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Development of Wireless RGB LED Dimming Control Technology Using Smart Phone

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Abstract:

Abstract—In this paper, a LED lighting control system based on the Bluetooth wireless network is proposed. The presented system includes a RGB LED light bar, a lighting control APP for smart phones and a Bluetooth communication module for remote control. The hardware and software design will be presented in detail. The experimental results show that smart phone is a good candidate for home lighting control applications. Moreover, smart phone APPs enable easy connection; therefore offers advantages include product interoperability, vendor independence, and accessibility to broader markets.

Keywords:

light emitting diodes (LEDs), Bluetooth, Android.

I. INTRODUCTION:

In recent years, the exhaustion of fossil fuel and the issue of climate change have attracted public attention on energy conservation and environment protection. Governments and professional associations have successively regulated the specification for "green" products and generated the certificate mechanism. As energy consumption on lighting rises continuously, lighting equipment which is environmental friendly and possesses high energy efficiency becomes popular. Energy and cost can then be saved through the enhancement of lighting efficiency. Among all the lighting products, Light Emitting Diode (LED) is one of most promising light sources since LED provides several unique strengths including small size, directional light emission, cold temperature operation, and controllability.

With the development of related technologies, LED now can be widely applied on various areas. Applications from household appliance to indoor lighting are common in the daily life. Furthermore, the smart phones and tablets have ushered in a new lifestyle for people. Many control systems have been developed and integrated with applications (APPs) of smart phones and tablets. Users can download the APP and then remotely control the household appliance, which is very different from traditional ways. In this paper, a LED lighting control system based on the Bluetooth wireless network is proposed. Fig.1 shows the system diagram. Through the connection between Bluetooth in the smart phone and the Bluetooth module, signal and command are transmitted wirelessly. Users can control the brightness and colors of LEDs by APP on Android system. Integrated with microcontroller, a wireless RGB LED dimming control system is also implemented.

Fig. 1. System diagram

II. APP DESIGN:

Fig. 2 shows the APP on the smart phone. When APP starts, the equipment will automatically detect whether the Bluetooth is available. Then a dialog box will pop up to ask for turning on the Bluetooth. Otherwise, the APP will close.

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Fig. 2 APP on the smart phone

The control bar for RGB brightness cannot work if the Bluetooth module is not connected to the smart phone. In Fig. 3(a), when clicking the "CONNECTION" button, the list will show all the equipment that has been connected and the equipment that has been found. Next, select the Bluetooth module to connect to. The information and the status will be shown next to the main title and all the control bars will be enabled as shown in Fig. 3(b).

