

A Review: Study of Various Techniques of Hand Gesture Recognition

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Abstract—In the past years, the recognition of gesture feature has been glamourised attention as a natural human. The communication system can build the human relationships. The mode of communication will be verbal and non-verbal. The non-verbal communication is not only used for the physically challenged person, but also used in gaming, surveying, etc. There is no need of peripheral device to interact with the computer. In this paper the various techniques are discussed to recognize the hand gesture. In today's era, the Kinect depth data is the famous research for the identification of new fingers and the recognition of hand gesture. Finally, discuss the recognition of hand gesture will applicable in many fields.

Keywords—Sign Language; Hand Gesture Recognition; HCI; Segmentation

I. INTRODUCTION

The Human relationships can build by the communication system. It enables easy to exchange ideas, feelings, emotions, and endearment to other human beings. The communication plays a very vital role. A message is being formulated and transmitted to the person or persons whether we are talking, walking, playing, sitting, or even sleeping. Communication can be in verbal or non-verbal form [1]. The verbal or spoken communication is the combination of speaking and listening. In this communication, people can express their views by face to face, telephone, radio or television and other media. In the non-verbal mean, a person can express their thoughts by body language, gestures (Swearing at someone, smiling, nodding, leaning forward), posture (Standing in a certain way to express emotions. Example-eye contact and Facial expressions like Frowns, Smiling. The Gun Shoot in the air is the example of non-verbal communication [2].

The word 'Gesture' means movement of the hand, arm, body, and head or face that is too expressive of an idea, opinion, emotions etc. The word 'Recognition' Means to detect and identifying the objects in the digital medium.



Fig. 1: Non-Verbal Communication

This paper focuses on Hand gesture recognition the gesture recognition is in the form of Static and dynamic in nature. Generally the name suggests, the static gesture recognition appeals that at the time of gesture period the hand position still remains constant. Static gesture based on the shape and flexural angles of the hand and dynamic refers that at the time of gesturing period hand position changes continually [3]. Dynamic gesture based on hand trajectories and orientations in addition to the shape of a hand and flexural angles of fingers.

The gesture technology permits the users to control or manipulate devices in a more inherent manner, such as TV, Microwave, and AC remote operates with hand movements. Gesture has the diversity in hand movement which is produced by the hand. The term 'Posture' focuses on the shape of hand, but 'Gesture' focuses on the movement of the hand. Human Computer Interaction (HCI), Robotics, T.V interaction, Sign Language recognition is widely applications used in the hand gesture recognition [4]. The various similarities and dissimilarities between the static and dynamic hand gesture recognition are shown in Fig. 2.

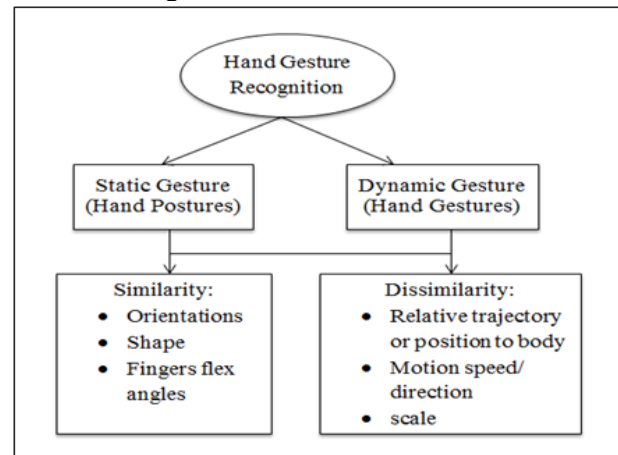


Fig. 2: Classification on Hand Gesture Recognition

The Rest of the paper is organized as follows. Section II describes the Literature Review; Section III describes the various techniques of Hand Gesture Recognition. Section IV describes the Applications and finally, Section V describe the conclusion.

II. LITERATURE REVIEW

Wang *et al.* [1] this paper based on a Superpixel earth mover's distance metric with the Kinect depth camera. Texture and depth of the hand are represented in the form of Superpixel which helps to recognize the color of the gesture. Superpixel earth mover's distance (SP-EMD) is used to measure the dissimilarity between hand gestures is proposed. With the proper preprocessing, it is invariant to scaling, translation and rotation. The simulation results shows high mean accuracy and fast recognition speed.

