ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

An Investigation on Gesture Analysis and Geometric Features Extraction

Noor Adnan Ibraheem[1, 2] Mokhtar Mohammed Hasan[2], RafiqulZaman Khan[1]

Department of Computer Science, A.M.U., Aligarh, India[1]

Department of Computer Science, College of Science for Women, University of Baghdad, Baghdad, Iraq[2]

ABSTRACT: Using the gesture for natural human computer interaction became one of the important issues in recent few decades, to encompass human life appliance. Sign languages usually used among people to explain specific meaning or deliver a meaningful message, for this reason gestures motivate to simulate the natural interaction between humans but in this time between human and computers by modeling, analysing the gesture, and finally recognize it. This paper present a study of hand gesture recognition systems by investigating different algorithms, and tools used for adopting hand gesture recognition system in various system stages starting from image pre-processing to segment that hand and methods applied to capture hand shape to extract necessary feature, and terminating with suitable recognition algorithm in this work gestures modeling, analysis and recognition are demonstrated in detail with challenges that obstacle the performance of recognition system. Comparisons of different gesture recognition factors are shown as well.

KEYWORDS: Human Computer Interaction (HCI), Hand Gesture, Segmentation, Geometric Feature, Features Extraction, Gesture Recognition.

I. INTRODUCTION

With the diffusion of the modern virtual applications the needs for understanding and dive deeply in human gesture recognition field especially the science that has various applications in our life. For life appliance, gestures have various domestic appliances [1][18] such as television control using hand gestures [2], domestic robot control [1], digital photo album [1], and other household's devices such as washing machine, refrigerator, vacuum cleaner, stove top as mentioned in [1]. TV channels can be switched on and off, turned on and off and changing the volume [2]. Domestic robot is an example for controlling robot using speech and gesture [1], vocal commands are interpreted according to speech vocabulary already stored, and gestures are detected by tracking the hand [1][22]. Digital photo album (GIA) where the fingertip is used to manipulate the photo using some commands (next, edit, slide) using on a touch sensitive screen [1]. Washing machine has some commands to set such as rotation speed [1][7][8], wash timer, spin dry timer, etc. gestures have to control these commands in a close distance [1].

Fig. 1. Blowing kiss gesture used especially by kids through waving the hand forward [5].

In this work a lot of lately algorithms and tools used in various gesture recognition systems are demonstrated with comparisons of different gesture recognition system factors. Short paper of this work is published in AITCC Conference [33].

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

The outline of the paper is as follows: Section 2 explains gesture classification system with a detail description of the system stages. Some recent studies are discussed in detail with a demonstration of the recognition system stages to make a close view of demonstrated gesture classification system steps. Finally, Discussion and conclusions are presented.

II. GESTURE CLASSIFICATION SYSTEM

The main stages for any gesture recognition system are: extraction technique, features analysis, and finally classification tool. Figure 2 demonstrates these steps.

Fig.2. Recognition gesture system stages.

Many internal sub-stages can in included in these steps according to the application [12][14], in each phase different processing steps can be used [14]. Different processing steps were needed when applied glove based and vision based for acquiring the data [14], geometric and non-geometric features extraction methods, postures and gestures classification tools used. In the following sub sections, we will discuss the main two stages only.

III. HAND EXTRACTION TECHNIQUES: RELATED WORK

For any gesture system, the first step is to extract the hand object from the entire image and this can be performed by firstly decided the input device required to collect the data necessary to accomplish a specific task, and secondly segmented the hand from other unrelated background objects to model the hand. For hand posture and gesture recognition system different technologies are used for acquiring input data, these technologies are: Instrumented glove based [9][16][19], computer vision [16][9][20], and marked glove or color markers technologies [14].The instrumented glove based technology demand the user to wear a special data glove-based device [9][16] which provides a measurements of hand location [4][6][14], position [4] [9], orientation angles [4] [9][16] and degree of freedom (DOF) with high accuracy [9][14]. Computer vision technology use the input hand image acquired from one or more cameras [9][16][14]. And finally the colored marker technology require the user to wear a color glove and depending on the color hand localization, fingertip, and hand blob are determined easily [14], however, these techniques are used for modeling the hand as well. Figure 3 shows pictorial representation of these technologies.

