www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 4 Issue 1 January 2015, Page No. 9962-9965

Evolution of Hand Gesture Recognition : A Review

Praveen Kumar Sharma[1], Shreya Sharma[2]

[1]B.K.Birla Institute of Engineering and Technology, Pilani,
Rajasthan-333031, India
praveen.sharma@bkbiet.ac.in

[2]B.K.Birla Institute of Engineering and Technology, Pilani,
Rajasthan-333031, India
shreyasharma840@gmail.com

Abstract: Hand gesture recognition has proven to be an excellent means of Human Computer Interaction over other approaches through keyboards and mouse. This paper presents a review of the evolution of this excellent, easy and natural way of Human Machine Interaction. In this review article the advantages and disadvantages of various techniques that have come up with time and ongoing researches in this field have been discussed. Most of the researchers initially used gloves for the interaction, and then came the vision based hand gesture recognition for 2D graphical interface which uses colour extraction through optical flow and feature point extraction of the hand image captured. New ideas and algorithms have come for 3D applications for moving machine parts or humans. This evolution has resulted in developing a low cost interface device for interacting with objects in virtual environment using hand gestures. Finally, the future work that can be done in this field is also discussed.

Keywords: Hand gesture, image processing, human computer interaction, gesture recognition.

1. Introduction

Human gestures constitute a variety of motion expressed by the body which includes facial expressions and hand movements. Among all the variety of gestures, hand gesture is the most expressive and the most frequently used and proves an excellent means for the physically disabled people as well. In order to enable a more natural and easy communication with virtual reality systems, automatic hand gesture recognition has proved to be an excellent means for the users having no technical knowledge as well[1]. Hand gesture recognition making use of digital images has been a research topic for many years now. Direct use of hands as an input device is an innovative method for providing natural Human Computer Interaction which has its inheritance from text- based interfaces through 2D graphical-based interfaces, multimedia-supported interfaces, to full-fledged multi-participant Virtual Environment (VE) systems [2]. According to P Premaratne the history of hand gesture recognition for computer control started with the invention of glove-based control interfaces. Researchers realized that gestures inspired by sign language can be used to offer simple commands for a computer interface. This gradually evolved with the development of much accurate accelerometers, infrared cameras and even fibre optic bend-sensors. Some of those developments in glove based systems eventually offered the ability to realize computer vision based recognition without any sensors attached to the glove.
This tracking technique that is based on data acquisition, feature extraction and hand gesture extraction for 2D is explained later in this paper. Hand gesture recognition is not limited to paper or digital surfaces, but has also been extended to the third dimension. Hand gesture recognition is a problem that has elicited significant attention and research as computational capabilities, camera performance, and computer-vision- style learning algorithms have rapidly improved over the past few years to get 3D applications [7].
According to Sonia [1] the machine is able to recognize the gesture made by human through two approaches:
Hand Detection approaches: It includes techniques to detect hand in the acquired image after pre-processing which include appearance based approaches and model based approaches.[5]
Soft computing approaches: The principal constituents are Neural Networks, Fuzzy Systems, Machine Learning, Evolutionary Computation, Probabilistic Reasoning, etc. and their hybrid approaches.[3][4]
Now, the hand gestures may be in the form of Chinese sign language or the sign language for the physically disabled or any other sign language pre defined in the system by the manufacturer to be used by the user as shown in the figures below.

Figure 1: hand gestures and there equivalent text character outputs [7].

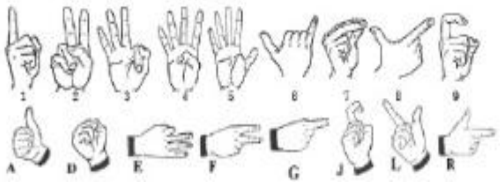

Figure 2: Chinese sign language [6].

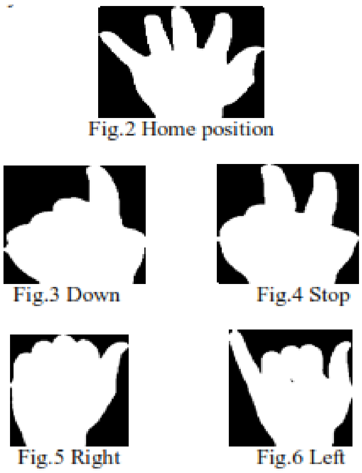

Figure 3: Sign language predefined by the manufacturer [11].

