtained from linear or nonlinear transformation from RGB. However, the perceptual features of color such as hue, saturation and intensity cannot be described by RGB. The YCBCR color space is also widely used as the luminance and chrominance are explicitly separated these spaces are favourable for skin detection. In contrast to RGB based schemes, the YCBCR color space is luminescence independent, resulting in a better performance. The HSV space defines color as hue, saturation and intensity property of color. But, Hue (H) is not reliable for the discrimination task when the saturation is low. The comparative analysis of mentioned color spaces shows that there are certain disadvantages if they are considered separately.

Thus, in the present work the combination of HSV and YCBCR color space is used to detect the skin candidate. The combination of color space model with morphological operations produces a filtered response. The skin candidate is identified as white pixel and remaining non skin area as black.

Once the area of interest is segmented from image the resultant image is processed through series of transformation to extract the required information. The palm region is extracted and the tip of palm is used to trigger the attributes of Media player application. The following figures 2 shows the main blocks of the prototype setup.

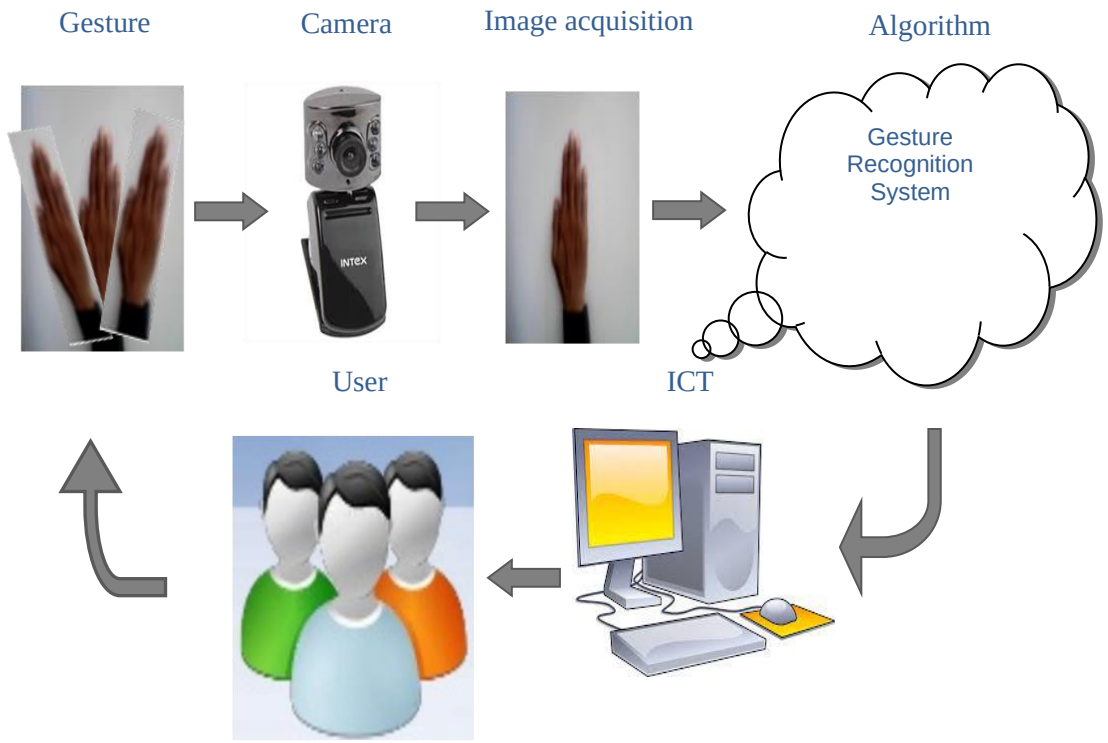

Figure 2: Block diagram of gesture based technology for ICT application

Result & Discussion

The prototype gesture interface for ICT application was designed build and tested successfully. The prototype setup has been used to analyse system response for varying light intensity and usability of gesture interface. The algorithm for accessing media file through gesture interaction for media player was developed.

In the present work a data base of images has been created to analyse the performance of algorithm. The data base includes lab generated images as well as images from the electronic sources. It consists of wide range of images having light variation, poor quality and complex background. The following figures show the response of developed algorithm.

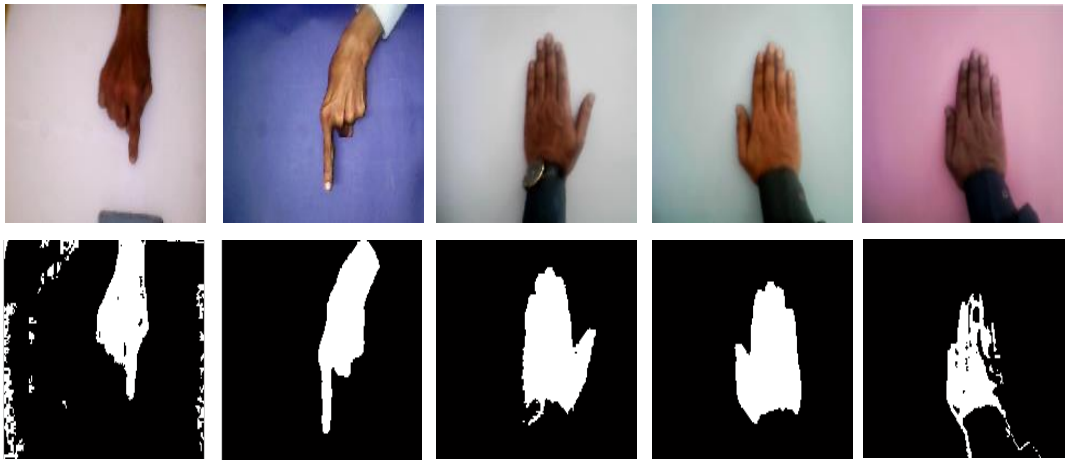

Figure 3: Response of algorithm over lab generated image samples

Figure 4: Response of algorithm over samples taken from electronic sources.

The proposed setup is tested using the developed algorithm, the user can start the media player or select next media file by vertical up swipe gesture. The vertical down swipe is used for selecting previous song. The following table 3 shows the response of system.

Attribute	Gesture	Command
Start windows media	Hand movement upwards	Start
Stop windows media	Hand movement downwards	Stop
Volume control	Hand movement horizontal axes	Volume control
Play/Pause	Close Palm movement	Play and pause

Conclusion

In conclusion it is seen that gesture recognition technology is the turning point in the current world drifting towards Virtual Reality and Augmented reality. The gesture based systems find a novel solution is ICT applications. With the growing technology the utilization of gesture base interaction for ICT learning material will be in great demand. It can allow seamless non-touchable control of computerized devices to create a highly interactive product.

In present work a comprehensive study of gesture based technique is done and it is seen that the explicit skin detection technique is simple approach and requires less memory. This provides a real time solution for ICT application.

The gesture interaction has significant effect of the camera view field, low light conditions, camera configuration, reflections and responsiveness. To deal with this a combination of HSV and YCBCR color spaces are used in the present work. The combination of these color models prove effective over images having varying lighting conditions and complex background. The developed algorithm was tested over sample database. It is seen that the qualitative analysis shows optimum skin detection. The developed prototype is implemented to control computer application.

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