Implementation of Intelligent LED Lighting Fixture

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Abstract

In this paper, we try to develop an intelligent LED lighting fixture system. Control the illumination output of each LED light module of the LED light module array.
To meet the user's lighting needs, but will not waste power to lighting the area has been bright enough, to meet the energy-saving and provide the entire indoor design requirements of adequate illumination.

Keywords: Intelligent LED lighting fixture system, lighting needs, energy-saving.

1. Introduction

LED has the characteristics of light weight, low power consumption, fast response, etc., so it is regarded as an emerging lighting source, an important green energy technology industry. However, the most commonly used fluorescent lamps still have considerable market advantages. Therefore, to compete with fluorescent lamps, it is necessary to improve the overall efficiency of LED lighting systems. Therefore, it is necessary to integrate intelligent lighting systems to make LED lighting systems competitive.

LEDs are different from fluorescent lamps. Even one LED can continuously adjust the light output in multiple stages or even without stages. Therefore, we propose energy-saving LED lighting fixtures that have completely different design concepts from other energy-saving LED lighting fixtures. Using new ideas and new circuit designs, the overall lighting conditions of a room can automatically meet the needs of users.

It will not waste electricity to illuminate a sufficiently bright area, and save energy-conservation lighting system that provides sufficient illumination throughout the room.

When I set a lighting place as for the general public, and assume that there is a window in one or more sides of this room to daylight on a sunny day. Because there is daylight outside the window, it is close to the area where the window has better ray, and the light is sufficient, and no light or only a small amount of auxiliary lighting is needed; areas without windows may require more lighting. Although some areas are too dim if the lights are not turned on, energy is wasted in some areas when the all lights are turned on. The regulations also stipulate that the lamps in different areas must be able to control the switches separately. i.e., we can turn on the lights in some areas and turn off the lights in some areas to save energy.

2. System Diagram

Figure 1 shows the system structure diagram of smart LED lamps for self-made productions. It consists of a microcontroller, sensors, and an LED light modules.

The controlled LED light module is sixteen modules. Because one HT32F1765 microcontroller only has 8 PWM outputs, it could have been done using two HT32F1765 microcontrollers. We are concerned that if the lamp module is to be added, the wiring will become complicated. We changed to a new idea and design and set sixteen light modules into a four by four array. Eight pulse-width-modulation signals are divided into two groups, one group of four, which control the horizontal axis (x-axis) and vertical axis (y-axis). The signals are synthesized through the mixer circuit to control the output of each LED light module of the LED light module array, so a total of sixteen LED light modules can be controlled by four by four.

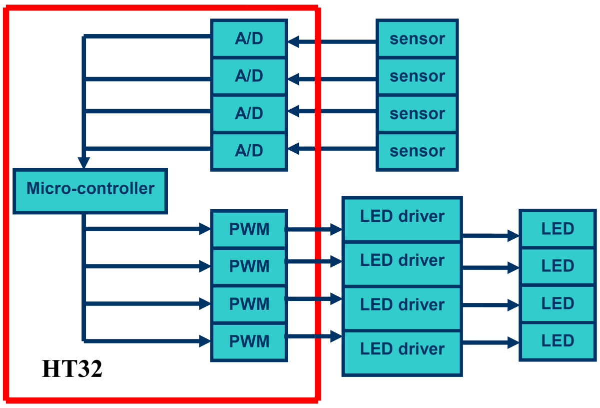

Figure 1. Schematic diagram of smart greenhouse system

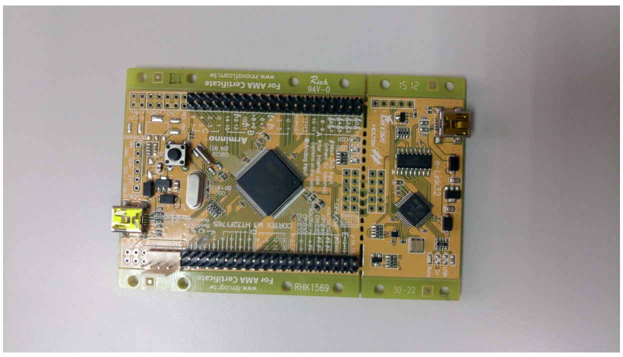

Figure 2. Photo of HT32F1765 experiment board

3. Hardware Equipment

Our intelligent LED lamps are mainly composed of a microcontroller, sensors, and LED lamp modules.