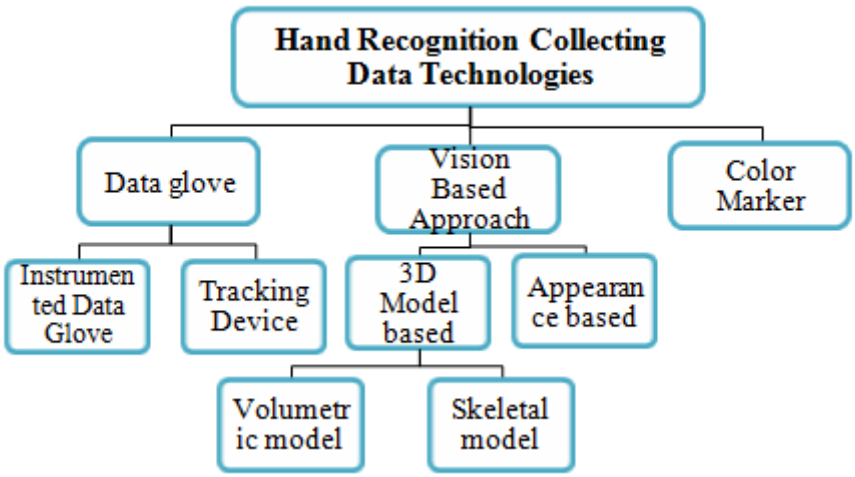

Fig. 3. Hand gesture recognition collecting data technologies.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

IV. SEGMENTATION TECHNIQUES

After acquiring the desired hand image in one of the methods mentioned above, the hand needs to be segmented from other objects. The extraction of the segmented hand represents an important step for the success of any recognition system [14], and hand modeling process relies on the correct and robust segmentation method [14]. Without doubting, the color model used and the background have great impact on the success of the segmentation process. Pixels color is the most important signs that are utilized for separating the human skin pigment [14], other cues can be used for detecting the hand, and some of these methods are [23]: color pixel information, motion information [10], or both of these methods are combined to achieve robust hand detection [26].

Different studies have addressed the segmentation problem [27], in [24] normalized RGB color model were applied for skin color detection using chrominance components only to minimize the illumination changes. Authors in [25] integrated parametric and non-parametric models which are: Gaussian Mixture Model (GMM) and histogram-based methods to locate the hands, the system trained offline using GMM and normalized r-g color space and tested online using histogram and HS color model [25], where GMM is affected with lighting variations, then histogram applied to overcome this problem [25]. It is noticeable that HSI color space has effective performance with the histogram [25].

Table 1: Segmentation employed in some of the discussed methods.

Method	Background	Color Model	Segmentation Technique
[2]	Uniform	Normalized RGB	Thresholding
[15]	Plain/ uniform	YCbCr color space	Thresholding
[28]	Simple / complex	Range information and intensity images	Combined K-means and EM approaches
[26]	complex	HS and rg color spaces	Combined GMM and histogram based Bayes method with depth information
[31]	uniform	CIE, and LUV color space	Gaussian mixture model.

V. GESTURE ANALYSIS

To analyse the gesture, the system firstly have to performed gesture detection and then extract the important features. To detect the gesture, the input image should be located [12] by segmenting the region of interest from other unwanted background objects as previously explained in the segmentation process. Features should be distinguished and not interfere with each other that can be classified clearly in the recognition stage, as well as when represent in the feature space domain [14] with minimum erroneousness during the testing step [14]. Parameters can be estimated in appearance based and 3D model based [12]. For 3D model based, the two crucial parameters are: joint angles [12] and palm dimensions [12], which require to estimate the initial parameter [12], and to change the parameters according to the development of hand gesture during the time [12]. Appearance based parameters estimation is: shape analysis [12], active contour [12], and image motion estimation [10][11].

