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Design and implementation of Human Computer Interactive system using Gesture Recognition

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***Abstract*—The use of gestures to convey information has been an important part of human communication. Hand gestures can be classified into two categories: static and dynamic. The use of hand gestures as a natural interface serves as a motivating force for research on gesture nomenclature, its representations, and recognition techniques. This paper is the summary of the reviews carried out in human computer interaction (HCI) studies and concentrates on different application domains that use hand gestures for efficient interaction. This fact-finding study wishes to provide a progress report on static and dynamic hand gesture recognition (i.e., gesture taxonomies, representations, and recognition techniques) in HCI and to identify future directions.**

***Keywords*—**Gesture recognition, Human Computer Interaction (HCI), AI, Language Processing.

INTRODUCTION

With the development of information technology in our society, we can expect that computer systems to a larger extent will be embedded into our environment. These environments will impose needs for new types of human-computer interaction, with interfaces that are natural and easy to use. In particular, the ability to interact with computerized equipment without need for special external equipment is attractive. Today, the keyboard, the mouse and the remote control are used as the main interfaces for transferring information and commands to computerized equipment [1]. In some applications involving three-dimensional information,such as visualization,computer games and control of robots, other interfaces based on trackballs, joysticks and data gloves are being used. In our daily life, however, we humans use our vision and hearing as main sources of information about our environment. Therefore, one may ask to what extent it would be possible to develop computerized equipment able to communicate with humans in a similar way,by understanding visual and auditive input. Hand gesture recognition is a relatively new field. Now a day much research is going on in the field of Artificial Intelligence in Natural language processing. Hand gesture, body postures are also the natural languages. The use of hand gestures provides an attractive alternative to the cumbersome interface devices for Human-Computer Interaction (HCI) [2]. Users generally use hand gestures for expression of their feelings and notifications of their thoughts. In particular, visual interpretation of hand gestures can help in achieving the ease and naturalness desired for HCI. People with severe disabilities who retained the ability to rotate their heads have other assistive technology options. For example, there are various commercial mouse alternatives. Some systems use infrared emitters that are attached to the user's glasses, headband, or cap.

The use of hand gesture recognition has been steadily growing in various human-computer interaction applications. Under realistic operating conditions, it has been shown that hand gesture recognition systems exhibit recognition rate limitations when using a single sensor. Hand gesture recognition for human computer interaction is an area of active research in computer vision and machine learning. The primary goal of gesture recognition research, is to create a system, which can identify specific gestures and use them to convey information or for device control. For that, gestures need to be modeled in the spatial and temporal domains,

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where a hand posture is the static structure of the hand and a gesture is the dynamic movement of the hand. Being hand-pose one of the most important communication tools in human's daily life, research on human-machine interaction through gesture recognition led to the use of such technology in a very broad range of applications, like touch screens, video game consoles, virtual reality, medical applications, etc [3]. There are areas where this trend is an asset, as for example in the application of these technologies in interfaces that can help people with physical disabilities, or areas where it is a complement to the normal way of communicating. Thus, it seems convenient that human-robot interfaces incorporate hand gesture recognition capabilities. For instance, we would like to have the possibility of transmitting simple orders to personal robots using hand gestures. The recognition of hand gestures requires both hand's detection and gesture's recognition. Both tasks arevery challenging, mainly due to the variability of the possible hand gestures (signs), and because hands are complex, deformable objects (a hand has more than 25 degrees of freedom, considering fingers, wrist and elbow joints) that are very difficult to detect in dynamic environments with cluttered backgrounds and variable illumination. Thus, it seems convenient that human-robot interfaces incorporate hand gesture recognition capabilities. For instance, we would like to have the possibility oftransmitting simple orders to personal robots using hand gestures. The recognition ofhand gestures requires both hand's detection and gesture's recognition [10]. Both tasks arevery challenging, mainly due to the variability of the possible hand gestures (signs),and because hands are complex, deformable objects (a hand has more than 25 degreesof freedom, considering fingers, wrist and elbow joints) that are very difficult todetect in dynamic environments with cluttered backgrounds and variable illumination.

The visual based human computer interaction is probably the most widespread area in HCI research. Considering the extent of applications and variety of open problems and approaches, researchers tried to tackle different aspects of human responses, which can be recognized as a visual signal. Some of the main research areas in this section are as follow:

- Facial Expression Analysis
- Body Movement Tracking (Large-scale)
- Gesture Recognition
- Gaze Detection (Eyes Movement Tracking)

Some of the Indian sign language gestures are as shown in Fig. 1.

Fig. 1 Indian sign language gestures

While the goal of each area differs due to applications, a general conception of each area can be concluded. Facial expression analysis generally deals with recognition of emotions visually [19]. Body movement tracking and gesture recognition are usually the main focus of this area and can have different purposes but they are mostly used for direct interaction of human and computer in a command and action scenario. Gaze detection is mostly an indirect form of interaction between user and machine, which is mostly used for better understanding of user's attention, intent or focus in context-sensitive situations. The exception is eye tracking systems for helping disabilities in which eye tracking plays a main role in command and action scenario, e.g. pointer movement, blinking for clicking. It is notable that some researchers tried to assist or even replace other types of interactions (audio-, sensor-based) with visual approaches. For example, lip reading or lip movement tracking is known to be used as an influential aid for speech recognition error correction.