Chen *et al.* [2] This paper reviews that the human-computer interaction is one of the important components of the hand gesture recognition. The history of hand gesture recognition is explained and then technical difficulties are also enumerated. The approaches vision based, glove-based, depth-based are explained in the paper. Microsoft launches the Kinect device data to new finger identification and hand gesture recognition and it is a popular research at this time. The applications discussed lastly, based on Kinect i.e. in clinical surgery, robots etc.

Pisharady *et al.* [3] In the last decade's human-computer interaction system is the successful efforts in the hand gesture recognition. The active research in the hand gesture recognition is the unresolved challenges such as sensitivity to size, shape, speed variations and issues due to occlusion. This paper surveys in the last 16 years is to discuss the vision based hand gesture recognition algorithm. The comparison of quantitative and qualitative algorithm is by using RGB and RGB-D cameras. From different attributes of algorithm quantitative comparison of the algorithm is done by using the 13 measures and experimental methodology adopted in the evaluation of algorithm. The prediction for its success in real-world applications is the accuracy of the algorithm. This paper also reviews 26 publicly available hand gesture databases, and for downloading the databases it provides the web-links to the users.

Cheng *et al.* [4] This paper surveys on hand gesture recognition using 3D depth sensors. In the 3D depth field the commercial depth sensors and public datasets are widely used. 3D hand modelling, static gesture, hand trajectory gesture and continuous hand gesture recognition are various fields in the system. Then, the art of the state research for 3D hand gesture recognition is used. This paper mainly focuses on gesture recognition techniques and briefly explain the areas where this technique is used.

Ahuja *et al.* [5] This paper focused on vision based recognition system. The database-driven hand gesture recognition based on skin color model and thresholding technique along with template matching using PCA. Firstly, segmentation of the hand region in YcbCr color space by applying the skin color model. To separate the foreground and background the Otsu thresholding is applied in the next phase. Finally, by using Principal Component Analysis (PCA), a template based matching

technique is developed for recognition. In this paper the system is tested from 4 subjects with 4 gestures and 5 different poses per gesture making 20 images per gesture and shows the average accuracy is 91.25% and average recognition time is 0.098251 seconds and finally drawn the confusion matrix.

Wang *et al.* [6] This paper reviews that a marker-less two hand gesture recognition systems based on Kinect. The mark-less hand extraction is achieved by using the depth and skeleton from Kinect. With the help of new morphological finger extraction method, the Finger Earth Mover's Distance (FEMD) is applied to measure the gestures. The intuitive and robust human-computer interaction is provided by the two hands based user interface. The effectiveness of the system have been shown by their experimental results.

Sonkusare *et al.* [7] The paper focuses on gesture communication after the evolution of human civilization. The non-verbal communication is equally significant to the verbal communication. Non-verbal communication applied in the surveying, 3D gaming, and aviation. without any peripheral device human can interact with the computer system. To design the system of hand gesture recognition system, it is basically divided into four phases, i.e. Acquisition of Data, segmentation and tracking, extraction of features and gesture recognition. The Paper reviews the various comparative studies of hand gesture recognition techniques.

Shimada *et al.* [8] This paper plays a vital role to convey the message from user to machine is the man - machine interface. There is no need of sensors attachment on the human body in the vision based techniques. Two important applications are to control the TV operations and mobile system by hand gestures. With the use of hand gestures, the user can directly communicate with the system. This paper said the how to design user-friendly and also machine friendly gesture applications. With the hand gesture selection system the user gives a chance to customize the interface of TV control by selecting the shapes and motions of the hand.

Zhu *et al.* [9] It is based on vision approach provides a natural and intuitive interface. This paper focuses on the dynamic hand gesture recognition techniques. A Three important phases have been declared i.e. detection and segmentation, tracking, classification. The various segmentation methods will be discussed that is based on the skin color, shape, particle filtering, TLD, camshaft etc. As to applications, it has been generating big impact on everyday life in many aspects.

Chastine *et al.* [10] This paper focuses on gesture based first person control. The two methods of input are the combination of keyboard and mouse, gamepad. The result presents to control the FPS game with a single hand gesture and then traditional input methods are compared with their performance. 26 participant's work together to present the results, including summaries of in-line

performance and survey of past games. With the use of their results the abilities of player have been established.

III. HAND GESTURE TECHNIQUES

The Approaches of Hand Gesture Recognition system can be broadly classified as: Glove based, Vision based, depth based. The Vision based again further classified into various categories as shown in Fig. 3.

