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TECHNICAL NOTE

Finger-stylus for non touch-enable systems

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Abstract Since computer was invented, people are using many devices to interact with computer. Initially there were keyboard, mouse etc. but with advancement of technology, new ways are being discovered that are quite common and natural to the humans like stylus for touch-enabled systems. In the current age of technology, the user is expected to touch the machine interface to give input. Hand gesture is used in such a way to interact with machines where natural bare hand is used to communicate without touching machine interface. It gives a feeling to the user that he is interacting in a natural way with some human, not with traditional machines. This paper presents a technique where the user need not touch the machine interface to draw on the screen. Here hand finger draws shapes on monitor like stylus, without touching the monitor. This method can be used in many applications including games. The finger is used as an input device that acts like a paint-brush or finger-stylus and is used to make shapes in front of the camera. Fingertip extraction and motion tracking were done in Matlab with real time constraints. This work is an early attempt to replace stylus with the natural finger without touching the screen.

1. Introduction

Communication using hand gestures exists in all civilizations since old times. There is a specific way to present hand to show a particular message. A gesture is a form of non-verbal communication in which any message is conveyed with the help of visible body actions. Hand gesture is potentially a very natural and useful modality for human–machine interaction. Hand gesture recognition (HGR) now has become an adoptable and reliable way to communicate with machines (Chaudhary et al., 2011a). People are using it to control robots (Chaudhary et al., 2011b), to learn/interpret sign languages (Liang et al., 1998; Starner and Pentland, 1995; Bragatto et al., 2006; Cooper, 2012), in health care (Chaudhary and Raheja, 2013) and many other fields. The use of hand gesture, as an interface between human and machines has always been a very attractive alternative to the conventional interface devices. HGR has been applied to many applications using different techniques since last three decades. Till date, mostly it is sensors or touch based recognition on devices which is used for interaction. The sensor-glove based method hinders the ease and naturalness with which humans interact with the computer. This has led to an increased interest in the visual approach.

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These days tablets and touch enabled mobiles are in use and mostly users go in for these devices like Apple iPad, Samsung Galaxy etc. They have few applications (apps) which are controlled or run by touching the screen in a normal way or in a specific way for example minimization of apps, entering data, and paint. It may be a single finger gesture or a multi finger gesture. Here to start with, we are focusing on one application which is paint. It is like 'Paper' or 'Fingerpaint Magic' available for iPad. They work the same as 'Paint' works on Microsoft Windows. There may be many applications like these on different platforms. A detailed analysis of paint with different computer vision algorithms has been done by Booch (2001). Forsline and Pedersen (2004) came up with a stylus to use a pen kind e-stick to draw or write on a computer screen which changes the world of interaction with computers. *Sensu* is a brush with stylus which works on these devices and gives a feeling of painting on a canvas.[1] After this, sensors detecting human body touch on the screen changed the technology of interaction. It seems very natural to draw or point on machines using sensors for example interaction with iPad.

In touch enabled machines, apps developed on different platforms provide flexibility to draw anything on computer canvas (which is screen) using hand fingers. Even few applications use finger pressure to decide the thickness of the paint brush. Among different parts of the body, hand is the easiest to use and shows the expression of human feelings. Also it is very robust in its operations because of its design and can move in any direction. A good comparison between stylus and hand touch devices is given in.[2] Here we are presenting a method to perform the same action by not touching the screen. The paper discusses the implementation of paint drawing on computer screen in real time using a vision based method, where touch-enabled device is not required. Here hand finger works as the stylus, say *finger-stylus*. This can be used on different tablets and replace many existing apps as discussed above because of its easy usage and mostly all tablets have a camera.

2. Background

The robust tracking of hand has been an active area of research in the applications where finger movements or hand geometry detection is needed. The existing methods are generally divided into two categories: Vision based approach (Sudderth et al., 2004) and Glove based approach (Wang and Popovíc, 2009). Both of them have their own pros and cons. Rehg and Kanade (1993) presented a method to detect articulated hand motion. He proposed 27 degree of freedom of hand in gray images but his method was not effective with complex backgrounds. Sato et al. (2000) used infrared cameras for skin segmentation on a table top and template matching for interpreting gesture commands. Chaudhary et al. (2011b) have also developed a real time finger motion detection framework which can be applied to many applications.

Garry (Berry, 1998) used virtual environments with gestures to control it in a natural way. Zeller et al. (1997) also used hand gestures in virtual environments. Starner and Pentland (1995) developed a system with a single color camera to track the American sign language in real time. Bragatto et al. (2006) translated the Brazilian sign language from video by tracking hand gestures. He used perceptron ANN for color segmentation and then classification separately. Cooper (2012) presents a method to control a complex set of sign language with *viseme* representation to increase the lexicon size. Ju et al. (1997) used hand gestures for analyzing and annotating video sequences of tech talks. In his work, gestures like pointing and writing were detected and recognized. Even systems which can detect the hand pointing spot have been developed (Raheja et al., 2014).

Figure 1 Finger captured by camera.

Araga et al. (2012) presented a real time gesture recognition system from video where they used few gesture images as gesture states. Wachs et al. (2008) developed a gesture based tool for sterile browsing of radiology images. A robust object detection method in indoor and outdoor field is described by Wang et al. (2011). The hand gesture could replace stylus on touch screens or touch screen sensors which are currently used in many places. A similar gesture based patient care system is described in Chaudhary and Raheja (2013). Coral Inc. has developed fingertip paint brush for touch enabled systems.[3] Hettiarchchi et al. (2013) presented *FingerDraw* where children can paint on an interactive screen with 'worm finger' device.

3. System description

The system uses a webcam either in-built in system or plugged. It tracks the hand movements made by the user by detecting the finger tips. These tips are displayed on the screen and finally the system shows the whole movement made by the user on the screen by connecting them. This movement further can be used to interact with computers and mobile devices without any physical intervention. For the simplicity of the system and to keep it near to the human behavior, we are considering only one finger for the tracking and display as one brush on a canvas. Later multiple criteria can be added to make the system for more applications.

Generally humans use the index finger to point or to gesture in their daily life. A 'session' is the time when the finger comes in front of the camera view and goes out of its capturing frame.

[1] https://www.sensubrush.com.
[2] http://purple-owl.com/drawin.
[3] http://www.corel.com/corel/product/index.jsp?pid=prod3720128&cid=catalog20038&segid=534&storeKey=us&languageCode=en.