SCOPE OF WORK

There are basically two types of approaches for hand gesture recognition: vision-based approaches and data glove methods. In the study, I will be focusing my attention on vision-based approaches. Why vision-based hand gesture recognition systems? These systems provide a simpler and more intuitive way of communication between a human and a computer. Using visual input in this context makes it possible to communicate remotely with computerized equipment, without the need for physical contact [9]. The main objective of this work is to study and implement solutions that can be generic enough, with the help of machine learning algorithms, allowing its application in a wide range of human-computer interfaces, for online gesture recognition. In pursuit of this, I intend to use a depth sensor camera to detect and extract hand information (hand features), for gesture classification. With the implemented solutions I intend to develop an integrated vision-based hand gesture recognition system, for offline training of static and dynamic hand gestures. This is an area with many different possible applications, giving

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users a simpler and more natural way to communicate with robots/systems interfaces, without the need for extra devices. So, the primary goal of gesture recognition research is to create systems, which can identify specific human gestures and use them to convey information or for device control. This work intends to study and implement a solution, generic enough, able to interpret user commands, composed of a set of dynamic and static gestures, and use those solutions to build an application able to work in a real-time human-computer interaction systems [4].

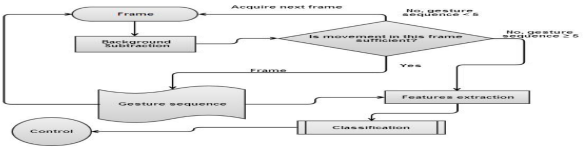

Fig. 2 Workflow of an algorithm

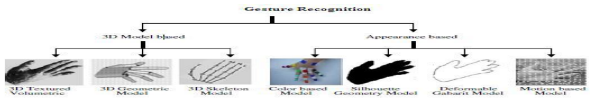

Fig. 3 Classification of vision based hand gesture recognition system

Fig. 3 shows the classification of Vision based hand gesture recognition system. 3D model based methods make use of 3D information of key elements of the body parts. Using this information, several important parameters, like palm position, joint angles etc., can be obtained. This approach uses volumetric or skeletal models, or a combination of the two. In computer animation industry and for computer vision purposes, volumetric approach is better suited. This approach is very computational intensive and also, systems for live analysis are still to be developed.

Hand Gesture recognition has a wide range of application in real life & real time scenarios such as;

- Some advanced applications include tablet PC, games, medicine environment, and augmented reality.
- In desktop applications, hand gestures can offer a substitute interaction medium for mouse and keyboard. Many hand gestures for desktop computing tasks involve manipulating graphic objects or annotating and editing documents using pen-based gestures. Also use of pen gestures, make marking menu selections using stroke gestures.
- Virtual reality is one of application.
- Robotics and Telepresence: Telepresence and telerobotic applications are typically situated within the domain of space exploration and military-based research projects.
- In games
- In Sign Language Recognition [2].

FACTORS IN HCI

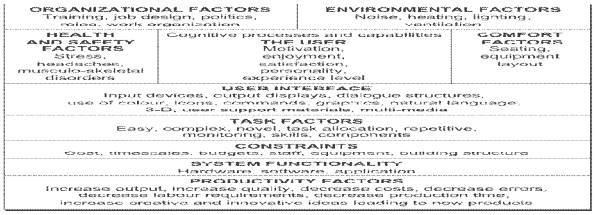

Fig. 4 Factors in HCI

The factors in HCI range from system constraints, system functionalities, productivity factors, to task factors, user interface, health and safety factors, comfort factors, the user, and organizational and environmental factors. The model is quite comprehensive in identifying all factors that contribute to HCI design. It also recognizes the user as a complex being with cognitive processes and capabilities but also with motivation, enjoyment, satisfaction, personality, and experience [5].

OBJECTIVES OF RESEARCH

The overall objective and purpose of this manuscript and research is to explore the Human-Computer Interaction (HCI) extensively for the benefit of computer users, and to introduce the emerging research area of affective HCI, some of the available methods, techniques, systems and applications. As computers have become more general in human society, its utility cannot be denied in all aspects of life. Facilitating natural Human–Computer Interaction (HCI) will have positive Impacts on the usages of computer. Hence, there has been growing interest in the development of new approaches and technologies for bridging the Human–Computer barrier [8]. The ultimate objective is to bring HCI to a system where interactions with computers will be as natural as an interaction between humans, and to this end, incorporating gestures in HCI is an important research area. Gestures have been considered as an interaction technique that can possibly deliver more natural, creative and intuitive methods for communicating with our computers [11]. My research will address a broad range of problems, use a variety of methods and techniques, and apply them in diverse application domains. The focus and objective of my research on HCI is to perform analysis, establish requirements, design and evaluate Interactive and collaborative computer-based systems and products.

