ISSN:0975-9646

Survey on Hand Gesture Recognition Approaches

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***Abstract*-Gesture recognition enables humans to communicate with the machine and interact naturally without any mechanical devices. Gesture recognition can be seen as a way for computers to begin to understand human body language, thus building a richer bridge between machines and humans than primitive text user interface or even GUIs (graphical user interfaces), which still limit the majority of input to keyboard and mouse. Gesture recognition pertains to recognizing meaningful expressions of motion by a human, involving the hands, arms, face, head, and/or body. This paper mainly focuses on Hand Gesture Recognition. Hand gestures provide a separate complementary modality to speech for expressing ones ideas. Hand gesture is a method of non-verbal communication for human beings for its freer expressions much more other than body parts. Hand gesture recognition has greater importance in designing an efficient human computer interaction system. This paper emphasis on different hand gesture approaches, technologies and applications. The approaches present can be mainly divided into Data-Glove Based and Vision Based approaches.**

Keywords: **Gesture recognition, computer vision, hand gesture, hand gesture recognition, human computer interaction.**

1. INTRODUCTION

Gestures are expressive, meaningful body motions involving physical movements [1] of the fingers, hands, arms, head, face, or body with the intent of: 1) conveying meaningful information on or 2) interacting with the environment. They constitute one interesting small subspace of possible human motion [1]. Gestures can be static (the user assumes a certain pose or configuration)or dynamic (with prestroke, stroke, and poststroke phases). Some gestures also have both static and dynamic elements, as in sign languages [1]. A dynamic gesture is intended to change over a period of time whereas a static gesture is observed at the spurt of time. A waving hand means goodbye is an example of dynamic gesture and the stop sign is an example of static gesture. To understand a full message, it is necessary to interpret all the static and dynamic gestures over a period of time. This complex process is called gesture recognition. Gesture recognition is the process of recognizing and interpreting a stream continuous sequential gesture from the given set of input data [2].

In recent years computerized hand gesture recognition has received much attention from academia and industry, largely due to the development of human-computer interaction (HCI) technologies. Hand gesture recognition is of great importance for human-computer interaction (HCI), because of its extensive applications in virtual reality, sign language recognition, and computer games [3]. In human's daily life hands play an important role to physically manipulate an object or to communicate with other people. Human Computer Interface is generally accomplished with devices such as mouse and keyboard, which are limited in terms of operational distance and convenience [4]. By contrast, hand gesture recognition provides an alternative to these cumbersome devices, and enables people to communicate with computer more easily and naturally [4].

For handling different hand gesture recognition many tools have been applied including mathematical models like Hidden Markow Model (HMM)[1] [5]and Finite State Machine (FSM)[1] [6],software computing methods such as fuzzy clustering[7], Artificial Neural Network (ANN) [8]. Numerous approaches have been proposed for enabling hand gesture recognition. A common taxonomy is based on whether extra devices are required for raw data collecting. In this way, they are categorized into data glove based hand gesture recognition [9], vision based hand gesture recognition [10], and color glove based hand gesture recognition [11].

For digitizing hand and finger motions into multi-parametric data, Data-Glove based methods use sensors. The extra sensors make it easy to collect hand configuration and movement [12]. However, the extra devices are quite expensive and bring much cumbersome experience to the users. In contrast, the Vision Based methods require only a camera, thus realizing a natural interaction between humans and computers without the use of any extra devices. These systems tend to complement biological vision by describing artificial vision systems that are implemented in software and/or hardware [12].

This paper is organized as follows: Section 2 demonstrates hand gesture recognition approaches. Section 3 explains vision based hand gesture recognition approaches. Applications of hand gesture recognition are presented in Section4. Section 5 explains the challenges in gesture recognition. This paper is concluded in section 6.

2. HAND GESTURE RECOGNITION APPROACHES

Present hand gesture recognition approaches can be classified into various categories.

A. Data glove based approaches:

Data Glove, based approach uses a glove-type device which could detect hand position, movement and finger bending. In this approach user require to wear a glove like device, which uses sensors that can sense the movements of hand(s) and fingers, and pass the information to the computer. . These approaches can easily provide exact coordinates of palm and finger's location and orientation, and hand configurations [12] [13][14],.The main advantage of these approach are high accuracy and fast reaction speed but this approach can be quite expensive.

B. Vision based approaches:

In this approach user not require to wear anything. Instead the system requires only camera(s), which are used to capture the images of hands for interaction between human and computers. Vision based approach is simple, natural and convenience [13]. However, there are still several challenges to be addressed, for instance, illumination change, background clutter, partial or full occlusion etc.

C. Color glove based approaches:

Color glove based approaches represent a compromise between data glove based approaches and vision based approaches. Marked gloves or colored markers are gloves that worn by the human hand [15] with some colors to direct the process of tracking the hand and locating the palm and fingers [15], which provide the ability to extract geometric features necessary to form hand shape [15]. The disadvantages are similar to data glove based approaches: they are unnatural and not suitable for applications with multiple users due to hygiene issues.

(a)Data-Glove based [21]. (b) Vision based. (c) Colored marker (from web gallery).

