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CONCEPTS AND APPROACHES ON HUMAN COMPUTER INTERACTION - A REVIEW

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Abstract

Human Computer Interaction (HCI) technology characterizes an extremely developing area of research with application expert systems. HCI is used in many areas such as industrial design, personal information and interaction management. This paper describes how HCI design can be used in various technologies in order to achieve a certain performance. In this study, the concept of mutual understanding between the user, the machine and the existing approaches using lip movement, gesture recognition, gaze detection and voice recognition have been investigated. This paper also reviews how different types of electrophysiological signal based HCI (electroencephalography (EEG), electromyography (EMG) and electrooculography (EOG)) are designed for the same application.

Introduction

Human Computer Interaction (HCI) technology characterizes an extremely developing area of research with application expert systems. HCI is used in many areas such as industrial design, personal information and interaction management. HCI design focuses specifically on the interaction between humans and computers. It is concerned with the design, evaluation and implementation of interactive computing systems for human use.

Concepts of HCI

Uni-Modal HCI Systems

An interface is a communication channel that mainly depends on number and diversity of its inputs and outputs. Each of the interfaces has different independent single channels called as modality and a system with one modality is called uni-modal. Based on the nature of different modalities, uni-modal systems can be divided into three categories: visual-based,

audio-based and sensor-based. Few of the main research areas in visual uni-modal section include facial expression analysis, lip movement, gesture recognition and gaze detection. Research areas in audio-based can be divided into speech recognition and emotion analysis.

Multi-Modal HCI Systems

A system that is based on more than one modality is called multi-modal systems. Based on the nature of different modalities, it may be helpful in applications such as smart video conferencing, intelligent homes/ offices, driver monitoring, helping people with disabilities, etc.

Approaches of HCI

Various approaches existing in the literature include lip movement, gesture recognition, gaze detection, voice recognition.

Lip Movement

Lip reading is the method of communication used by people with hearing impairment when conversing with others. Computer-based lip reading system may help them to track those words based on the movement of the lips. Computer based lip reading system may track the words based on the movement of the lips that may differ between several words. In order to recognize the spoken word by the computer, feature parameter such as surface area had to be extracted and stored in the database. Horizontal and vertical distances of the lip are used to find the surface area. The experiments showed that the surface area is not the accurate technique for computer based lip reading as compared to elliptical area (Talha et al., 2014).

Dalka and Czyzewski (2010) proposed human computer interface based on visual lip movement and gesture recognition in which multi-modal HCI called lip mouse has been used that allows the user to work on the computer using movements and gestures made with their mouth. Web cam is used to obtain the input image from face and face detection is done by using the cascade of boosted classifiers. Lip movements are tracked from the mouth region that allows the user to control the screen cursor. Three different lip gestures namely mouth opening, sticking out the tongue and forming puckered are recognized from the mouth region.

Lip control system (LCS) is specially designed for tetraplegia person. Lip control system (LCS) consists of headset and a joystick placed in front of the lower lip. According to the Fitts' law, the lower lip potential is evaluated and it is used to control an input device (Jos and Lopes, 2015). With the same input condition, the lower lip throughput is compared with

the thumb throughput. Tin (2011) proposed a method using optical flow for facial extraction and lip tracking using facial points. Using an optical method, lip muscular shape is considered as a triangle in which the feature points of the lip are extracted from the vertices of triangle. The shape of the model has been tracked using deformed triangles.

Gesture Recognition

Gesture recognition enables the human beings to communicate with the machine and to interact naturally without any mechanical device. Gestures are the non-verbal kind of communication. Gestures can be from any parts of body motion but mainly face and hand gestures are considered and it enhances the efficiency of the system control. Sharma and Verma (2015) investigated a study on the usage of hand gesture to control the computer. The hand gesture image is extracted as frames and transformed from RGB to YbCr color model. Pre-processing is done by image filling and morphological erosion. Using the skin color based detection; the hand from the image is detected. The feature parameters such as area, diameter, perimeter, centroid and orientation are extracted from the objects. By counting the number of white objects the orientation of image gestures was recognized. Face recognition used viewer verification and hand recognition for interacting with media player. Skin and cascade detector is used to extract the gestures from the main image and it is given to the recognition stage. A high precision ratio is obtained for American Sign Language (ASL) database. The correctness rate of about 99.4% is achieved (Azad et al., 2014).