2. GLOVE BASED CONTROL INTERFACES

Data glove in essence is a wired interface with certain tactile or other sensory units that were attached to the fingers or joints of the glove, worn by the user. The tactile switches, optical goniometer or resistance sensors which measure the bending of different joints offered crude measurements as to determine a hand was open or closed and some finger joints were straight or bent. These results were mapped to unique gestures and were interpreted by a computer. The advantage of such a simple device was that there was no requirement for any kind of pre-processing. By looking at the evolution of data gloves, there were two distinct categories emerged over the years.

1. Active data glove—consisted of few or variety of sensors on the glove to measure flexing of joints or acceleration and had a communication path to the host device using wired or wireless technology. These gloves are known to restrain the user of artistic ability.

2. Passive data glove—consisted only of markers or colours for finger detection by an external device such as a camera. The glove did not have any sensors onboard.

The first glove to use multiple sensors was offered by the 'Digital Entry Data Glove' which was developed by Gary Grimes in 1983. It used different sensors mounted on a cloth. It consisted of touch or proximity sensors for determining whether the user's thumb was touching another part of the hand or fingers and four "knuckle-bend sensors" for measuring flexion of the joints in the thumb, index, and little finger. It also had two tilt sensors for measuring the tilt of the hand in the horizontal plane and two inertial sensors for measuring the twisting of the forearm and the flexing of the wrist. These gloves had limited accuracy and were tethered to computers using cumbersome wiring. They were meant for very specific applications and as proof of concept.

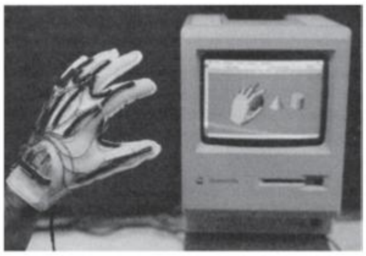

Figure 4: The ZTM Glove developed by Zimmerman [12].

The first commercially available Data Glove appeared in 1987.This was an improved version of the first Data glove. It carried fibre optics instead of light tubes and was equipped with 5–15 sensors increasing its ability to distinguish different gestures.

Today we have a variety of new data gloves including MIT data glove, Cyber Glove II, Cyber Glove III, Fifth dimension sensor glove ultra, X IST data glove, P5 glove and vision based coloured glove.

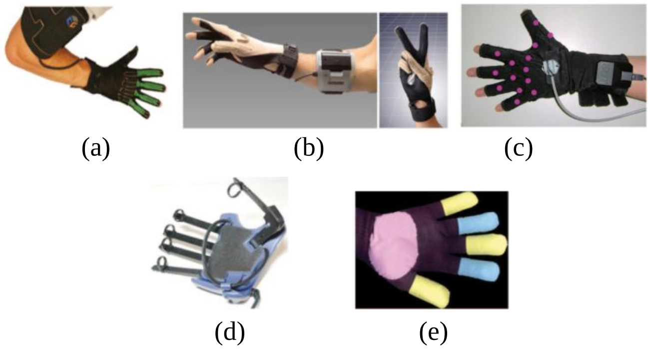

Figure 5: Different type of gloves [12]

Glove based interfaces proved to be very cumbersome and costly method for commercial use and is not flexile also. Various problems were faced with various gloves like-constraining the flexibility of hand movements and other issues due to which they could not receive much attention beyond experimental tools and were not much commercialized

3. VISION BASED HAND GESTURE RECOGNITION FOR 2D

The hand gesture recognition system consists of three modules: vision based data acquisition, feature extraction, and hand gesture recognition. The process is described in steps below:

1. Image Acquisition-The input images are captured by a webcam placed on a table or laptop. The system is demonstrated on a conventional PC/ Laptop computer running on the desired Processor with certain RAM. Each image has a certain spatial resolution based on the camera used. The system developed can process hand gestures at an acceptable speed. Given a variety of available image processing techniques and recognition algorithms, a system based on preliminary process on detecting the image as part of our image processing can be designed. The system starts by capturing a hand image from user with a webcam. The next process will convert the RGB image into grey scale. The edge of each object is then computed against the black background. The object can then be

segmented and differs greatly in contrast to the background images [7].

2. Pre Processing- Changes in contrast can be detected by operators that calculate the gradient of an image. One way to calculate the gradient of an image is the Sobel operator [8], [9], [10], which creates a binary mask using a user-specified threshold value. The binary gradient mask show lines of high contrast in the image. These lines do not quite delineate the outline of the object of interest. Compared to the original image, the gaps in the lines surrounding the object in the gradient mask can be seen.

3. Image Segmentation- Image segmentation is necessary for getting good results. In this algorithm, the RGB image is taken as input image. Image segmentation is typically performed to locate the hand object and boundaries in image. It assigns label to every pixel in image such that the pixels which share certain visual characteristics will have the same label [7].