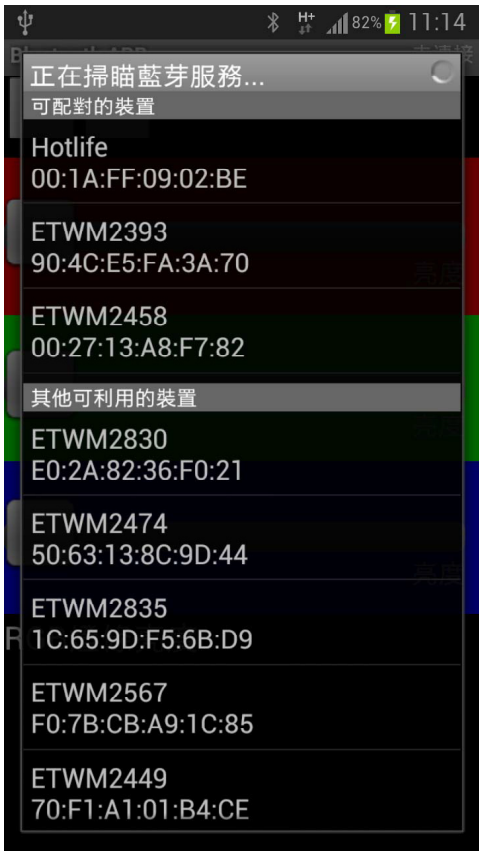


Fig. 3 (a) Bluetooth device list

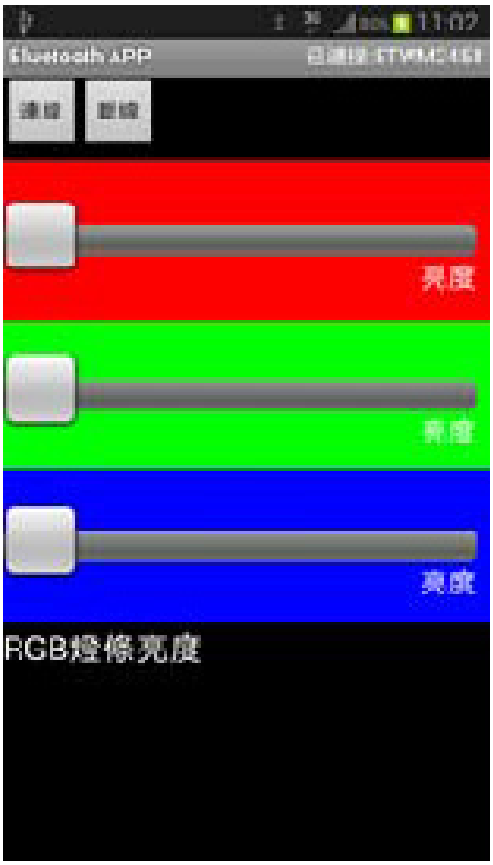
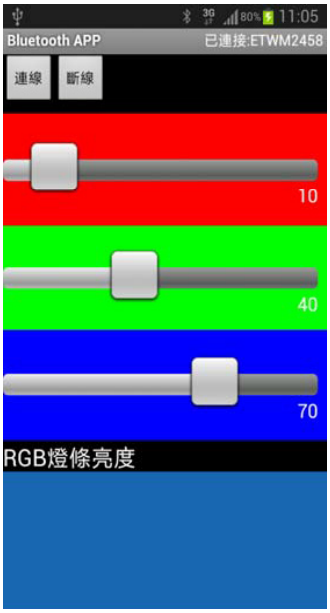


Fig. 3 (b) Connection established

After connecting to Bluetooth, users can slide the control bar to adjust the brightness of RGB LEDs. Fig. 4 shows the operation scene of APP and the circuits for dimming command 10% red, 40% green and 70% blue.