Fig 1: Examples of hand gesture recognition input technologies.

3. VISION BASED HAND GESTURE RECOGNITION

In vision based hand gesture recognition system there is no need to wear anything, this technology use a bare hand to extract data for recognition[1].with the help of this technology user can directly interact with the system[1] [15]. In vision based hand gesture recognition system [16], the movement of the hand is recorded by video camera(s). Vision based technology deals with some image characteristics such as texture and color for acquiring data needed for gesture analyze [1].

The approaches to Vision based hand posture and gesture recognition

(i) 3D hand model based approach

(ii) Appearance based approach

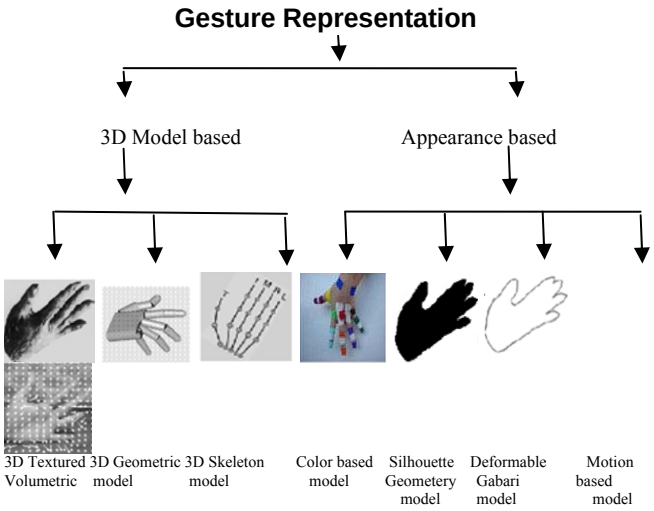

Fig. 2 Vision based hand gesture representations (Bourke et al. 2007)

A. Appearance based approaches:

Appearance based approaches also known as View Based Approaches, which model the hand using the intensity of 2D images and define the gestures as a sequence of views. These models don't use a spatial representation of the body anymore, because they derive the parameters directly from the images or videos using a template database. Some are based on the deformable 2D templates of the hands. Appearance based approaches considered easier than3D model approaches, due to the easier extraction of features in 2D image.

B. 3D Model Based Approaches :

Three dimensional hand model based approaches rely on the 3D kinematic hand model with considerable DOF's, and try to estimate the hand parameters by comparison between the input images and the possible 2D appearance projected by the 3D hand model. Such an approach is ideal for realistic interactions in virtual environments [12]. In contrast,3D model based approaches can exploit the depth information and are much more computationally expensive but can identify hand gestures more effectively. 3D Model can be classified into volumetric and skeletal models [16][24]. Volumetric models deal with 3D visual appearance of human hand [17] and usually used in real time applications The main problem with this modeling technique is that it deals with all the parameters of the hand which are huge dimensionality [16]. Skeletal models overcome volumetric hand parameters problem by limiting the set of parameters to model the hand shape from 3D structure [15][17].

4. APPLICATION

This section includes applications of vision based hand gesture recognition.

A. Sign Language

Sign language is the natural way of communication of hearing and/or speech impaired people. Various vision based gesture recognition methods have been embedded into sign language interpreters [19]. Usually, a capture device is used to find and track hands and record the shapes

and trajectories of hands, which are represented by feature vectors. After being matched to corresponding signs, the feature vectors are compared against a grammar library to determine whether the signs make sense in a grammar context.

B. Robot control

Through the use of gesture recognition, "robot control with the wave of a hand" of various devices is possible. The signal must not only indicate the desired response, but also which device to be controlled. The system consists of a robot unit, a video or infrared camera affixed to the robot unit for capturing hand images, a gesture recognition unit and a gesture database. It is also possible to use train robots to learn new gestures in an online or interactive manner [18].

C. Surgical System

In a surgical environment, hand gesture recognition systems can help doctors manipulate digital images during medical procedures using hand gestures instead of touch screens or computer keyboards

D. Alternative computer interfaces

Instead of using the traditional keyboard and mouse setup to interact with a computer, strong gesture recognition could allow users to accomplish frequent or common tasks using hand or face gestures to a camera.

5. CHALLENGES

There are many challenges associated with the accuracy and usefulness of gesture recognition software. For image-based gesture recognition there are limitations on the equipment used and image noise. Images or video may not be under consistent lighting, or in the same location. Items in the background or distinct features of the users may make recognition more difficult. The number of cameras used for recognition. For example, an algorithm calibrated for one camera may not work for a different camera. The amount of background noise also causes tracking and recognition difficulties, especially when occlusions (partial and full) occur. Furthermore, the distance from the camera, and the camera's resolution and quality, also cause variations in recognition accuracy.

6. CONCLUSION AND FUTURE WORK

There are many approaches to hand gesture recognition and each approach has its strength and weaknesses. This survey paper has provided a comprehensive overview of various hand gesture recognition approaches.

In this paper, we reviewed several existing methods for supporting vision-based human-computer interaction based on the recognition of hand gestures like data glove based method. Vision based method and colored glove method. There are many hand gesture recognition applications are available.

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