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

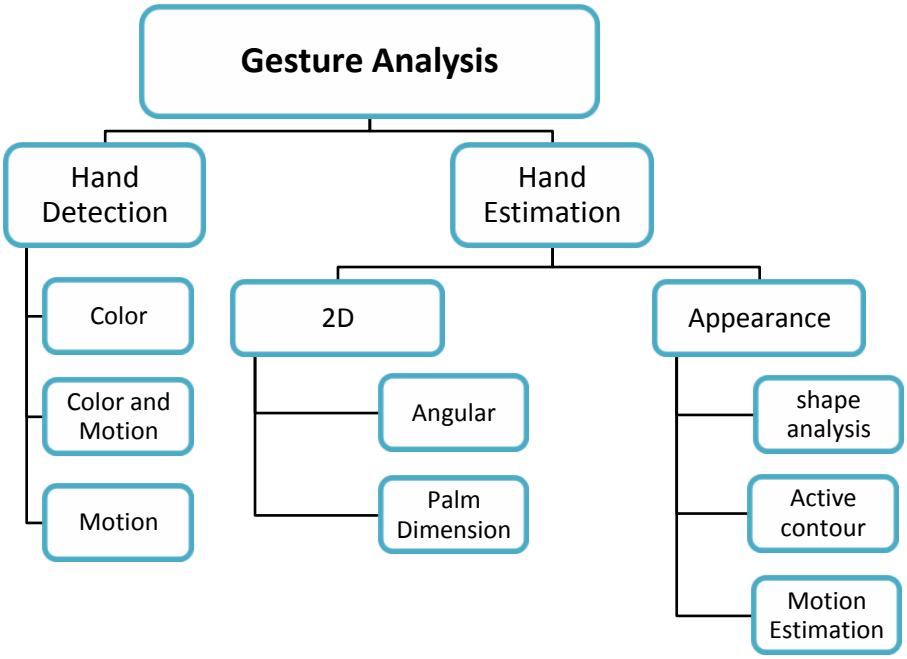

Fig. 4. Gesture Analysis paradigm.

Hasan [28] recognize the hand gesture using geometrical features, the input image is segmented used HSV color model, and four features has been extracted, these features are; Perpendicular Casted Distance (PD) which represents the distance between the casted finger's base and the palm center, Base Angle (BA) which is the angle between the line formed by finger's base to palm center and hand direction line HDL, Base(s) Angle (BsA): which is similar to BA feature but it replaces the HDL with the line formed by palm to finger's base, and Base Border (BB) that represents the distance between the vertical casting of a particular boundary pixel that has a higher distance from the mentioned line and the nearest finger's base. In [30], we proposed a hand gesture recognition system that applied an innovative approach to model the hand using variable length chromosomes genetic algorithm where the outcome of this algorithm is the detailed extraction of hand structure (palm, fingers, and wrist). Palm center coordinate has been located using GA with a decreasing population size. The wrist and fingers' reference points are determined to facilitate the extraction of the important features required for classification purposes [30].

Stergiopoulou [15] recognized hand gesture by applying SGONG algorithm to capture the hand shape, and extracted three features; RC Angle: which represents an angle formed by the hand slope line and the line that joints the root with centre of the hand, TC Angle: which is the angle formed by the hand slope line and the line that joints the fingertip with the hand centre, and the distance from the palm centre. For recognition, systems [28] and [30] applied mixture of Gaussian classifiers whereas [15] applied Gaussian distribution.

Yang [31] extracted and classified two-dimensional motion in sequence image using motion trajectories. Yang depends on the idea that the shape of the human hand and face approximately take the ellipses form, the merged the motion regions and skin color to extract the shape of the hand and the face, and the emergence continuous until the merged areas approximately become close elliptic shape [31]. Chen et al. [32] extracted the palm and fingers area to recognize the fingers and identify the gesture accordingly where a rule classifier is applied to identify fingers' labels; they used 1300 images as a data set.

VI. DISCUSSION AND CONCLUSIONS

Gesture system has the potential to simplify the interaction with various life applications [17] ranging from sign language to virtual environments [29] and different household appliances. The segmentation process plays a major role in hand detection and gesture recognition. Various techniques have been applied for segmenting the hand; the most

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

common method used is to extract the skin color from the input image. Other studies applied hand motion or both skin color and motion to extract the hand. The extraction of the hand shape provides a great benefit in features extraction step. [15] [28] and [30] applied different methods for capturing the shape of the hand to extract hand geometric features. Other studies used non-geometric features to extract the hand such as silhouette and contour. Various input devices are available for acquiring hand images and the choice to select a specific input device relies on the demanding application. Gesture analysis is explained with parameters modeling and estimation required to achieve robust gesture recognition system are provided as well [11]. Table 2 shows some recognition factors such as recognition rate and recognition time with number of recognized +gestures of some selected gesture recognition methods.

Table 2: Some factors related to some selected gesture recognition methods

Method	# Recognized gestures	# Total gestures used for training andtesting	Recognition percentage	Recognition time
[3]	7	N/A	91%	2-4 seconds
[15]	31	130 for testing	90.45%	1.5 seconds
[28]	32	126	Finger-wise 98.5%	0.407 second
			Gesture-wise 97.8%.	
[31]	40 video database	40 video database	For training set 98.14%	N/A
			For testing set 99.2%	