4. Feature Point Extraction-It is used to estimate the direction of the hand. The motion of the estimated hand area is extracted using optical flow technique. The features are first detected from the input image, and are pursued by using optical flow. The Harris filter is used to capture the features. The Harris filter is one of the techniques for detecting edges, an effective characteristic for the tracking. The Lukas-Kanade algorithm was used for the tracking of the feature. This algorithm pursues a feature around the image. However, if the hand area is small, we expand the area that contains the hand, to detect feature points thereafter, we use the Harris operator as feature point's extractor. It can detect fingertips, because, it can detect corners. Hand area is enlarged to get more feature points.

Figure 6: Feature point extraction [11].

In this method the hand gestures are divided into motion and hand direction. Optical flow is used to estimate the motion of the hand and distribution of feature points is used to estimate the hand direction [11].
The problems encountered include color extraction and feature points. It is difficult to detect hand area when there is overlapping with the skin area in the background and the hand. Moreover in several images, the feature points between the fingertip and fingers are not detected. The robustness of the application may be increased by applying some more robust algorithms that may help to reduce noise and blur motion in order to have more accurate translation of gestures into commands.

4. MOVING OBJECT RECOGNITION IN 3D

It is done using range cameras. The range camera used is a Swiss Ranger SR4000. The SR400 is a time-of-flight camera that takes both range and intensity images at the same time using an integrated sensor. It has a low resolution of 176 × 144 pixels. Once the image is acquired, the range information is used for generating the x, y, z coordinates in meter for each pixel. The range camera produces images at a rate of up to 54 frames per second. An interface has been designed to visualize simultaneously the range image, the segmented hand and the moving object. Though this research is intended for manipulation of oil and gas reservoirs in a virtual environment, it has been considered in this paper as moving object, a 3D cube with different colors on its six faces.

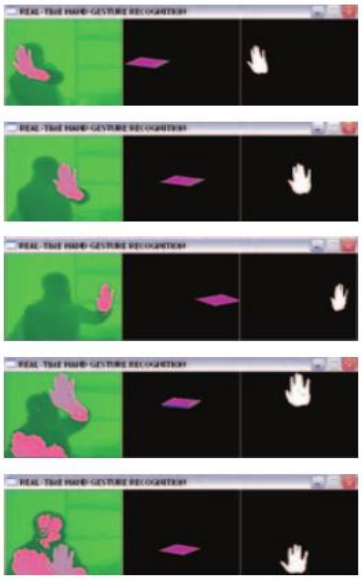

Figure 7. Translation of a moving objects [13].

Range cameras, with their capability of simultaneously capturing a full 3D point cloud with an array sensor at video rates, offer great potential for real-time measurement of dynamic scenes. A human-machine interface using the 3D information provides a range camera for identifying hand gestures. The first application designed recognizes the number of the simultaneous translation and rotation determined from the hand blob and applied to the moving object appears realistic. The range camera has sensitivity to surrounding objects, integration time and lighting conditions. Range based segmentation is also done in the process.
The segmentation speed and the tracking process need improvement for this procedure but otherwise it is of great help for real time applications [13].

5. APPLICATIONS OF HAND GESTURE RECOGNITION

The increasing scope of the applications show us the importance of more researches in a gesture controlled system. Most applications are to replace traditional input devices like keyboard and mouse, accessible application for elderly-disable like accelerometer. Initial applications were on pc applications for text edit [14, 15], presentation [16]. Gesture visualization has been included for feedback and training [17]. Using digital camera rather than sensor has provided new dimension to develop gesture based user interface development. Now people can interact with any media using gesture to control wide range of applications. We have got gesture based commercial products in 2003.

Gesture recognition has various applications like entertainment, controlling home appliances, tele care, tele health, elderly or disable care, artificial intelligence, simulation, training and education, assistive living and many more [18].

6. Conclusion and Future Work

All these evolving techniques from glove based approach to the use of range camera for moving 3D recognition have proved to be of great use to humans and are finding great applications not only in theories and labs but also commercially. The present application though seems to be feasible and more user friendly in comparison to the traditional input modes but is somewhat less robust in recognition phase. An attempt to make the input modes less constraints dependent for the users hand gestures has been preferred [4]. But robustness of the application may be increased by applying some more robust algorithms that may help to reduce noise and blur motion in order to have more accurate translation of gestures into commands. So in future the work can be done on improving each of the technology and new ideas can be discovered to make the methods easy. The system can be made faster and accurate, different search algorithm techniques can be used [19, 20] and also can design the library software to auto-generate a folder for most used hand gesture by the user and discarding the least used one. This would make the search process faster and better for the user. Future work includes not only improvement of the designed strategy but also taking into account more challenges such as dynamic gestures involving both hands and/or multiple cameras. The final objective involves gestures with a high degree of freedom; which may require detection of fingers and articulated hands.

