Research on Key Technologies of Electroluminescent Costumes' Application

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ABSTRACT: In team gymnastics performances, the existing manual control method leads to poverty of synchronization and precision. Therefore, the concept of moving pixels is presented. The wireless group control system is completed including system protocol formulation, software design and hardware manufacture. Test results show that the system can satisfy the certain scale group performance requirements and improve performance effect.

KEYWORDS: luminous clothing; moving pixel; wireless control

1 INTRODUCTION

As a new performance clothing, luminous clothing have been successfully used in various domestic and international performance activities, such as the opening ceremony Beijing Olympic Games in 2008, United States Super Bowl's (Super Bowl, the American National Football League's championship game) halftime show in 2011, Large-scale live performance "Impression • Third Sister Liu" and so on, luminous clothing in these activities leave a deep impression to the people. Luminous clothing have bright colors, glittering in the dark, under the coordination of the music, through the actors' reasonable movement and control, resulting in brilliant, fantastic and stunning scene effect. There are a variety of application forms for luminous clothing in performances. For example, In terms of the number of the people, there is a single person solo, multiplayer (several to several tens) together dance, everyone (hundreds to several thousand) Dances; in terms of performance place, it can be small space like bars or theater, but also large space like stadium, stadiums or squares; In terms of watching forms, it can be divided into living show and filmography on the television; in terms of the function in the action, actors wearing the luminous clothing can be the body or the background of the performance. The different using forms lead to the different luminous clothing in designing, producing, using and controlling. The above mentioned several successful applications are all large open-air performances, with large performing site area, large apace and so many actors, such as the 2008 Beijing Olympic Games opening ceremony countdown show, as shown in Figure 1, More than 2,000 actors perform in the nearly ten thousand square meters of space. For this kind of performance character. In this paper, we'll research key technologies of luminous clothing used in large-scale performance characteristic.
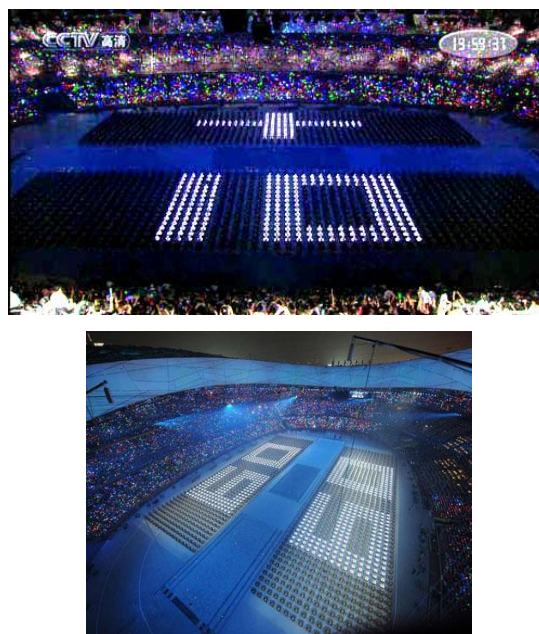

Figure 1. 2008 Beijing Olympic Games opening ceremony countdown show

When spectators watch group calisthenics performances in stadiums, they can see the whole scene, but each dancer will not occupy the main part of its vision. Thus, each of the dancer may be considered of a pixel in the overall, and the pixel is independent and can move. So, you can regard each

dancer dressed in luminous clothing a moving pixel (below referred to as: moving pixels). Prior to the performance process, several dancers wearing luminous clothing use switches and buttons to control the light-emitting device turning on and turning off, to achieving luminous formations conversion or graphics transformation. Long training period, poor, converting synchronous, and difficult to achieve dynamic graphics. So, how to control a plurality of movable pixels, to achieve unity and rapid transformation effect , making luminous props or costume switching more accurate, efficient, structuring sophisticated and dynamic light-emitting pattern, creating a visual expression of the mood. This paper presents a solution designed to achieve a model system.

2 LIGHT-EMITTING DEVICES AND LIGHT-EMITTING CLOTHING PROFILE

2.1 *The common light emitting device*

A light emitting diode (abbreviated as LED) is a kind of commonly used light-emitting devices. The diameter of LED is usually 5mm or 3mm, SMD LED's size is smaller than it. LED's color is various, and there is a color LED, the single LED device is configured on red, green, and blue LED, can be adjusted separately by the current flowing through each LED and change the color or brightness of the LED light.

