Development of Driving IC for POV Display using Two-Dimensional LED Array and Micro-LED

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ABSTRACT

The driving IC for persistence of vision display using a rhombus-arranged two-dimensional LED array with cylindrically rotation is developed for improving its resolution by increasing the bit-rate for digital signal and decreasing the number of contacting pads. This driving method is also available to reduce the number of LED in a micro-display.

1 Introduction

1.1 POV Display

Persistence of vision (POV), also known as positive afterimage, is a phenomenon in which the vision produced by light on the retina is retained for a period after the light has stopped acting.

The POV display uses a light source such as a high-speed moving LED and illuminates it according to its moving position, and the residual image is displayed as a single pixel in a time-multiplexed manner.

By moving the light source at high speed, it becomes difficult to see the hard part of the image, and the residual image that is visualized stands out, making it possible to display images floating in mid air. Another advantage of this technology is that it is using LEDs, so it is highly luminous, can be used in natural light, and does not require special glasses.

Current POV displays usually use one-dimensional (1D) array of LEDs arranged in a straight line, and the resolution is limited by the LED pitch and response speed. In this research, a cylindrical POV display using an 8×8 two-dimensional (2D) LED array will be developed, the resolution can be increased by allowing other rows of LED to pass within the pitch. Besides, considering the application of micro-LED (μ-LED) to this technology, more signals will be needed, so in this study, the improvement of the signal writing speed will also be investigated.

1.2 Micro-LED

In recent years, the μ-LED displays have been developed to replace liquid-crystal displays (LCD) and organic light-emitting diode (OLED) displays, which are the mainstream displays. The μ-LED displays are characterized by their high brightness, low power consumption, and long life compared to LCD and OLED displays. One of the successful approaches to achieve a μ-LED display is to use the micro-IC as a substrate to mount RGB LEDs. The micro-IC is also used to drive and control the LEDs with a constant current and a pulse width modulation, which is the most ideal driving for LED in terms of efficiency and color [1].

In our laboratory, we are considering applying the μ-LED display to a rotating POV display. This floating display can be applied to advertisements, *etc*., and is expected to improve advertising [2].

Since the commercially available LED strips are used in our current POV display, the driving ICs operating RGB LEDs do not have enough high bit-rate to transfer the digital data and enough small die size mounted in μ-LED display. Therefore, our goal is to fabricate a costum IC which has high bit rate and small die-size. Considering the ease of mounting, the IC should have the only four I/O pads consisting of VDD, GND, DI, DO, using clock data recovery (CDR) system.

2 Experiment

2.1 Development of Driving IC for μ-LED

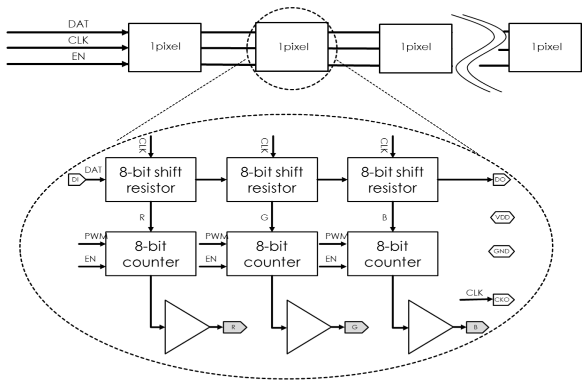

Fig. 1 Blosck diagram of micro IC for μ-LED driving.

Figure 1 shows a block diagram we are now designing, which includes the single sequence of μ-LEDs in operation and a magnified view of one pixel. As shown in Fig. 1, one pixel is made of RGB μ-LEDs, which are arranged vertically. The display is created by making the same arrangement vertically as well as horizontally. And the inputs are DAT, CLK, and EN (reset signal) at the current stage. As shown in the enlarged view of one pixel in Figure 1, RGB colors are controlled by PWM method respectively to represent the data (colors) input to that pixel.

