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Hardware Based High Efficient Recognition of 3D Hand Gestures ⋆

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Abstract

This paper addresses the technical issues related to hand gestures generation and their real-time recognition. The arbitrary 3D gestures are generated by the Leap-motion Controller which detects and tracks the hands and fingers to acquire position and motion information. We combine Leap-motion sensor and hardware based pattern engine to make gesture recognition easier and propose an efficient recognition solution involving a neuron chip (named CM1K). In our experiment, we used one-finger gesture cases to demonstrate the efficiency of our solution. Experimental results showed that our solution owns a high accuracy in gesture data acquiring and only costs a few milliseconds in recognizing speed. We also considered the situation of similar gestures recognition and analyzed the causes of low matching rate from specific data.

Keywords: Gesture Recognition; Human Computer Interaction; Leap-motion; CM1K

1 Introduction

Gesture recognition, as one of the advanced nature communication means, is becoming a research focus in the filed of human computer interaction [4, 12] and playing key roles in a wide area of applications including sign language, gesture controlling [10], virtual reality, and other immersible games [8].

Especially, with the development and realization of virtual environment, the current human machine interaction approaches, such as mouse, joystick, keyboard and electronic pen are becoming more and more inefficient.

Gesture is the motion of hands or physical action, including temporal and spatial sequence information, can be used to convey sufficient meaningful messages by the users. In fact, gesture recognition is the process by which gesture made by the user is made known to the system [3].

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Hand gesture has the natural ability to represent ideas and actions easily, thus using these different gestures, being identified by human beings and interpreted to generate corresponding event, has the potential to provide a more natural interface to the computer system.

In past decades, there came many gesture recognition techniques and they had their advantages and disadvantages. For example, data glove [5], a sensor for hand motion and gesture recognition using motion sensors such as accelerometer, gyroscope, bend sensor, force sensor and so on. They are widely used in many applications, including virtual reality applications, biomechanics, robotics, and telecheric applications. However, the data glove a kind of wired technology [3] like electronics gloves cannot freely move in the room as they connected with the computer system via wire and limited with the length of wire. Through the use of sensors, these data gloves provide good results but they are extremely expensive to utilize in wide range of common application.

Data gloves are then replaced by optical markers. These optical markers project infra-red light and reflect this light on screen to provide the information about the location of hand or tips of fingers wherever the markers are wear on hand, the corresponding portion will display on the screen [7]. These systems also provide the good results but require very complex configuration. Later on some advanced techniques have been introduced such as image-based technique which requires processing of image features like texture, color and so on. But this technology is not very mature and the results could be different as skin tones and texture changes very rapidly from person to person and from one continent to other or someone under different illumination condition.

Although there are many ways to achieve gesture recognition, the improvement and innovation in this field is continuously made for years. All these approaches can not give overall consideration on either the accuracy, efficiency or convenience.

To resolve the mentioned problems in another way, this paper turns to the hardware based recognition and tries to make a good balance between accuracy and speed. Therefore, our solution combines Leap-motion Controller with CM1K chip together to construct a novel gesture capture and recognition platform.

2 Related Work

Leap-motion Controller is a tiny somatosensory controller for the PC and Mac which was first released by Leap Motion Company on Mar 19th, 2013. It can detect and track hands, fingers and finger-like objects reporting discrete position and motion. Its function is similar to Kinect and at present there has been some way of gesture recognition by using Kinect [6]. With its rapid popularization, the device has been widely applied in many related areas, such as dynamic gesture recognition, Arabic sign recognition [1], Robotic arm manipulation [2], and so on by researches and developers all over the world.

The CogniMem neural network chip named CM1K was developed by Guy Paillet which is actually a descendant of the ZISC (Zero Instruction Set Computer) chip manufactured by IBM until 2001. CM1K can be considered a high-speed recognition engine for artificial intelligence. Up to now, many companies and developers have integrated the CM1K chip in their designs, mostly to add recognition capabilities to embedded sensor boards. CM1K chip is a high-performance pattern recognition processor featuring a network of 1024 neurons operating in parallel. Also, the chip contains a recognition engine ready to classify a digital signal received directly from a