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Real Time Gesture Recognition System for Interaction in Dynamic Environment

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Abstract

Human Computer Interaction techniques have become a bottleneck in the effective utilization of the available information flow. The development of user interfaces influences the changes in the Human-Computer Interaction (HCI). Human hand gestures have been a mode of non verbal interaction widely used. Naturalistic and intuitiveness of the hand gesture has been a great motivating factor for the researchers in the area of HCI to put their efforts to research and develop the more promising means of interaction between human and computers. This paper designs a system for gestural interaction between a user and a computer in dynamic environment. The gesture recognition system uses image processing techniques for detection, segmentation, tracking and recognition of hand gestures for converting it to a meaningful command. The interface being proposed here can be substantially applied towards different applications like image browser, games etc.

Keywords: Human Computer Interaction; Gesture Recognition; Dynamic Environment;

1. Introduction

A ubiquitous computing provides advanced dynamic environments where humans want to make assorted types of interface for interaction with media and information without any physical restrictions [1]. Evolution of computer from super computers to desktops to palmtops has made the presence of human computer interaction felt in every walk of life. The keyboard, mouse etc lack the sensitivity desired in required application. Eventually the researchers working the area of Human Computer Interaction made a common emphasis to design and develop the user interfaces capable enough fulfill the intended performance criteria desired in the dynamic environment. For achieving submergence within a dynamic environment, user shall be capable of interacting efficaciously in the dynamic world. The term efficaciously here explicitly indicates the capacity of minimizing the cognitive load and maximizing goal

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success [2]. For accomplishing it, a successful 3D user interface should be natural, intuitive, powerful enough and easy to learn allowing users to accomplish the necessitated tasks. The present contact based devices like accelerometers, data glove [3], sensors/actuators and other input devices used to capture the user movement and control the selection, manipulation and movements of objects in virtual scenes. The use of these devices is hindered by number factors such as awkwardness, unintuitive, rigidity, and prone to distortion from the physical environment. These devices have cost which is prohibitive for their frequent use by the general user. Hence they are mostly used by highly trained professionals like the surgeons and ace pilots to train and carry out their operations in the virtual environment.

The primary objective of the present system is to use a natural device free interface that recognizes the hand gestures as commands. The paper is further subdivided as follows: section 2 provides the related work done in area of gesture recognition for human computer interaction. Section 3 shows the system design for the gesture recognition system. Section 4 provides the results and analysis of gesture recognition system. The effort ends in Conclusion that is in the section 5. References used for designing the gesture recognition system are summarized in section 6.

2. Related Work

To improve the interaction in qualitative terms in dynamic environment it is desired that the means of interaction should be as natural as possible. Human hand gestures could be defined as a set of permutation generated by movements of the hand and arm [4]. Gesture input can be categorized into different categories depending on various characteristic [5]. One of the categories is deictic gesture that refers to reaching for something or pointing an object. Accepting or refusing an action for an event is termed as mimetic gestures. It is useful for language representation of gestures. An iconic gesture is way of defining an object or its features. Chai et al. [6] presents a hand gesture application in gallery browsing 3D depth data analysis method. It combines the global structure information and the local texture variation in the gesture framework designed. Pavlovic et al. [7] have concluded in their paper that the gestures performed by users must be logically explainable in order to design a good human computer interface. The current technologies for gesture recognition are not in a state of providing acceptable solutions to the above mentioned problems. One of the major challenges that have evolved in the due course of time is the complexity and robustness that is associated with the analysis and evaluation for gestures recognition. Different researchers have proposed and implemented different pragmatic techniques for gesture as the input for human computer interfaces. Dias et al. [8] presents a free-hand gesture user interface which is based on finding the flight of fiduciary color markers connected to the user's fingers. The model used for the video presentation, is grounded in its decomposition in a sequence of frames or filmstrip. Liu and Lovell [9], proposed an interesting technique for real time tracking of hand capturing gestures through a web camera and Intel Pentium based personal computer. The proposed technique is implemented without any use of sophisticated image processing algorithms and hardware. Atia et al. [10] designs a tilting interface for remote and quick interactions for controlling the directions in an application in ubiquitous environment. It uses coin sized 3D accelerometer sensor for manipulating the application. Controlling VLC media player using hand gesture recognition is done in real time environment using vision based techniques [11]. Xu et al. [12] used contact based devices like accelerometer and EMG sensors for controlling virtual games. There are several studies on the hand movements especially gestures, by modeling the human body and creating a consolidated body of knowledge. On the basis of that body of knowledge now it is possible to face the problem from a mathematical viewpoint [13]. The major drawbacks of such techniques are they are very complex and highly sophisticated for developing an actionable procedure to make the necessary jigs and tools for any typical application scenarios. This

