Vision based hand gesture recognition for human computer interaction: a survey

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Abstract   As computers become more pervasive in society, facilitating natural human–computer interaction (HCI) will have a positive impact on their use. Hence, there has been growing interest in the development of new approaches and technologies for bridging the human–computer barrier. The ultimate aim is to bring HCI to a regime 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 long been considered as an inter-action technique that can potentially deliver more natural, creative and intuitive methods for communicating with our computers. This paper provides an analysis of comparative surveys done in this area. The use of hand gestures as a natural interface serves as a motivating force for research in gesture taxonomies, its representations and recognition techniques, software platforms and frameworks which is discussed briefly in this paper. It focuses on the three main phases of hand gesture recognition i.e. detection, tracking and recognition. Different application which employs hand gestures for efficient interaction has been discussed under core and advanced application domains. This paper also provides an analysis of existing literature related to gesture recognition systems for human computer interaction by catego-rizing it under different key parameters. It further discusses the advances that are needed to further improvise the present hand gesture recognition systems for future perspective that can be widely used for efficient human computer interaction. The main goal of this survey is to provide researchers in the field of gesture based HCI with a summary of progress achieved to date and to help identify areas where further research is needed.

Keywords   Hand · Gesture recognition · Human computer interaction · Representations · Recognition · Natural interfaces

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1 Introduction

In the present world, the interaction with the computing devices has advanced to such an extent that as humans it has become necessity and we cannot live without it. The technology has become so embedded into our daily lives that we use it to work, shop, communicate and even entertain our self (Pantic et al. 2008). It has been widely believed that the computing, communication and display technologies progress further, but the existing techniques may become a bottleneck in the effective utilization of the available information flow.

To efficiently use them, most computer applications require more and more interaction. For that reason, human-computer interaction (HCI) has been a lively field of research in the last few years. Firstly based in the past on punched cards, reserved to experts, the interaction has evolved to the graphical interface paradigm. The interaction consists of the direct manipulation of graphic objects such as icons and windows using a pointing device. Even if the invention of keyboard and mouse is a great progress, there are still situations in which these devices are incompatible for HCI. This is particularly the case for the interaction with 3D objects. The 2 degrees of freedom (DOFs) of the mouse cannot properly emulate the 3 dimensions of space. The use of hand gestures provides an attractive and natural alternative to these cumbersome interface devices for human computer interaction. Using hands as a device can help people communicate with computers in a more intuitive way. When we interact with other people, our hand movements play an important role and the information they convey is very rich in many ways. We use our hands for pointing at a person or at an object, conveying information about space, shape and temporal characteristics. We constantly use our hands to interact with objects: move them, modify them, and transform them. In the same unconscious way, we gesticulate while speaking to communicate ideas ('stop', 'come closer', 'no', etc). Hand movements are thus a mean of non-verbal communication, ranging from simple actions (pointing at objects for example) to more complex ones (such as expressing feelings or communicating with others). In this sense, gestures are not only an ornament of spoken language, but are essential components of the language generation process itself. A gesture can be defined as a physical movement of the hands, arms, face and body with the intent to convey information or meaning (Mitra and Acharya 2007).

In particular, recognizing hand gestures for interaction can help in achieving the ease and naturalness desired for human computer interaction. Users generally use hand gestures for expression of their feelings and notifications of their thoughts. Researcher Karam (2006) in his work reported that hand has been widely used in comparison to other body parts for gesturing as it is a natural form of medium for communication between human to human hence can best suited for human computer interaction also as shown in Fig. 1.

The interest in this area has led to a large body of research which has been digested in a number of surveys directly or indirectly related to gesture recognition. Table 1 shows some of the important surveys and articles presented in the area of gesture recognition.

The following comprehensive analysis of the surveys and articles published earlier related to hand gesture recognition could be used for the design, development and implementation of evolved, robust efficient and accurate hand gesture recognition systems for human computer interaction. The key issues addressed in the research articles could in many ways help the researchers in identifying the arid regions of the said area and tapping these arid regions towards advances in more user friendly human computer interaction systems. The remainder of this paper is organized as follows:

Section 2 provides an overview of the enabling technologies available hand gesture recognition.