References

[1] 'Ankit Chaudhary , J. L. Raheja , Karen Das , Sonia Raheja ' - Intelligent Approaches to interact with Machines using Hand Gesture Recognition in Natural way: A Survey- IJCSES Vol.2, No.1, Feb 2011.

[2] 'Siddharth S. Rautaray, Anupam Agrawal ' -REAL TIME HAND GESTURE RECOGNITION SYSTEM FOR DYNAMIC APPLICATIONS-IJU, Vol.3, No.1, January 2012.

[3] Nolker C., Ritter H., Visual Recognition of Continuous Hand Postures, IEEE Transactions on neural networks, Vol 13, No. 4, July 2002, pp. 983-994.

[4] Verma R., Dev A., Vision based Hand Gesture Recognition Using finite State Machines and Fuzzy Logic, International Conference on Ultra-Modern Telecommunications & Workshops, 12-14 Oct, 2009, pp. 1-6.

[5] Nguyen D.D., Pham T.C., Jeon J.W., Fingertip Detection with Morphology and Geometric Calculation, IEEE/RSJ International Conference on Intelligent Robots and Systems, St. Louis ,USA, Oct 11-15, 2009, pp. 1460-1465.

[6] Zhang J., Lin H., and Zhao M. A Fast Algorithm for Hand Gesture Recognition using Relief. Sixth International Conference on Fuzzy Systems and Knowledge Discovery. Tinajin, China .14-16 Aug, 2009. pp 8-12.

[7] 'Monuri Hemantha, M.V.Srikanth'- Simulation of Real Time Hand Gesture recognition for Physically Impaired- IJARCCE Vol. 2, Issue 11, November 2013

[8] Title: "Real-time DTW-based gesture recognition external object for max/msp and pure data": proceedings of the SMC 2009 6th sound and music computing conference, July 2009, porta-portugal.

[9] Oi Mean Foong, Tan Jung Low, and Satrio Wibowo, "Hand Gesture Recognition: Sign to Voice System (S2V)", World Academy of Science, Engineering and Technology 42- 2008.

[10] Kiran Kunnur,Pallavi Guijal : "Real time hand gesture recognition using sift", international Journal of Electronics and Electrical Engineering, ISSN : 2277-7040 Volume 2 Issue 3 (March 2012).

[11] 'Suneetha.G, A. Kabir Das, N. V. G. Prasad'- Finger Based Indoor Robot by Gesture Recognition- IJMER Vol.2, Issue.5, Sep-Oct. 2012 pp-3434-3436.

[12] P. Premaratne, Human Computer Interaction Using Hand Gestures, pp. 5-14.

[13] 'Hervé Lahamy and Derek Litchi'- REAL-TIME HAND GESTURE RECOGNITION USING RANGE CAMERAS.

[14] Wolf, C. G. Can people use gesture commands? IBM Research Report, (RC 11867), April 7, 1986.

[15] Zimmerman, et. Al. (1987). A hand gesture interface device, in the Proceedings of the SIGCHI/GI conference on Human factors in computing systems and graphics interface, P.189 - 192. ISBN:0-89791-213-6,1987. ACM, Canada

[16] Baudel, T., Beaudouin-Lafon, M. (1993), Charade: remote control of objects using free hand gesture . Communications of the ACM P. 28 - 35,ISSN:0001-0782, 1993 , ACM, USA.

[17] Sanna K., Juha K., Jani M. and Johan M (2006), Visualization of Hand Gestures for Pervasive Computing Environments, in the Proceedings of the working conference on Advanced visual interfaces, ACM, Italy, p. 480-483.

[18] 'Moniruzzaman Bhuiyan and Rich Picking'- Gesture-controlled user interfaces, what have we done and what's next?

[19] A.W.M Smeulders and M. Worring, Content-based image retrieval at the end of the early years, in Proc. Of IEEE Transactions on Pattern Analysis and Machine Intelligence, Volume 22, Issue 12, pp. 1349-1380, 2000.

[20] 'Praveen Kumar Sharma, Rohan Sheoran, Dinesh Kumar'- A Study of Hand Gesture Technique to Communicate with a Robot- IJERT Vol. 4 Issue 01,January-2015.