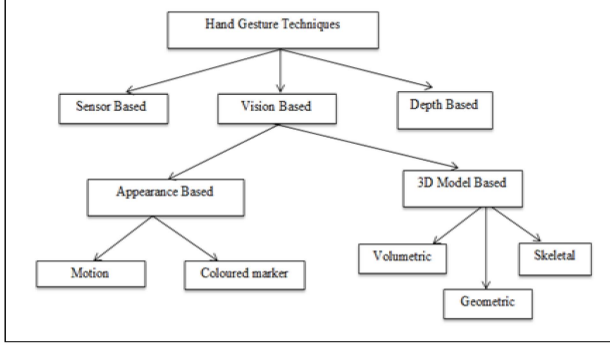


Fig. 3: Classification of Hand Gesture Recognition Techniques

A. Sensor based Recognition

Sensor based recognition use the electronic gloves or sensors for capturing the motion and position of hand gesture. Sensors can be of many types, i.e. mount bases, multi-touch screen, vision based sensors. By using the sensors of the gloves we can easily sense the palm and finger location. This approach is somewhat difficult because the user needs to be connected with the electronic device. Data glove [5] is the Example of sensor based approach. High accuracy and fast reaction speed are the benefits of this approach.



Fig. 4: Data Glove

The Limitation of this approach is that data gloves are too expensive and it requires the full hardware toolkit and not flexible in nature. So to overcome this limitation, the vision based approach came into existence.

B. Vision based Recognition

In vision based approach the user does not require to wear anything i.e. with the naked hands. This technique is very popular, simple, natural and convenient to use for the users because human and computer will communicate directly [6]. Hand images are captured by the digital

cameras. By using the vision based techniques captured images can be processed and analyzed. The various types of cameras can be used, i.e. monocular, fish eye, time of flight and infrared cameras etc [7]. The representations of alphabets and numbers are easily recognized with the vision based approach. The illumination change, background cluster, partial or full occlusions are the several challenges to be addressses.

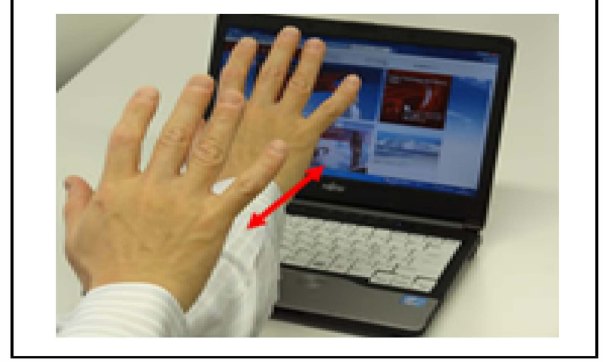


Fig. 5: Vision based Recognition

1) Appearance based recognition

This approach relied on to extract the features from the visual appearance of the input hand image and already defined templates can be compared with it. The advantage of this approach is Real time performance and easily compared with the 3D model approach. The different skin colors can be detected by this approach. Using the invariant feature such as an Adaboost learning algorithm that enables the identification of points and a portion of the hand. The advantage of this approach is to overcome the problem of occlusion [2][8]. It includes the two categories, i.e. 2D static based model and motion based model. These models can be classified into other variants. The 2D static based model includes:

C. Motion based recognition

Motion based models are used for the object recognition or its motion based on the object motion in sequence of the image. For the learning action model, Adboost framework uses for the local motion histogram object detection, object description, motion modelling, pattern recognition are required for the gesture recognition and it is complex in nature.

D. Color based recognition

This model is used to track the motion of the body or body parts based on different colored markers. Users mounted the Red, Green, Blue, Yellow colored markers and it is used to interact with the virtual models and it gives the functionality zoom, move, draw, write on virtual keyboards. This model provides greater flexibility.



Fig. 6: Color based Recognition

1) 3D model based recognition

3D model basically defines the 3D spatial description of human hand and analyze the shape of a hand. Some data is lost at the time of 2D projection, so to make more accurate the intended depth parameter is added in the 3D model. The real target can be focused by the many cameras. The parameters of the real target are computed by matching the spatial description and then during the recognition process motion of the hand will be followed. The advantage of 3D model is that it update the parameters of the model while it checks to match the transition in the temporal model [9]. There are three classifications of 3D model, i.e. volumetric, Geometric and skeletal model.