3.1. HT32 F1765 Microcontroller

The HT32F1765 Starter Kit provides a standard C language program development environment for Keil μVision, IAR EWARM, and CooCox CoIDE. On this base, Holtek provides a complete function library. The function library can save the user from the complicated low-level function development and help the user focus on the final application design. Users only need to connect the built-in debugging interface (SWD Debugger) and the PC-side IDE via a USB cable to download code and real-time debugging functions. Figure 2 shows a photo of the HT32F1765 experimental board.

3.2. Driving circuit

In our smart LED luminaries, the LED lamp module uses DC 12V power supply, which is controlled by the driving circuit. Figure 3 shows a photo of the driving circuit.

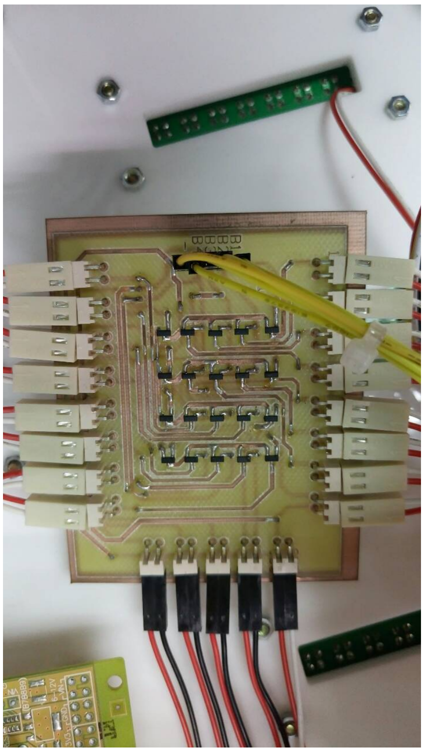

Figure 3. Photo of the driving circuit

4. Production Results

Figure 4 shows the photo of the LED module. The LED is eagle-eye LED. Eagle-eye LED has 4 pins, ordinary 5mm LED only has 2 pins. There is a certain distance between the light emitting part of the 4 pins and the soldering place of the circuit board. The design of 4 pins and the spacing is to make eagle-eye LED's heat dissipation much better than ordinary LED. The operating current that can be passed is larger than ordinary LED. The maximum current can be 40-50mA. The ordinary LED is 20mA. It is brighter than the ordinary LED.

Eagle-eye LEDs are getting more and more attention because they dissipate heat better than ordinary LEDs with a diameter of 5mm. Eagle-eye LEDs have a large viewing angle, low light attenuation, and a long life. It is suitable for making line lamps, light boxes with backlights, and light sources in large font slots. Because line lights are generally used as the outline lights of high-rise buildings in cities, and the backlit light box advertising screens and large font lights are placed high. If the LED light is off or dimmed, its repair is very difficult. Due to the good heat dissipation of the eagle-eye LED, compared with the ordinary LED of 5mm, its light attenuation is small and its life is long. Therefore, the use time will also be long, which can save considerable maintenance costs.

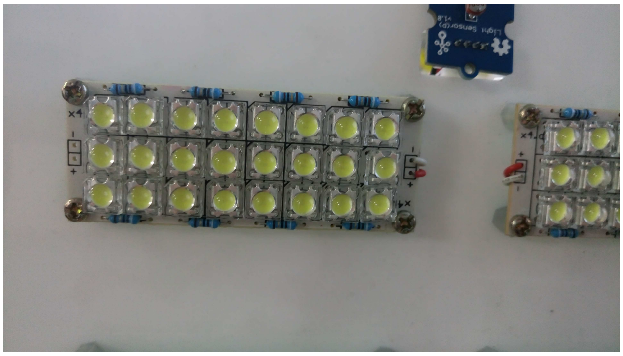

Figure 4. Photo of LED modules

Figure 5. Photo of light sensor

Figure 5 shows a physical diagram of the light sensor. The photo resistor is simply called photocell, and it is widely used in low-cost photo sensors. For example, photometers, fire and smoke alarms, burglar alarms, industrial control circuits, and automatic switches for lamps.