problem can be overcome by pattern recognition methods having lower hardware and computational overhead.

3. System Design

The gesture recognition system is designed using an integrated approach for hand gesture recognition. It recognizes static and dynamic hand gestures. Figure 1 shows the methodology used for designing a dynamic user interface. Once the image of hand is captured from camera it is then processed through the following phases/algorithms. The procedure starts by acquisition phase. This is the reason that our system has to yield the better performance even in poor illumination, cheaper cameras and even the variation in the light of the environment. The system has to work within the real time constraints. Hence the procedure has to limit the parameters to the minimal possible level by removing the unnecessary information at the first instance. As the initialization phase is over, the haar cascade [14] classifier is responsible for locating hand position and classifying gestures (open, close, pointing, etc.). Haar-Like Features [15] is features that digitalize images to analyze images in object recognition applications. The tracking of hand is done through camshift technique [16] with shifting the region of interest with average shift in the object of interest i.e. hands. As the hand is tracked a contour is mapped with the corresponding hand which further extracts a corresponding convex hull (area). The recognition has been done through modeling of the hand by mapping it to the number of defect formed in it. Afterwards system tracks the number of defects that have been generated by the hand and maps it to a meaningful command.

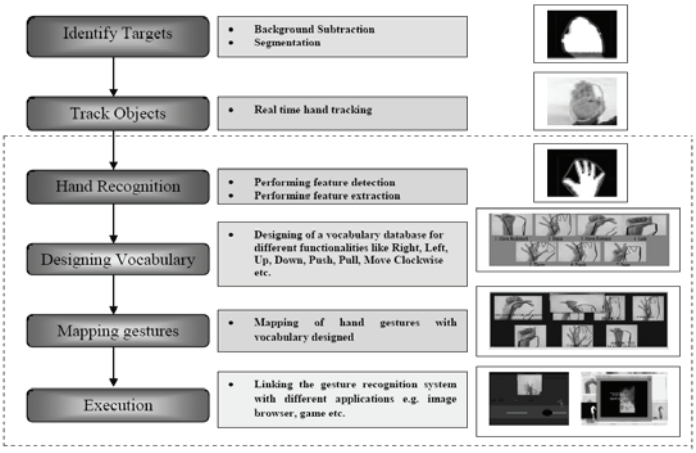

Fig. 1 Methodology for proposed gesture recognition system.

4. Results and Analysis

The dynamic user interface is designed using the image processing techniques which are implemented in C++ with the use of OpenCV Library. Practical experiments show that the system performs well in environments with little noises (i.e., existence of objects whose color is similar to human skin) and with the balanced lightning condition.

Figure 2 shows some hand gestures along with their assigned commands (functions) that are used in the complex environment. Though the gestures have to be mapped for commands in specific applications, the same gesture vocabulary could be reused for mapping different set of commands according to different range of applications like controlling games, browsing images etc. This makes the gesture

recognition system more generalized and adaptive towards human computer interaction. Figure 3 shows the intermediate results of the hand obtained for designing the gesture recognition system.