REFERENCES

1. J. Koster, (2006) "Applying gestures in domestic appliances", University of Twente, Human Media Interaction. Available at: http://hmi.ewi.utwente.nl/verslagen/capita-selecta/CS-Koster-Jacobjob.pdf
2. Freeman, W. T., Weissman, C. D. (1995). "Television Control by Hand Gestures".IEEE International Workshop on Automatic Face and Gesture Recognition.
3. Xingyan Li. (2003) "Gesture Recognition Based on Fuzzy C-Means Clustering Algorithm", Department of Computer Science. The University of Tennessee Knoxville.
4. S. Mitra, and T. Acharya. (2007) "Gesture Recognition: A Survey" IEEE Transactions on systems, Man and Cybernetics, Part C: Applications and reviews, Vol. 37, No. 3, pp 311- 324, doi: 10.1109/TSMCC.2007.893280.
5. Website: http://comps.fotosearch.com/comp/CSP/CSP659/isolated-boy-child_~k6595985.jpg
6. Laura Dipietro, Angelo M. Sabatini and Paolo Dario (2008) "Survey of Glove-Based Systems and their applications," IEEE Transactions on systems, Man and Cybernetics, Vol. 38, No. 4, pp 461-482.
7. Simei G. Wysoski, Marcus V. Lamar, Susumu Kuroyanagi, and Akira Iwata (2002) "A Rotation Invariant Approach On Static-Gesture Recognition Using Boundary Histograms And Neural Networks," IEEE 9th International Conference on Neural Information Processing, Singapura.
8. RafiqulZaman Khan, Noor Adnan Ibraheem, (2012) "Survey on Gesture Recognition for Hand Image Postures", International Journal of Computer and Information Science, Vol. 5, No. 3, pp 110-121. doi:10.5539/cis.v5n3p110
9. Joseph J. LaViola Jr. (1999) "A Survey of Hand Posture and Gesture Recognition Techniques and Technology", Master Thesis, NSF Science and Technology Center for Computer Graphics and Scientific Visualization, USA.
10. Thomas B. Moeslund, Erik Granum (2001) "A Survey of Computer Vision-Based Human Motion Capture," Elsevier, Computer Vision and Image Understanding, Vol. 81, pp 231–268.
11. Ali Erol, George Bebis, MirceaNicolescu, Richard D. Boyle and XanderTwombly, (2007) "Vision-based hand pose estimation: A review", Elsevier Computer Vision and Image Understanding, Vol. 108, pp 52–73.
12. Pavlovic, V. I., Sharma, R. and Huang, T. S. (1997)" Visual Interpretation of Hand Gestures for Human- Computer Interaction: A Review". IEEE Transactions on Pattern Analysis And Machine Intelligence, Vol. 19, No. 7, pp 677- 695, doi; 10.1109/34.598226
13. Qing Chen, (2008). "Real-Time Vision-Based Hand Tracking and Gesture Recognition", PhD thesis, Electrical and Computer Engineering.
14. Mokhtar M. Hasan, Pramod K. Mishra, (2012) "Hand Gesture Modeling and Recognition using Geometric Features: A Review", Canadian Journal on Image Processing and Computer Vision Vol. 3(1).
15. E. Stergiopoulou, N. Papamarkos. (2009) "Hand gesture recognition using a neural network shape fitting technique," Elsevier Engineering Applications of Artificial Intelligence, Vol. 22, No. 8, pp 1141–1158, doi: 10.1016/j.engappai.2009.03.008
16. Eun-Jung Holden (1997). "Visual Recognition of Hand Motion", Ph.D. Thesis, Department of Computer Science the University of Western Australia.
17. Mark Billinghurst, (2011). "Gesture based interaction", chapter 14.Haptic input. Available at: www.billbuxton.com/input14.Gesture.pdf
18. Ying Wu, Thomas S. Huang, "Vision-Based Gesture Recognition: A Review", Lecture Notes in Computer Science, Gesture Workshop, proceedings of the international Gesture Workshop on Gesture-Based communication in Human-Computer interaction, vol.(1739), pp. 103-115, 1999.
19. Luigi Lamberti, Francesco Camastra, (2011) "Real-Time Hand Gesture Recognition Using a Color Glove", Springer 16th international conference on Image analysis and processing: Part I (ICIAP'11), pp. 365-373.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 1, January 2015