Electroluminescent light (abbreviated as EL wire) is another common light-emitting devices. EL wire diameter of between 0.8-5mm. EL ends of the adjustment value or frequency of the AC line voltage, can change the intensity of EL light emission line, but the line is not easy to change the color of EL. EL wire can emit green, red, blue, purple, white and other colors of light. Compared with the LED, the light brightness of the EL line weak.

2.2 *luminous costumes*

Luminous apparel design and production related to how the various types of electronic devices, light-emitting devices with traditional textile materials together organically problem. For example, in the conventional light-emitting material added to the clothing, in a reasonable manner with the light emitting device with an organic luminescent clothing accessories constituted. Since the luminous ornaments are connected by wires, are found in various parts of the body, so when the fixed wire should first pay attention to wear and does not affect the movement, taking into account the hidden, so as not to affect the appearance. In the light-emitting apparel design, because the proportion of light-emitting devices are generally larger than the

traditional clothing materials, excessive light emitting devices or electronic devices fixed on the fabric surface makes fabric deformation, so that the weight clothing is greatly increased. If the fabric has a locally installed linking devices overweight can cause deformation of the fabric, affecting the function of dress and appearance. LED devices are rigid, EL, or LED light wire with flexible device is part. These devices are not suitable for installation in the clothing of the joints or abdomen position, because with the wearer's movement, make clothing and light-emitting devices by force, thereby limiting the body's movement or force the device, folded or forced deformation, resulting in life shorten or even damaged.

In large-scale performance in a more holistic performance results, just as the overall effect of a single actor in a point, can be seen in a screen pixel, so luminous apparel, clothing commonly used surface-emitting effect, use a person as a light point to control. When only monochromatic light and destroy two effects, it is possible according to the time by actor nodes manual control switch on and off to achieve. In order to enrich the performance results, it is sometimes necessary emission color, brightness control, thus constituting a static graphics, characters, or even need to generate dynamic fast transform images, which are difficult to complete manual control.

3 DESIGN OF WIRELESS CONTROL SYSTEM CAPABLE OF MOVING PIXELS

The connotation of the modern large-scale group gymnastics concept is that the show which can express certain large style theme with the performing subject by the tens of thousands of performers in large field (Museum) done in the various forms of sports, literature and literary style performance and the performance form of formation transform and blew the majestic pattern modeling, With music, clothing, props, backgrounds, scene (stage) and high-tech art decorative lights. In this kind of performance, using the light clothing need to change all moving pixels on-off state, emitting light colors, brightness etc, that can't be completed by the dancers themselves. This paper proposes to use the wireless network control technology to complete the wireless control of mobile pixels, the structure of the control system is shown in Figure 2, consisting of a base station and a plurality of movable pixels. The hardware of the base station can be micro- computer with a wireless communication module, which can also be with wireless communication module of portable embedded base station unit based on ARM. Each moving pixel includes a control unit, a wireless communication unit and light emitting device[1].
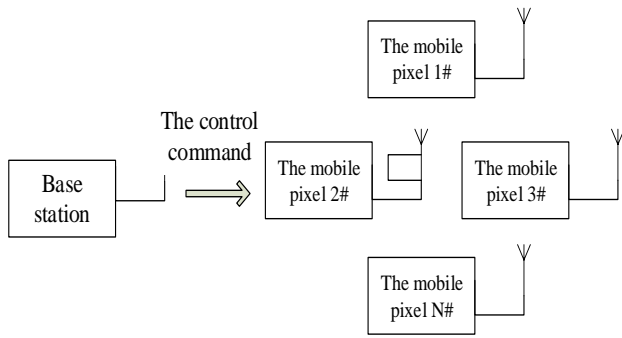
Figure 2 mobile pixel wireless control system structure