2) 3D volumetric based recognition

3D volumetric model deals with the highest details of skin surface and the human body skeleton information. While designing these models they have some constraints. The volumetric model is applicable in Real time application. This model is also called 3D textured kinematic because it deals appearance of the human hand in 3D model base [10].



Fig. 7: 3D Volumetric based Model

3) 3D geometric based recognition

3D geometric models are less precise than 3D textures volumetric models with respect to information of skin surface, but it contains some needed information about the skeleton [11][12].

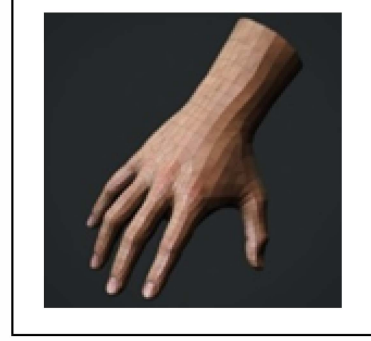


Fig. 8: 3D Geometric based Model

E. Skeletal based Recognition

Skeletal model overcomes the problems of the volumetric model by limiting the parameters. Higher efficiency will be provided by the sparse coding. It is a complex feature optimization. To recover the sparse signal from few observations, the compressive sensing is used and it helps to reduce the resource consumption [12].



Fig. 9: 3D Skeletal based Model

F. Depth based Recognition

With the advancement of human computer interaction, one of the key components of HCI is gesture recognition. This approach is very robust in nature. The acquisition of 3D geometric information depth camera approach is used [13]. Before 2010 the Two main approaches being used, i.e. Time of Flight (TOF) principle and light coding. 3D feature directly reflects the depth image when we compared with the color images [14]. So illumination, shadow and color will not affect this approach. With the help of visible light image, we could separate the covered object and different parts of the same object. During this, depth camera will hard apply due to expensiveness. After few years Microsoft launched the Kinect device. This device is used to find the depth of the object in the RGB images [15].

IV. APPLICATION PROSPECT

The applications for recognition of the hand gesture system can be stated as follows:

- In the techniques of Virtual environment interaction
- In the techniques of Sign language
- Gaming Zone, medicine, business, computer science and many other fields [5] [16].

A. In Clinical Surgery

In the department of clinical surgery, the surgeon requires the patient detail which is given from the sterile computer imaging data. Generally it increases the workload and the operation personnel for the purpose of successful recovery. So it is difficult to ensure a timely, accurate, safe surgery. The Microsoft Research team has used the Kinect device to simplify the process. The doctors will use the hand gesture system to operate the different functions such as move, change, zoom in on CT scans, MRIs, and other medical images [17].

B. Candy Crush Game

The Candy crush saga is a popular match puzzle (minimum three). The main objective is to form one formation, ie either of 3, 4 or 5 with matching candies in horizontal or vertical way. Stripping candies is just like a bomb, wrapping candies clearing the near by 8 candies and color bomb removes the formation with the same color of candies. In Fig.10 to represent 3 commands different hand gesture will be employed. When user selects a square one formation can make [18].

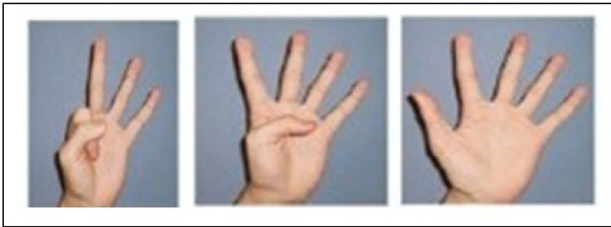


Fig. 10: Candy Crush Saga Adopted the 3 Gesture Commands

V. CONCLUSION AND FUTURE WORK

In the field of 3D gaming, Surgeries, robotics the Hand gesture recognition is applicable. It is just like a non-verbal Communication. There is a need for research due to an increasing number of applications. The vital components and techniques that are used in a hand gesture recognition system are described. The hand gesture recognition system requires the high precision segmentation algorithms for the purpose of designation. Some algorithms take very long time to recognize the object. So there is a need to develop the efficient and accurate algorithms, either by combining the existing techniques or by developing new techniques. In the future work we plan to investigate other hand gestures, including the two hand gesture or other body postures. This type of recognition might also support more robust interaction.

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