20. G. R. S. Murthy and R. S. Jadon. (2009) "A Review of Vision Based Hand Gestures Recognition," International Journal of Information Technology and Knowledge Management, Vol. 2, No. 2, pp. 405-410.
21. Wikipdeia Web Page.
22. P. Garg, N. Aggarwal and S. Sofat, (2009). "Vision Based Hand Gesture Recognition," World Academy of Science, Engineering and Technology, Vol. 49, pp 972-977.
23. Mohamed BechaKaaniche, (2009). "Gesture Recognition From Video Sequences". Ph.D. thesis. INRIA Sophia Antipolis
24. WÃlodzimierzKasprzak, ArturWilkowski, and Karol Czapnik, (2009). "Hand Gesture Recognition in Image Sequences Using Active Contours and HMMs", Image Processing & Communications Challenges, Academy Publishing House EXIT, Warszawa, pp. 248-255.
25. M. Van den Bergh, E. Koller-Meier, F. Bosch´, L. Van Gool, (2009). "Haarlet-based Hand Gesture Recognition for 3D Interaction", Workshop on Applications of Computer Vision (WACV), pp. 1-8, doi: 10.1109/WACV.2009.5403103
26. Zhan Gao, "Appearance-based Hand Gesture Detection", available: http://www.cs.auckland.ac.nz/courses/compsci705s1c/exams/SeminarReports/HandGesture_zgao014.pdf
27. S. E. Ghobadi, O. E. Loepprich, K. Hartmann, and O. Loffeld, (2007). "Hand Segmentation Using 2D/3D Images", conference of Image and Vision Computing, pp. 64–69, New Zealand, December 2007.
28. Mokhtar M. Hasan, Pramod K. Mishra, (2012). "Novel Algorithm for Multi Hand Detection and Geometric Features Extractionand Recognition", International Journal of Scientific & Engineering Research, Vol. 3(5).
29. R. G. O' Hagan, A. Zelinsky, S. Rougeaux, (2002). "Visual Gesture Interfaces for Virtual Environments", Elsevier, interacting with computers, Vol. 14, pp. 231-250, doi: http://dx.doi.org/10.1016/S0953-5438(01)00050-9
30. RafiqulZaman Khan, and Noor Adnan Ibraheem, (2013). "Genetic Shape Fitting for Hand Gesture Modeling and Feature Extraction using Variable Length Chromosome", British Journal of Science, Vol. 10(1), pp. 1-11.
31. Ming-Hsuan Yang, Narendra Ahuja, Mark Tabb, (2002). "Extraction of 2D Motion Trajectories and Its Application to Hand Gesture Recognition", IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol. 24(8).pp. 1061- 1074.
32. Zhi-hua Chen, Jung-Tae Kim, Jianning Liang, Jing Zhang, and Yu-Bo Yuan, (2014), "Real-Time Hand Gesture Recognition Using Finger Segmentation", Hindawi Publishing Corporation, Scientific World Journal, doi: http://dx.doi.org/10.1155/2014/267872
33. RafiqulZaman Khan, Noor Adnan Ibraheem, (2012). "Comparative Study of Hand Gesture Recognition System", International Conference of Advanced Computer Science & Information Technology (ACSIT-2012). Chennai, India.
34. Min B., Yoon, H., Soh, J., Yangc, Y., and Ejima, T. (1997) "Hand Gesture Recogrution Using Hidden Markov Models". IEEE International Conference on computional cybernetics and simulation, Vol. 5, pp 4232-4235. Doi: 10.1109/ICSMC.1997.637364

BIOGRAPHY

Noor Adnan Ibraheem: She received her B.Sc. and M.Sc. in computer science from BGU in2001 and 2005 respectively, she is currently a Ph.D. student at Aligarh MuslimUniversity, Aligarh, Uttar Pradesh, India. Her research interests include computer vision,image processing, and artificial intelligent.

Dr.Mokhtar Mohammed Hasan: He is Lecturer in University of Baghdad (BGU), he obtained his Ph.D. degree from Banaras Hindu University, Varanasi, Uttar Pradesh, India. He has done the B.Sc. and M.Sc. in computer science from BGU in 1999 and 2001 respectively, he is interested in image processing, computer vision, database managements, and artificial intelligent.

Dr.Rafiqul Zama Khan: He obtained his B.Sc degree from M.J.P Rohilkhand University,Bareilly, M.Sc and M.C.A from Aligarh Muslim University, Aligarh, and his Ph.D.from JamiaHamdard University, New Delhi. He has 18 years of rich teachingexperience of various reputed National (Pune University, JamiaHamdard University)& International Universities (King Fhad University of Petroleum & Minerals,Dharan, K.S.A; Ittihad University, U.A.E). Presently he is working as an AssociateProfessor in Department of Computer Science, Aligarh Muslim University, Aligarh(U.P), India. He worked as a Head of the Department of Computer Science at PoonaCollege, University of Pune. He also worked as a Chairman of the Department ofComputer Science, at Aligarh Muslim University, Aligarh, India. He is also working as a PhD guide ofseveral students. He has published more than 25 research papers in International/National Journals. He isthe member of Editorial Board of number of International Journals.