Fig. 5 Video capturing devices

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These devices rely on video sequences captured by one or several cameras to analyze and interpret motion. Such cameras include infrared cameras that provide crisp images of gestures and can be used for night vision (Fig. 5 a). Traditional monocular cameras are cheapest with variations, such as fish-eye cameras for wide-angle vision and time-of-flight cameras for depth information. Stereo vision-based cameras (Fig. 5 b) deliver 3D global information through embedded triangulation. Pan-tilt-zoom cameras are used to identify details in a captured scene more precisely. Vision-based cameras also use hand markers (Fig. 5 c) to detect hand motions and gestures. These hand markers can be further classified into reflective markers, which are passive in nature and shine only when strobes hit them, and light-emitting diodes, which areactive in nature and flash in sequence. Each camera in these systems delivers a marker position from its view with a 2D frame that lights up with either strobe or normal lights. Preprocessing is performed to interpret the views and positions onto a 3D space [6].

The design of any gesture recognition system essentially involves the following three aspects: (1) data acquisition and pre-processing; (2) data representation or feature extraction and (3) classification or decision-making. Taking this into account, a possible solution to be used in any vision-based hand gesture recognition system for human-computer interaction is represented in the following Fig.6 and Fig. 7 [7].

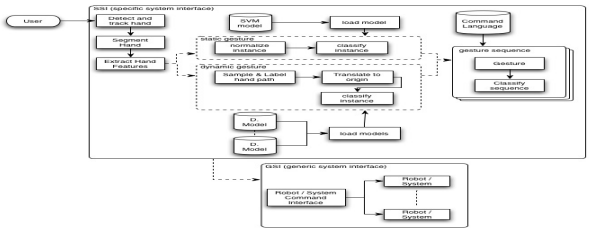

Fig. 6vision-based hand gesture recognition system

Fig. 7 Defined Hand postures for Static commands

CHALLENGES

The main challenge in vision-based gesture recognition is the large variety of existing gestures. Recognizing gestures involves handling many degrees of freedom, huge variability of 2D appearance depending on the camera viewpoint (even with the same gesture), different silhouette scales (e.g., spatial resolution), and many resolutions for the temporal dimension (e.g., variability of gesture speed) [12]. The trade-off between accuracy, performance, and usefulness also requires balancing according to the type of application, cost of the solution, and several other criteria, such as real-time performance, robustness, scalability, and user-independence. In real time, the system must be able to analyze images at the frame rate of the input video to provide the user with instant feedback on the recognized gesture.The present survey has found across the literature the tendency of the developed hand gesture recognition systems trying to attain specific performance accuracy against various real time challenges faced during the design and implementation of these systems. These set of real time challenges varied from variations in illumination conditions to occlusion problems to real time compatibility of performance along with forward and backward compatibility among the technologies implemented. Nevertheless some of these real time challenges are worked upon to a certain extent by some of the authors but still no robust framework for solution to all of these real time challenges has been proposed [13]. Efforts are need to be organized for the design and development of a framework that generates a hand gesture recognition system satisfying all the real time challenges posed by these systems. Without any detailed level of performance defined within the framework it would be really difficult to develop an optimal solution based system for various real time challenges. The static and dynamic sets of background from which the hand gestures need to be segmented are also one of the prime real time challenges that need to be addressed for the wide applicability of these systems [14].

CONCLUSION

Over the past few years, use of natural human hand gestures for interaction with computing devices has continued to be a thriving area of research. This survey has identified more thantwo hundred fifty recent related publications in major conferences and journals [15]. Increased activity in this research area has been a driven by both scientific challenge of recognizing hand gestures and the demands of potential applications related to desktop and tablet PC applications, virtual reality etc. This survey is an endeavor to provide the upcoming researchers in the field of human computer interaction a brief overview of the core technologies related to and worked upon in the recent years of research. This paper presented a system able to

interpret dynamic and static gestures from a user with the goal of real-time human-computer interaction. Although the machine learning algorithms used are not the only solutions, they were selected based on obtained performance, and the type of system that we want to design and implement. Over the last decade numerous methods for hand gesture taxonomies and representations have been evaluated for the core technologies proposed in the hand gesture recognition systems. However the evaluations are not dependent on the standard methods in some organized format but have been done on the basis of more usage in the hand gesture recognition systems. Hence the analysis of the detailed survey presented in the paper states the fact that the appearance based hand gesture representations are more preferred than the 3D based gesture representations in the hand gesture recognition systems [16]. Though there are vast amount of information and research publications available in both the techniques but due to complexity of implementation the 3D model based representations are less preferred. The industrial applications also require specific advances in the man to machine and machine-to-machine interactions [17]. The potential related to the application of hand gesture recognition systems in day-to-day life always keeps inspiring the advances required to realize the reliable efficient accurate and robust gesture recognition systems. Hand motion guided human-computer interface based on the new dynamic patterns descriptor is presented [18]. The distinctiveness of proposed gesture description was demonstrated by cross-class Euclidian distance measurement of training samples. Hand motion is described by the sequence of motion distribution histograms. This method demonstrates sufficient processing speed in terms of end user experience and classification accuracy for gesture sequences to be used for remote slideshow control. Further research within proposed approach aims to support different gestures types and non-relevant objects motion filtering using skin color map, depth map and motion map [20].

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