The resistance of the photo-resistor is affected by the intensity of the light. As the intensity of the incident light increases, the resistance value decreases. With this feature, it can be used as a component of a light detector.

5. Production Architecture And Execution Results

We use multiple sets of light sensors to sense the overall indoor lighting situation, and the output of each light module for the controller.

If it is too bright, reduce the light output of the lamp module, and if it is too dark, increase the light output of the lamp module.

Save energy by reducing unnecessary light output while ensuring adequate lighting is provided.

Shown in Figure 6, suppose there is a window on the right side of a room, and under sunlight (red line), the right, left, bottom, and top of the room are measured by four light sensor circuits: sensor 1, sensor 2, sensor 3, and sensor 4.

The control circuit compares the values measured by the four photo-sensing circuits. The lower right area is the brightest and the upper left area is the darkest, so control the relative maximum brightness of the upper left LED array output.

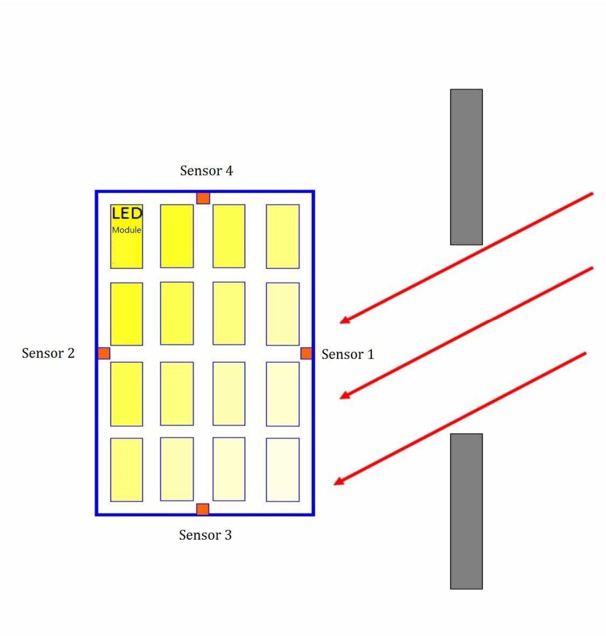

Figure 6. The Schematic diagram of the system lighting variation 1 during simulating sunlight

Here, we use the color shade of the diagram to indicate that different light shades can control the brightness of each LED light module. The lower right LED array outputs relatively minimum brightness, and the upper right and lower left LED arrays output relatively medium brightness (but not the same) according to conditions.

The so-called relatively maximum, relatively minimum, and relatively medium brightness refers to the difference in light output brightness depending on the location.

The brightness of the light output is determined by the sensed light intensity. When the external light intensity is strong, the overall LED light output is reduced, and when the external light is weak, the overall LED light output is increased. Figure 6 shows the schematic diagram of the system lighting variation 1 during simulating sunlight.

Shown in Figure 7, when the sunshine changes (such as morning to afternoon), the upper right area is the brightest and the lower left area is the darkest.

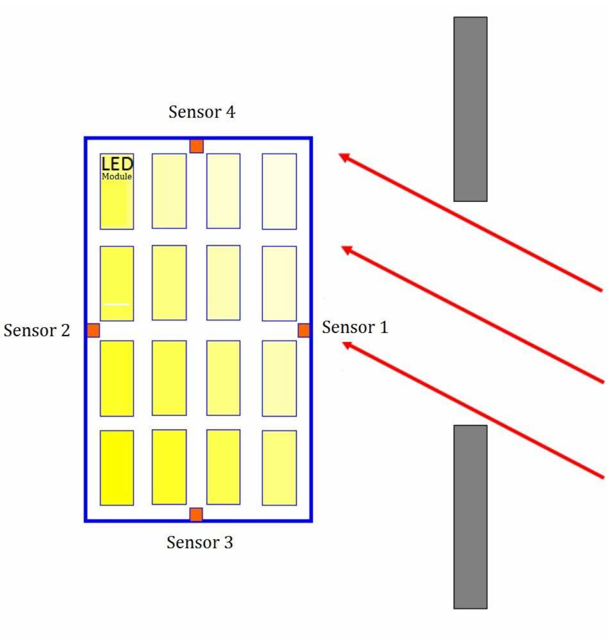

Figure 7. The Schematic diagram of the system lighting variation 2 during simulating sunlight