Before creating the costum IC, we checked the performance of our design by using CPLD. The CPLD used in this study and its evaluation platform are shown in Figure 2. By connecting several CPLDs in series and adding LEDs, we can check the highest bit-rate and viridity of our logic design. We will also develop the CDR system suited to reduce the number of pads on a chip.

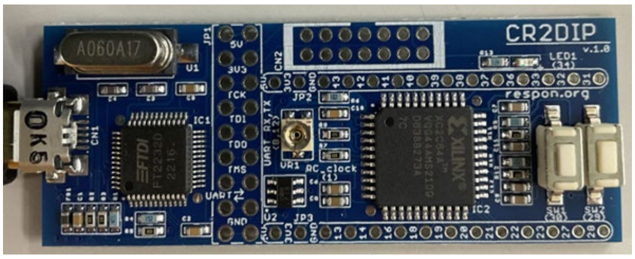

Fig. 2 The CPLD used in this research

2.2 Enhancement of POV display

This research will improve and enhance the display based on the completed display in our research lab. The POV display was fabricated according to the structure shown in Figure 3. And the display performance as shown in Figure. 4 was successfully obtained. The LED tape used in the past is WS2812B, which could send data at speeds of 800Kbps, while the LED tape SK9822 that will be used this time has a maximum frequency of 30 MHz serial data input.

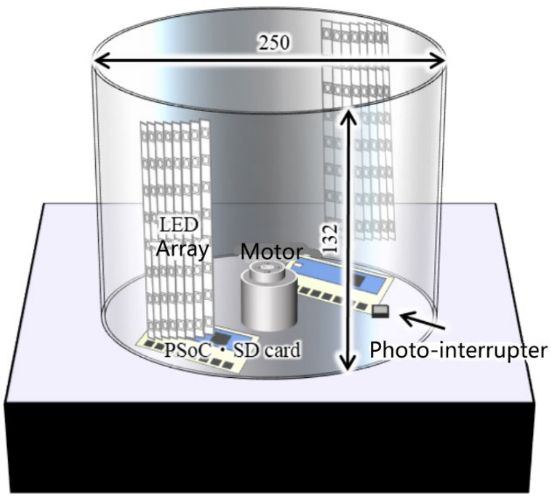

Fig. 3 Structure of POV Display

The POV display in this research is cylindrical in shape and can rotate at high speed because a motor is fixed to a wooden box, which is the base, and the shaft (axis of rotation) of the motor is attached to the center of a circle on a cylindrical acrylic plate.

The motor used was Nidec's 42F704Q780. Two sets of LED tapes (SK9822) with eight vertical and horizontal rows of LEDs are attached to the sides of the acrylic board so that they face away from the display, thus realizing a display with two two-dimensional LED arrays. The LEDs are controlled by PSoC 5LP Prototyping Kit, a micro-controller product with relatively low weight and cost, making it a good match for this display. On the other hand, the rotation angle of the LEDs is detected by the BPR-105F photo reflector.

Fig. 4 Image of POV Display

3 Results

3.1 Current stage results of POV Display

We have completed the hardware part of the POV display as shown in Figure 5.

Fig. 5 Current Hardware Part

Its structure is shown in Figure 6. After that, we will carry out the software part to reach the control of the LED strip, match and adjust the rotation of the hardware part.

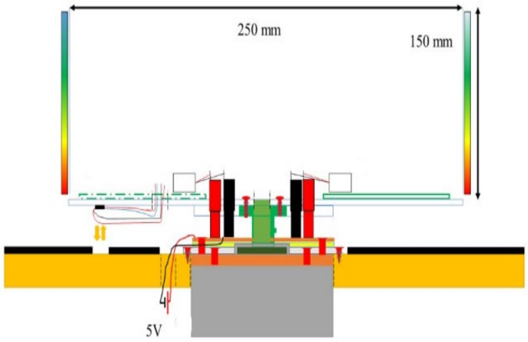

Fig. 6 Structure Overview

References

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