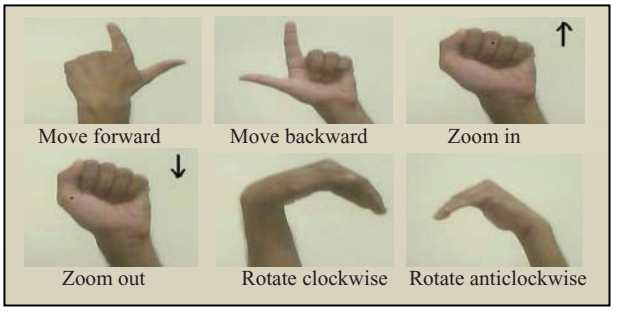

Fig. 2 Hand gesture vocabulary

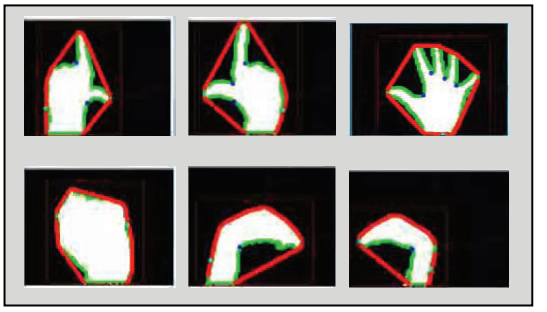

Fig. 3 Intermediate results of hand gesture

The hand gestures browse the images in the image browser as shown in figure 4. The figure 5 depicts and complex environment of gaming where the proposed gesture recognition system could be implemented in the gaming. The user may operate the game commands using hand gesture corresponding to it.

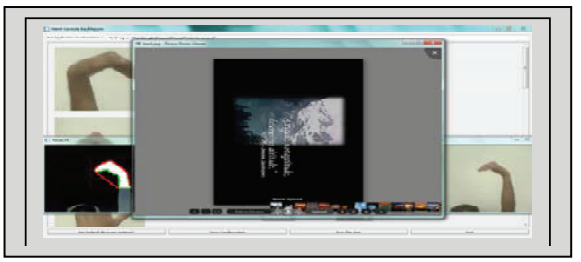

Fig. 4 Applications hand gestures in image browsing

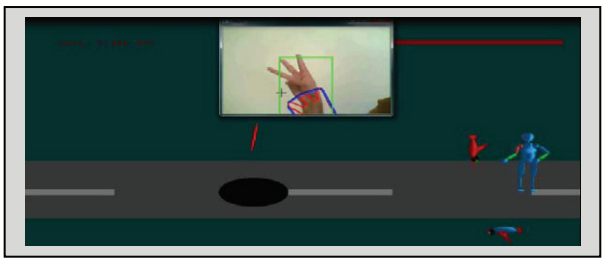

Fig. 5 Applications hand gestures in gaming environment

In order to find out the performance and viability of the gesture recognition system it has been tested in real life application scenarios like image browser and virtual games. The results obtained during execution of the experiments present some interesting results that inspire for experimental implementations in a varied domain of applications.

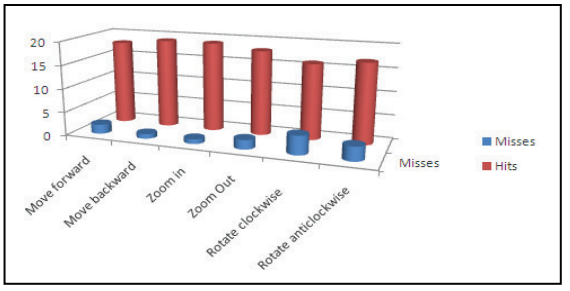

Fig. 6 Hits versus misses ratio for different gestures

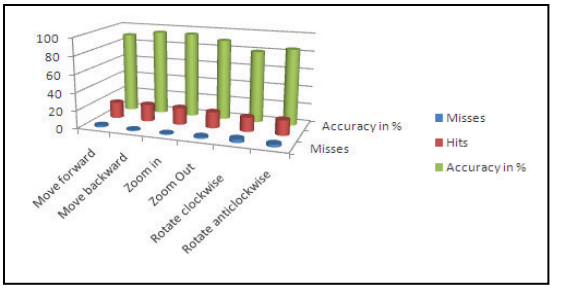

Fig. 7 Comparative analysis of gesture recognition rate

Figure 6 gives a depiction of hits versus miss ratio of different gestures. The figure 7 shows the comparative analysis of gesture recognition rate.

