A Novel Design of Motion Detector Using Mouse Sensor

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ABSTRACT

This paper presents a novel design using a mouse sensor to construct a system for motion detection in normal vision environment. A mouse sensor is packed under an optical mouse for detecting the motion of mouse on desktop and sending out the data and parameters to a controller or a computer directly. This paper introduces this kind of sensor to vision motion detection field by designing and building a circuit system. The feasibility of the design is demonstrated and degree of reliability is measured by experiments performed on the designed system. Additionally the authors point out the advantages of this design in comparison with other traditional methods or devices in brief.

Keywords: Circuit System, CMOS Sensor, Motion Detection, Motion Sensors, Mouse Sensor

1. INTRODUCTION

Due to various demands and applications, motion detection has become an important field of digital and semiconductor technologies, which is attracting more and more attention. In traditional vision motion detection, CCD and CMOS sensors are widely used, mostly with a complex servo in background such as a server of a DSP (Digital Signal Processor) with a customized algorithm. Therefore, a new conception which is cheaper to build, easier to develop, more portable, and more reliable to use is desired by engineers and users.

A number of de-interlacing algorithms are widely and commonly adopted in the motion detection field (Han, Shin, Choi, & Park, 1999; Lee, Chang, & Jen, 1991; Shahinfard, Sidd-Ahmed, & Ahmadi, 2008) which are based on TV signal. However, the improved fabrication technology and architecture bring forward some other applications based on CMOS Image Sensors (CIS) directly (Ma & Chen, 1999; Sohn, Kim, Lee, Lee, & Kim, 2003). Lately, SOC replaced the foregoing techniques and became the dominate technology in motion detection area for its low power consuming and compatibility.
But sometimes SOC costs a long development cycle because of the developer must grasp the overall situation of hardware and software.

During the past several years, the progress of the optical navigation area has led to us to a new period of time that solid-state optical mouse has inevitably become a new standard. Inspired by the mouse devices and considering the situation of motion diction, we attempted to use the mouse CMOS sensor which is in low resolution ratio for motion detection. An experimental system was built tentatively to validate this idea. The feasibility of the design is demonstrated and degree of reliability is measured by experiments performed on the designed system.

In this paper, Section 2 will introduce what is mouse CMOS sensor, and explain the elements of it. Section 3 is the design of it that prototype is showed. In Section 4, we designed a series of experiments to test the system in resolution, color, texture, and luminance. Then advice is given for the application that needs the function with this module.

**MOUSE CMOS SENSOR**

The heart of an optical mouse is a mini camera in low-resolution. Just as Figure 1 showed that the navigation LED in the mouse illuminates a surface, and the light reflects off the surface to the lens. When the mouse is moved, the mini camera of the mouse (the sensor) takes continuous snapshots of the surface. The built-in digital signal processor (DSP) would process the data and determine the distance and direction of the movement. Then the micro-controller will send the result to the PC via the USB wire or other communication channel.

Figure 2 displays the algorithm of motion detection in the mouse DSP. When the mouse is moved, image A and B are captured by the CMOS sensor continuously. Ref is the same sub-image on both A and B, so that it can be a reference of image for A and B. In other words, it must be made sure that there is something on the image which is captured by the CMOS sensor. Then the DSP will figure out the vector of the movement based on the reference.

Because the resolution of CMOS of mouse sensor is very low (about 200 pixel in our prototype), and the DSP is making use of the algorithm for simple figure and point, the cost of the processor is low. So this is the reason of low power and high speed.

**2. DESIGN**

In this section, we present a novel design taking full advantage of the mouse sensor introduced above to achieve motion detection with lower cost and faster response.

Figure 3 shows how we change the typical usage of mouse sensor to a novel one, where we abandon the desktop and put the chip upside and replace the single lens with an optical camera lens. Therefore, an optical path is generated and the image will appear on the CMOS. Then the motion of object which we are concerning about can be detected by the sensor.

The high level design of the system is illustrated by Figure 4, which is simple to implement. A controller is used for sequential process control. In our work, an AVR MCU is chosen for this role. For this prototype, we choose the mouse sensor model: ADNS5030. This IC provide an I2C (Inter Integrated Circuit) communication port to transmit data. Since I2C bus has a lot of advantages such as small footprint, low cost, long distance, high speed transmit etc., this bus is quite suitable for this project. Then we put an output modular here not only to display the result of our testing, but also for future expanding.

Figure 5 is the prototype of this design. The circuit is divided into two parts: control board and sensor camera. The MCU is on the control board, which has done most of the job: initializing the sensor, reading the sensor state, transmitting the data to the USB port IC, and displaying result by the LED on the board. On the right is the mouse sensor which is packed in a small plastic box as a light tight box. The wire not only provides a communication way
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