Gaze Detection

Gaze detection or eye tracking is the process of measuring the motion of an eye relative to the head. An eye tracker is a device for measuring eye positions and eye movement. The method of gaze detection points out the person's gaze and record the activity of that gaze point. A special lens that is attached to the cornea may record the eye movement.

Rantanen et al. (2011) discussed about wearable, wireless gaze tracker with integrated selection command source for human computer interaction. This paper introduces a less weight and easily wearable gaze tracker for HCI. Head mounted and video based gaze tracking methods are combined by the prototype.

This method determines the eye and head orientation to map the movement from the capacitive signal. The gaze direction was estimated by considering the head postures or movements. From the triangular attributes of eye and mouth, it establishes the head position and postures. Normal eye outline fitted with horizontal and vertical projection are estimated. Results demonstrated the accuracy of head posture and gaze direction of this proposed method. This method has more

accuracy in gaze estimation (Wan-zhi Zhang, 2013). Eye control system was proposed based on the Ameliorated Hough transform algorithm (Xiong et al., 2013). Eye control system employing the eye gaze tracking technique is proposed in this paper for disabled people with healthy eye. This paper deals with the overview of existing methods like hardware complexity and accuracy. Blink detection are functioned and designed. About 87% of demonstrated result is obtained using the proposed Hough transform algorithm.

Voice Recognition

Voice recognition refers to identifying the speaker but not what they are saying. Recognizing the speaker can be used to authenticate or verify the identity of a speaker as part of a security process. Husnjak et al. (2014) proposed a method of using speech recognition systems of smart terminal devices in traffic environment. The paper describes the pros and cons of voice recognition system in integration with car. The advantage of this integration is primarily seen in the use of mobile phones. This integration of smart device with car's in built device allows the driver to use the mobile phone without interfering with the driving. Hofmann (2007) discussed a method on speech recognition for human computer interaction. Voice is used as an approach to recognize the user. This paper deals with the overview of voice recognition, and the existing system results and different stages of feature extraction such as linear prediction as well as cepstral coefficients and feature matching in speech processing. The feature matching process includes the template matching and statistical methods.

Electrophysiological Signal based HCI

The various electrophysiological signals such as electroencephalography (EEG), electromyography (EMG) and electrooculography (EOG) are being used to design HCI.

EEG based HCI

Electroencephalography is a method to record the electrical activity of the brain along the scalp. EEG measures voltage fluctuations resulting from ionic current within the neurons of the brain. Robinson et al. (2013) proposed EEG-based classification of fast and slow hand movements using Wavelet-CSP algorithm. The application of non-invasive EEG based on computer interface is estimated in the study. The EEG signal is taken by the movement of the right hand with different speeds and with different directions. The features are estimated by Wavelet-CSP which provides high temporal resolution. 83.71% of result is obtained by Fisher Linear discriminant. The multi-class MI EEG signals by applying the

Gaussian mixture model to every channel to construct normal Bayesian network. The common and varying edge modes are constructed using CBN and state vector machine (SVM) is used for classification. The result proved that it has a very high accuracy and is found to be very efficient than other techniques.

Kim and Jo (2015) proposed quantitative evaluation of a low-cost non-invasive hybrid interface based on EEG and eye movement. The computer interface used with eye tracking is analyzed in this paper and also deals with the difficulty of Fitts' law based on quantitative method. The main aim of this paper is to build low cost recording device with inexpensive eye tracker. The pupil variation from the eye and neutral signal from the EEG signals are the features that are used to control the mouse cursor. The proposed Fitts' law is compared with different schemes like tracking with keyboard, mouse, etc.