5. Conclusions

Gesture based interfaces allow human computer interaction to be in a natural and intuitive manner. The most important advantage of the usage of hand gesture based input modes is that using this method the user can interact with the application from a distance without any physical interaction with the keyboard or mouse. This paper develops a hand gesture recognition system for interacting with different applications like image browser; games etc. and provides a fruitful solution towards a user friendly interface between human and computer. The gesture vocabulary designed can be further extended for controlling different applications like game control etc. As the system provides the flexibility to the users and specifically physically challenged users to define the gesture according to their feasibility and ease of use.

References

1. Choi, Yoo-Joo., Lee, Je-Sung, Cho. We-Duke. A Robust Hand Recognition In Varying Illumination. *Advances in Human Computer Interaction*, *Shane Pinder (Ed.*), 2006.
2. Hagan, R. G. O', Zelinsky, A., Rougeaux, S. Visual gesture interfaces for virtual environments. *Interaction with computers*, vol. 14, 2002, pp. 231-250.
3. Karlsson, N., Karlsson B., Wide, P. A glove equipped with finger flexion sensors as a command generator used in a fuzzy control system. *IEEE Trans. On Instrumentation and measurement*, pp. 1330-1334, 1998.
4. Krevelen, D. W. F. V., Poelman, R. A Survey of Augmented Reality Technologies, applications and limitation. *The International Journal of Virtual Reality*, vol. 9 9(2), 2010, pp. 1-20.
5. Mitra, S., Acharya, T., Gesture Recognition: A survey. *IEEE Transactions on Systems. Man and Cybernetics (SMC) - Part C: Applications and Reviews*, vol. 37(3), 2007, pp. 211-324.
6. Chai, Xiujuan, Kongqiao Yikai, Wang, Fang. Robust hand gesture analysis and application in gallery browsing. *In Proceeding of ICME*, New York, 2009, pp. 938-94.
7. Pavlovic, V., Sharma, R., Huang, T.S. Visual interpretation of hand gestures for human-computer interaction: A review. *IEEE Trans. on Pattern Analysis and Machine Intelligence (PAMI),* vol. 7(19), , 1997, pp. 677–695.
8. Miguel, José, Dias, Salles., Nande, Pedro., Santos, Pedro., Barata, Nuno., Correia, André., Image Manipulation through Gestures. *In Proceedings of AICG'04*, , 2004, pp. 1-8.
9. Liu, N., Lovell. B. Mmx-accelerated Realtime Hand Tracking System. *In Proceedings of IVCNZ*, 2001.
10. Atia, Ayman., Tanaka, Jiro. Interaction with Tilting Gestures in Ubiquitous Environments. *In International Journal of UbiComp (IJU)*, Vol.1, No.3, 2010.
11. Rautaray, S.S., Agrawal, A. A Novel Human Computer Interface Based On Hand Gesture Recognition Using Computer Vision Techniques. *In Proceedings of ACM IITM'10*, pp. 292-296, 2010.
12. Xu, Z., Xiang, C., Wen-hui, W. Ji-hai,, Y., Lantz, V., Kong-qiao, W. Hand Gesture Recognition and Virtual Game Control Based on 3D Accelerometer and EMG Sensors. *In Proceedings of IUI'09*, , 2009, pp. 401-406.
13. Lee, C. S., Ghyme, S. W., Park, C. J., Wohn. K. The Control of avatar motion using hand gesture. *In Proceeding of Virtual Reality Software and technology (VRST)*, 1998, pp. 59-65.
14. Lienhart, R., Maydt. J. An extended set of Haar-like features for rapid object detection. *In Proceedings of ICIP02*, 2002, pp. 900-903.
15. Messom, C.H, Barczak, A.L.C. Fast and Efficient Rotated Haar-like Features Using Rotated Integral Images. *In Proceedings of Australian Conference on Robotics and Automation (ACRA2006)*, 2006, pp. 1-6.
16. Bradski, G. R. Computer video faces tracking for use in a perceptual user interface. *Intel Technology Journal*, Q2, 1998, pp. 1-15.