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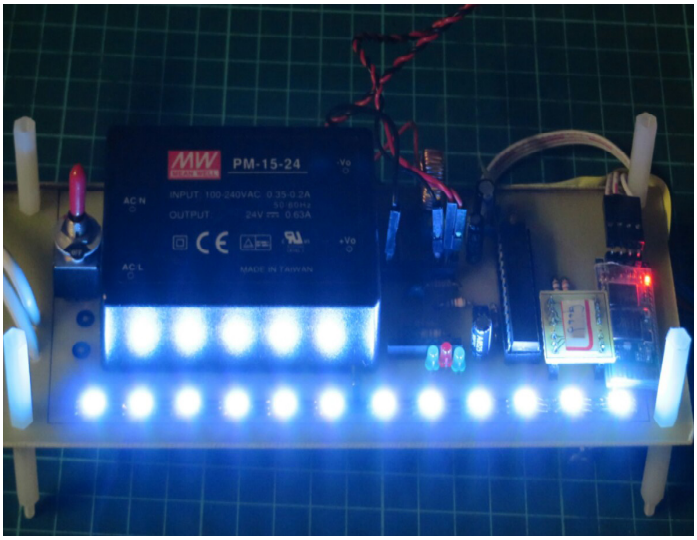
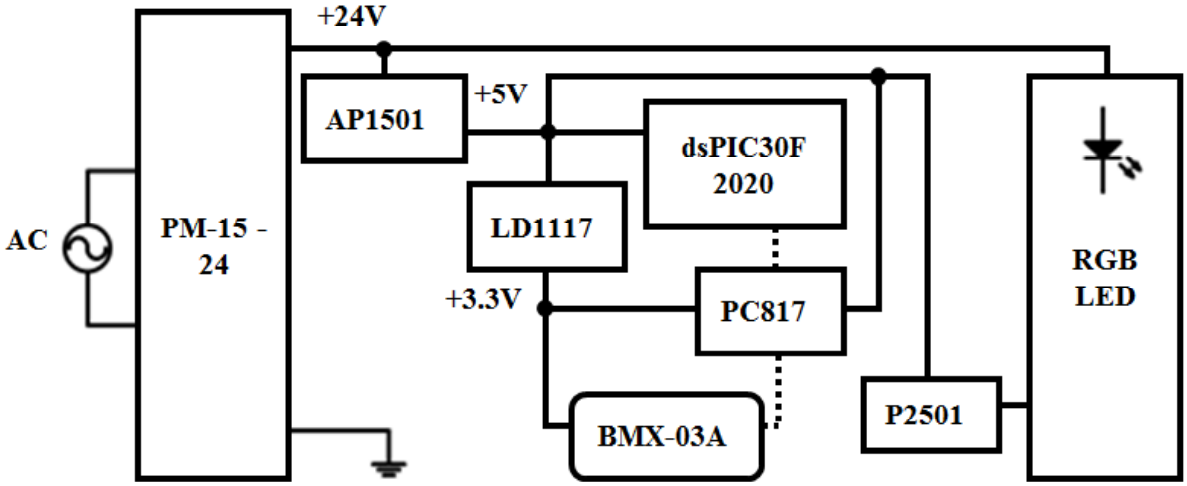


Fig. 4 The operation scene of APP and the circuit

III. HARDWARE CONFIGURATION:

The block diagram of the proposed system is illustrated in Fig. 5. Since the input voltage is 110VAC, a power supply module PM-15-24 is used to step down to 24VDC to provide driving voltage to LED. Then, IC AP1501 is utilized to further step down the voltage to 5V for supplying microcontroller and IC P2501. Also, IC LD1117 provides 3.3V to Bluetooth module BMX-03A. Photocoupler PC817 is employed to adjust the voltage level, which therefore can avoid the error during data transmission since the operating voltage of microcontroller and Bluetooth module is different.



In this study, a low cost digital signal controller (DSC) dsPIC30F2020 from Microchip Corp. is used to provide digital control for the LED dimming. As shown in Fig. 6, timeline comparison method is utilized to realize the dimming control. The dimming command will be compared with timeline and driving the LEDs at a high frequency. The detailed flowchart of LED dimming control is shown in Fig. 7.