3.1 *The hardware design of the control unit*

The basic function of the control unit mainly includes: (1) The real-time receiving control message the base station sends ;(2) The parsing instructions, in accordance with the instructions to control the light emitting device open, shutdown, discoloration, shiny or adjust the brightness;(3) Press the specific function key, can locally control light emitting device action to work artificially; (4) Equipped with touch or vibration sensor, and can upload the related information to the base station[3]. The control unit hardware is composed of the following 4 modules:(1)SCM module;(2)The power management module; (3)The power drive module; (4)The wireless communication module. As shown in Figure 3.
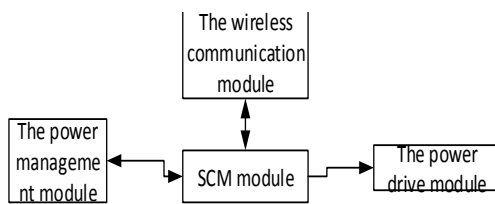

Figure 3 control unit function block diagram

SCM module is the core module of the control unit. The module should be equipped with single chip, crystal oscillator circuit, on-off circuit. In practical application, the selection of single chip should be according to the software needed and the data storage space, input and output interface and the number of uses, and the calculation load. For example, brightness adjustment often uses PWM (pulse width modulation) mode, if the microcontroller computing load is not high, you can use the software simulation method to solve; Otherwise, we need to select the single chip that is equipped with the 3-6 channel PWM out-put interface, which can reduce the computational load of microprocessor[4].

There are many kinds of wireless communication module, wireless transceiver chip decides the technology characteristics of the module. Table 1 summarizes several common wireless communication chip characteristics, Need to choose wireless communication module according to the

actual needs. Measurement results show that, in the communication distance, module SRWF is better than other wireless communication module table. After comprehensive comparison, choosing the SRWF wireless communication module for mobile pixels, that the maximum rate of communication is 19200bits/s, and which has the same chip serial standard interface standards and can be directly connected to a microcomputer. Also, the programming is convenient, which can make the software programming work be simplified to a certain degree. But the main drawback of this scheme is the communication rate high enough[5].

Table 1. Technical characteristics of several common wireless transceiver module [2-3]

The RF module	Interface	RF communication rate	The communication distance
nRF2401	SPI	1Mbps(ShockBurst method)	<100m
CC2430	SPI	250Kbps	<100m
SRWF	Standard serial port	19200 bits/s	800m

Figure 4 is a basic LED drive circuit. For small common LED, Forward current should be less than 25 mA, the N drive current is a branch of each LED forward current total. The principles of selecting the general power triode is that the rated current is 3-4 times bigger than the total of driving current.
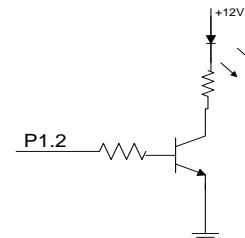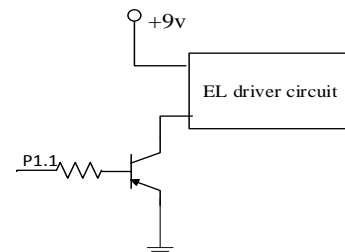

Figure 4 The basic LED drive circuit

Figure 5 EL line driver circuit

Figure 5 is a typical EL wire drive unit. EL drive unit of DC side series between power are end and power transistor of set electrode, dang in base very plus high level, can makes transistor in saturated guide pass state, will to EL drive unit plus electric, in this State Xia, drive unit put DC voltage inverse

into low exchange voltage, by transformer boost into effective value about between 110 and 250V exchange high-pressure, frequency about for 2000HZ, drive EL line. EL driver unit size larger, consisting mainly of oscillating circuit and transformer. The drive unit powered on instantly, self-excited oscillation of the oscillation circuit, a brief time oscillator can be in a State of stable oscillation, which light up EL.

3.2 *The software design of the control unit*

The main functions of the control unit software are: receive the message control commands by interrupt, extract control commands, according to the instructions to turn off or light the LED. The software includes the following 6 modules: (1) Initializing module; (2) The Main Control module; (3) Serial Communication module; (4) Timer Interrupt module; (5) LED Driver module; (6) Self-test module. Now these is the introduction about basic functions, parameters, and calling methods:

(1) Initializing module: used to initially set the timer, interrupt the program parameters, input and output ports, and the corresponding control registers;

(2) The Main Control module: in normal working conditions, according to instructions received, call the LED driver modules, according to the native keyboard instructions switch to different modes, such as switching to self-test mode;

(3) Serial communication module: to interrupt the message receiving control commands, distinguish between messages, control instructions, and the tail to the head. According to the number of the control unit, filter out control commands that should be executed in this unit. When the right to receive the tail when you check code, you will receive instruction transfers control to the corresponding storage unit, and notify the main program;

(4) Timer interrupt module: adjust the PWM parameters;

(5) LED Control module: contains several LED control subroutine, for example: light, off, Flash, slow Flash, gradually becoming out bright, etc. In practice usually extracted from the control command

message in this module control directives, corresponding LED according to the instructions call the subroutine.