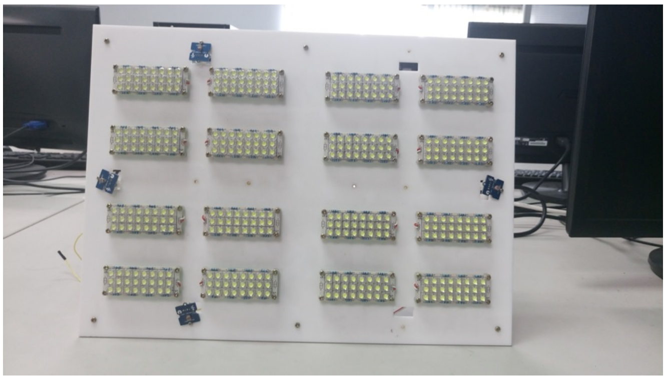

Figure 8. The front view of a smart LED lamp composed of an LED module and a light sensor

The lower left LED array outputs relatively maximum brightness, the upper right LED array outputs relatively minimum brightness, and the lower right and upper left LED arrays output relatively medium brightness according to conditions. Figure 7 shows the schematic diagram of the system lighting variation 2 during simulating sunlight. Figure 8 shows the front view of a smart LED lamp composed of LED modules and light sensors. When there is a difference in illuminance in a single direction in the horizontal or vertical direction, the difference is shown in Figure 9, Figure 10, Figure 11, and Figure. 12.

Figure 9 shows a photo of the lighting variation of the upper sensor shielding system. It can be clearly seen from the photo that when the upper part is darker, the upper part of the lamp is brighter. That is, the system can work normally when the upper part is dark.

Figure 9. The photo of the lighting variation of the upper sensor shielding system

Figure 10 shows a photograph of the lighting variation of the shielding system of the right sensor. It can be clearly seen from the photo that when the right side is darker, the right side lamp is brighter. That is, the system can work normally when the right side is dark.

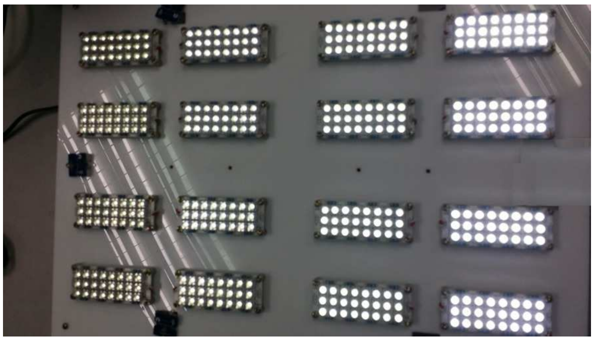

Figure 10. The photograph of the lighting variation of the shielding system of the right sensor

Figure 10 shows a photograph of the lighting variation of the shielding system of the right sensor. It can be clearly seen from the photo that when the right side is darker, the right side lamp is brighter. That is, the system can work normally when the right side is dark.

Figure 11 shows a photograph of the lighting variation of the lower sensor shielding system. It can be clearly seen from the photo that when the lower part is darker, the lower part of the lamp is brighter. That is, the system can work normally when the lower part is dark.

Figure 11. The photograph of the lighting variation of the lower sensor shielding system

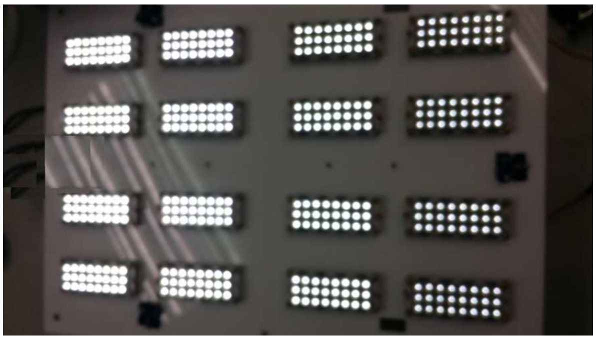

Figure 12. The photograph of the lighting variation of the left sensor shielding system