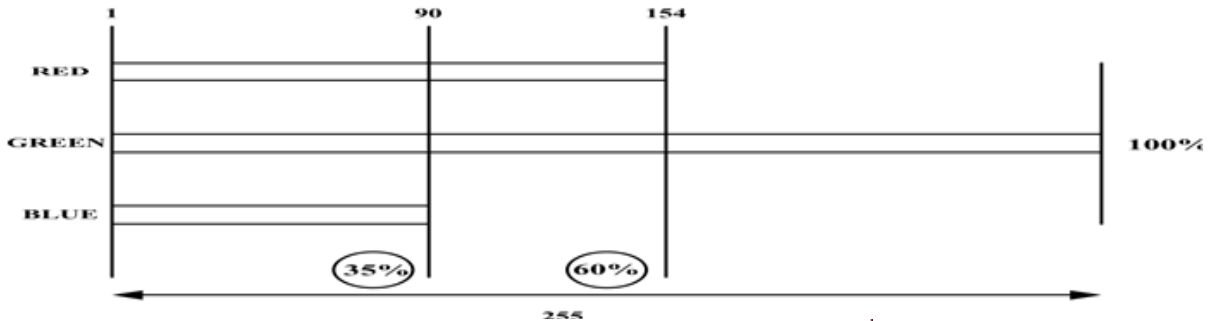


Fig. 6 Dimming control method used in this paper

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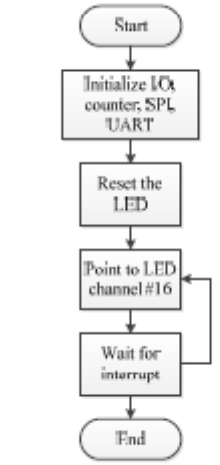
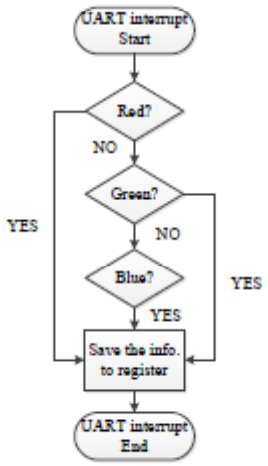
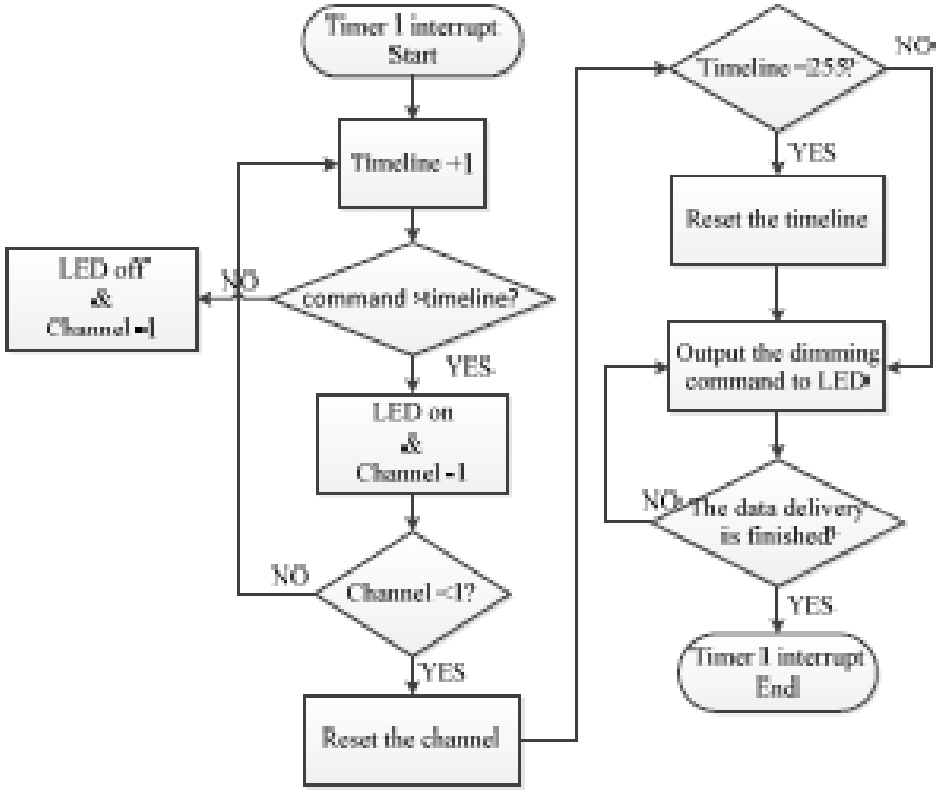


(a) the flowchart of main code



(b) the flowchart of UART interrupt



(c) the flowchart of Timer1 interrupt

Fig. 7 The flowchart of LED dimming control

IV. EXPERIMENTAL RESILTS:

To verify the correctness of the dimming control signal, measured waveforms of the serial-data transmission is shown in Fig. 8. In Fig. 8, channel 1 is the clock signal, channel 2 is the transmitted data, and channel 3 is the acquired signal which is in the format of SPI.