Self-test module: pressed post button, switches to the self-test State of the main program, calls self-test modules, test each LED pattern changes as required, and then self-test key to return to normal status, namely wireless control status.

3.3 *Design of wireless control protocol*

Wireless Control Protocol is used to coordinate communication between base stations and mobile pixel rate, message format, such as entry and exit mechanisms and responses. As mentioned earlier, the choice of wireless communication module can receive or send data packets, due to the characteristics of the wireless Group controlled exchange of data the main part of the base station to Mobile Pix message sends control commands. If you want, but also from mobile pixel upload messages to the base station. Here, the main broadcast in wireless communication, these relatively high transmission efficiency of communication, but the occasional error led light emitting unit malfunction.

Base station to mobile pixel control commands that are sent messages, as shown in table 2. In the message header includes the current total number of pixels that can be moved, message number, respectively, represented by 2 bytes. Body of the message is n bytes of control command, where n is the total number of pixels that can be moved, each piece of control orders is 1 byte, single control directive format as shown in table 3. 5-bit control instruction, 3-color LED turn on or shut off control bit, data bits for '1' that open, contrary to turn-off. Control message including 2 byte checksum word. Therefore, the control command packets totaling N+6 bytes. When the baud rate 19200bits/s, update the time frame can be calculated: $T_f = \frac{(N+6) \times 10}{19200}$.

When N=256, $T_f \approx 0.136458$ s, Updated 7.3 times per second.

Table 2. Message sent by the base station to the light emitting element control directive format

The head of the message (4 bytes)		1#control command	....	N#control command	Check code
The total number for pixels (2 bytes)	The message Number (2 bytes)	1 byte	....	1 byte	The tail of the message (2 bytes)

Table 3. A single control instruction format

The instruction part	red LED	green LED	blue LED
5 bits	1 bit	1 bit	1 bit

3.4 *System test*

According to the design, production model with a wireless control system 256 can move pixels, the base station is implemented by connecting a PC through the serial port transceiver modules, each movable pixel geometry for 250X250X120 (mm), according to the design layout formation, swing placed in a large space, as shown in Figure 6. Also by multiple performers handheld, complete the scheduled group calisthenics formations[2]. Powered by a rechargeable battery, under adequate conditions, you can use 3-5 hours. By the base station transmit pre-command editor of 256 can be controlled to move pixels to achieve a static luminous characters (such as "Beijing") control, and dynamic change control (such as Tetris dynamic presentation, trim scanning, pixel tracking, etc.)
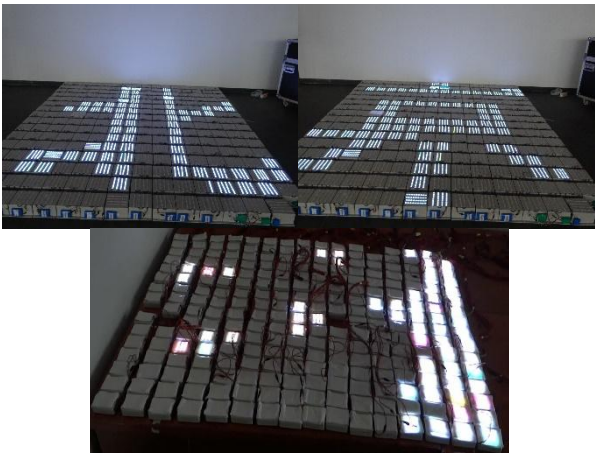

Figure 6. Mobile pixel array

4 CONCLUSION

This paper presents the concept that "mobile pixel", briefly introduces the method of making light clothing design, design and development of mobile pixel wireless control system can be directly used to control light clothing, creating graphics and formation testing done on a system. Reached the regiment gymnastics performing the required results, provides a new method for this kind of performance, can be used for large-scale celebration or gymnastics.

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