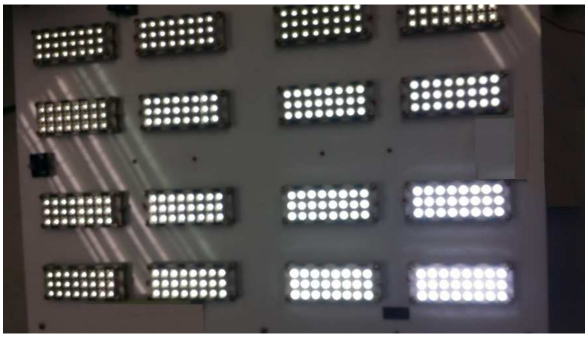

Figure 13. The photograph of the lighting variation of the lower and right sensors

It can be clearly seen from the photo that when the left side is darker, the left side light is brighter. That is, the system can work normally when the left side is dark.

When there are differences in illuminance in the horizontal and vertical directions, the differences are shown in Figure 13, Figure 14, Figure 15, and Figure 16.

Figure 13 shows a photograph of lighting variation of the shielding system of the lower and right sensors. It can be clearly seen from the photo that when the lower and right sides are darker, the lower and right lamps are brighter. That is, the system can work normally when the lower and right part is dark.

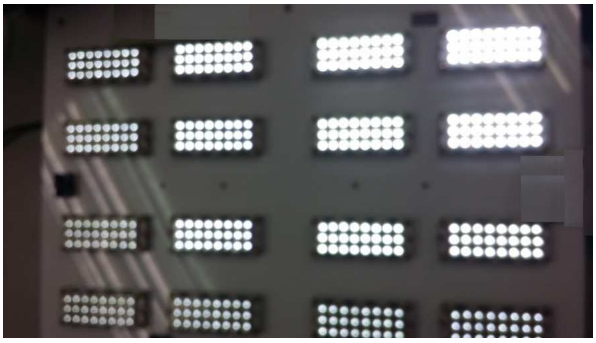

Figure 14. The photo of the lighting variation of the shielding system of the upper and right sensors

Figure 14 shows a photograph of lighting variation of the shielding system of the upper and right sensors. It can be clearly seen from the photos that when the upper and right sides are darker, the upper and right lamps are brighter. That is, the system can work normally when the upper and right part is dark.

Figure 15 shows a photograph of the lighting variation of the shielding system of the lower and left sensors. It can be clearly seen from the photos that when the lower and left sides are darker, the lower and left lamps are brighter.

That is, the system can work normally when the lower and left sides are dark.

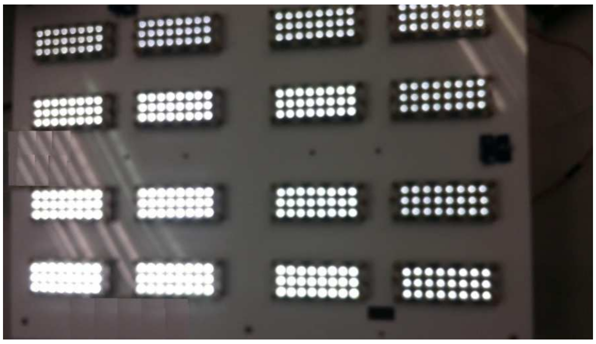

Figure 15. The photograph of the lighting variation of the shielding system of the lower and left sensors

Figure 16 shows a photograph of lighting variation of the shielding system of the upper and left sensors. It can be clearly seen from the photos that when upper and left sides are darker, the upper and left lamps are brighter.

That is, the system can work normally when the lower and left sides are dark.

Figure 16. The photograph of the lighting variation of the shielding system of the upper and left sensors

6. Conclusion

Depend on the actual lighting conditions of the whole room, our LED luminaires can effectively control the lighting output of each LED light module of the LED light module array. Enhancing the lack of lighting, reduce the light output to where there is enough lighting.

It meets not only the lighting requirements set by users without wasting electricity to illuminate areas that are bright enough, but also meets the need for energy saving while providing sufficient illumination throughout the room.

Acknowledgements

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