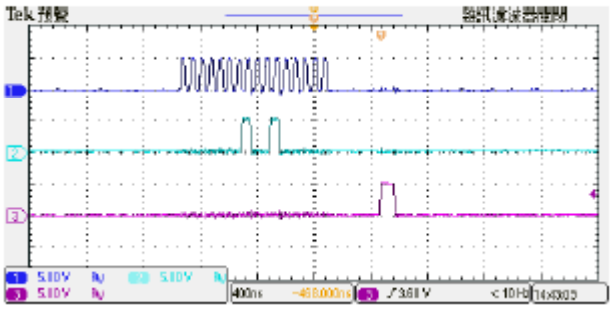
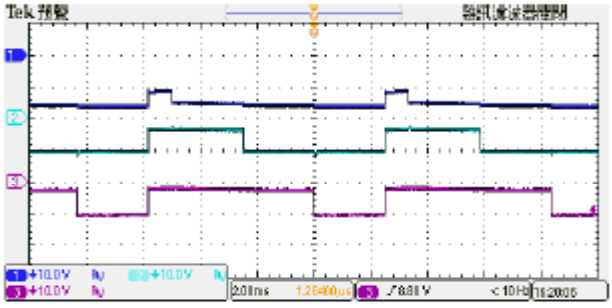


Fig. 8 Waveform of data transmitted and received

Fig. 9 shows the profiles of RGB LED under different duty cycle. In Fig. 9(a), Channel 1 stands for 10% duty cycle of color red, Channel 2 represents 40% duty cycle of color green and Channel 3 is 70% duty cycle of color blue. The picture of the circuit is shown in Fig. 9(b). Fig. 9(c) shows 30%, 30% and 30% duty cycle of red, green and blue respectively and the corresponding picture is Fig. 9(d). Fig. 9(e) shows 90%, 60% and 5% duty cycle of red, green and blue respectively. The picture of the circuit is shown in Fig. 9(f).



(a) Waveform of RGB duty cycle (R=10%, G=40%, B=70%)

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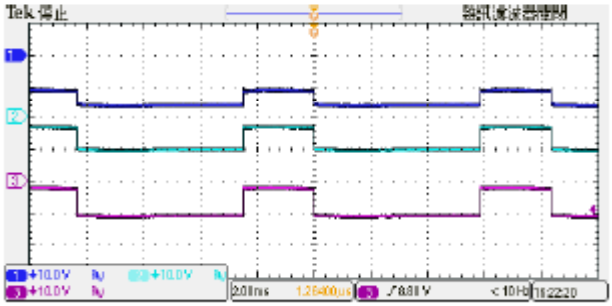
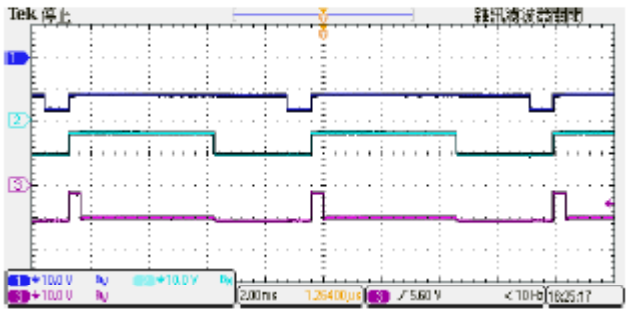
(b) Picture of the proposed system (R=10%, G=40%, B=70%)



(c) Waveform of RGB duty cycle (R=30%, G=30%, B=30%)

(d) Picture of the proposed system (R=30%, G=30%, B=30%)



(e) Waveform of RGB duty cycle (R=90%, G=60%, B=5%)

(f) Picture of the proposed system (R=90%, G=60%, B=5%)

Fig. 9 Measurement results & pictures of the circuit under different cases.

V. CONCLUSION:

In this paper, a wireless RGB LED dimming control system based on Android operating system is realized. With the connection of Bluetooth, users can control the brightness and colors of LED lights by Android smart phones or tablets. According to the experimental results, the command from the smart phone is transmitted to RGB LED light bars and the LED light bar can illuminate correctly.

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