EMG based HCI

Electromyography is a technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG is performed using electromyography to produce a record called as electromyogram. Barreto et al., (2000) demonstrated a practical EMG based human-computer interface for users with motor disabilities that has been designed and developed as an alternate input device that could be used by individuals with severe motor disabilities. Various cursor movements are realized by the real time bio-signals. HCI system is used to classify the bio-signals as mouse functions and to estimate power spectral densities. The outcome of this paper is to help the user to operate the computer very easily. The evaluation of head orientation and neck muscle EMG signals are used as command inputs to a human computer interface for individuals with high tetraplegia. Three user interfaces are used to investigate the cursor control from 2-D subjects. According to the Fitts' Law performance is evaluated. The sequential EMG commands exhibited high speed in two directions. The throughput performance of EMG signal with head orientation showed that EMG is less accurate (Williams et al., 2008).

EOG based HCI

Electrooculography is a technique for recording eye movements and used in ophthalmological diagnosis. The resulting signal is called the electrooculogram. Bulling et al., (2011) described the eye movement analysis for activity recognition using electro-oculography. This paper investigated the eye modality for recognition of activities. Three different eye movement characteristics such as saccades, fixations as well as blinks and 90 different features based on the

characteristics are evaluated using the minimum redundancy maximum relevance (MRMR). For feature selection 76% of result is obtained using SVM classifier. EOG based HCI is used for tracking the eye-movement for disabled persons (such as injured-vertebra, neuron disease, etc.). Based on EOG signal, the direction in which the eye moves have been detected and these eye signals are converted into digital signals and then used as control signals for HCI. The feature parameters they used are corneal-retinal potential difference. This method obtained an accuracy of about 90% when used in eye controlling games (Deng et al., 2010). Shang-Lin et al. (2013) discussed Controlling a HCI System with a novel classification method that uses electrooculography signals. This paper classified nearly eight directions (up, down, left, right, up-left, down-left, up-right, down-right) of the eye movement. The features namely horizontal and vertical parameters are used. These extracted features are compared with encoded signal in the database for classification.

Result

This study illustrates how HCI can be designed using different concepts and approaches. Talha et al. (2014) has used elliptical area to track the lip movements and ensured that it is the best feature for lip movement tracking. Lip mouse as an interface based on lip and gesture recognition and concluded that lip shape recognition with ellipse provided best results (Dalka and Czyzewski, 2010). Lip control system with a headset and joystick to extract throughput from lip and the results showed that the lower lip can control a device well (Jos and Lopes, 2015). Tin (2011) used optical flow method which used VAD to separate audio of speaker and the results obtained are with low complexity which could be used for real time implementations.

An interface through the face and hand gestures and also introduced hybrid interfaces but the performance of the system is not good (Azad et al., 2014). Rantanen et al. (2011) designed a gaze tracker but it could be performed only with healthy participants. Hough transform used as an eye control system and concluded that it could also be developed in the processors (Xiong et al., 2013). Husnjak et al. (2014) used speech to control the traffic and the comparisons of various applications can be made in the future. Hofmann (2007) made the mobile to operate from speech and concluded that the recent technologies could be used for control. Wan-zhi Zhang (2013) used head posture and eye direction as an accurate interface. Position of pupil is estimated accurately from direction of gaze. Controlled an external device based on hand movement and results show that the accuracy decreases when the wavelet order increases (Robinson et al., 2013). Bayesian network showed best classification results only after 1.5 sec time duration (He et al., 2015). Bulling et al. (2011)

used minimum redundancy maximum relevance technique to recognize the eye movement. This could be further enhanced in the future by considering more eye features. Deng et al. (2010) used eye signal to control the injured vertebra of the disabled. Direction sensor Interface was used to interface the direction of the eye movement.

Conclusion

The design of human computer Interaction using various concepts and approaches has been reviewed. There are also chances that it could be developed better in order to make human to easily communicate with the external world. Care should be taken in all the fields in order to make the human to interact with the machine easily so that the work of human is simplified thus leading to better human computer interface. Software may also be developed in future for easy communication.

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