Design of Wireless Group Control System Embedded Linux

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Abstract: Group gymnastics combined with the photoelectric technology can show brilliant visual effect. However controlling of the lighting clothing is usually done manually, which greatly increases the complexity of the performance and probability of the error to the performer. This article presents a plan with the control system including a mobile terminal device based on embedded Linux, which collects the nodes' electric quantity information by wireless sensor network and implements the optimization of the detection of electric quantity. And the system will control the lighting modules of all performance clothing on the mobile terminal to compound the dance movements of performers for the implementation of expected theatrics.

Key Words: embedded; Linux; sensor network; wireless group control system

1 Introduction

Group calisthenics performance is not a fresh product in 21st century, early in the last century, group calisthenics had appeared on opening ceremony of many large games. Since 1959, the last session of the national games "National Celebration", which is participated with nearly eight thousand people, group calisthenics performance has become a regular at the opening ceremony of the games. With group calisthenics performance developing, some traditional artistic expression has been difficult to meet the aesthetic of the audience, thus, modern gymnastics performance combined of modern sound and light technology has appeared.

However, the actors themselves play the leading role in this way, also pay attention to the photoelectric effect when performing. It is difficult for them to present a high level show with superior difficulty and shock-containing photovoltaic effect of group calisthenics. In addition, there are some obvious deficiencies need to be improved. Therefore, the light emission control can be provided on a mobile device, actors only need to make a series of actions and movements with the music beats without giving much thought to manually adjust the colors that light emitting clothes presented. That not only reduces the complexity of group calisthenics training, but also can get a better visual effect.

2 Wireless Group Control System

The luster effect of gymnastics performance can be realized of using the lighting modules which contain performing service node. The control taken by mobile terminals is for a number of nodes on all clothes. Therefore, setting a wireless sensor networks which combined of sensors and mobile devices, together with the PC side, a group control system will be formed.

The wireless sensor network has developed to be a distributed network in the past two decades, network end-point is scattered a large number of sensors with powerful functions. As the communication system adopts a wireless communication, building a network has becoming relatively more flexible. In recent years, with the micro-electromechanical systems , wireless communication and low power embedded technology developing, wireless sensor networks achieves a rapid development. The type sensors becomes much more various, such as detecting temperature and humidity, electromagnetic, light intensity, noise and pressure sensors, then , the wireless sensor networks has also been applied in more fields[2]. Wireless sensor network technology now is relatively mature, so using it to build this group control system is an appropriate choice.

According to the actual demand, the final wireless group control system is shown in Figure 1:

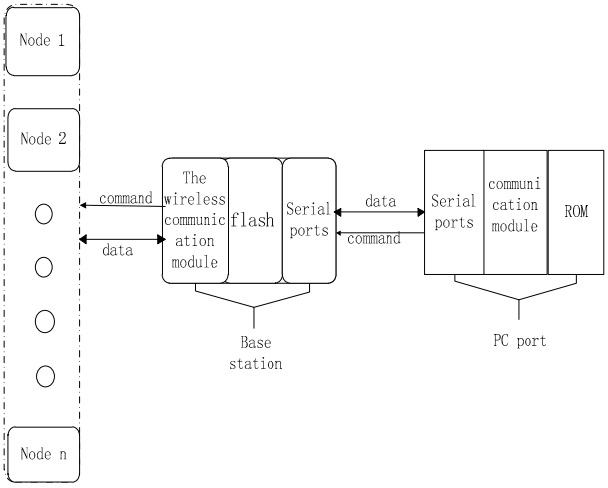

Figure 1 Wireless group control system block diagram

Each node has a wireless communication module with the base station, nodes can collect and upload information to the base station and the base station can also transmit control commands to each node. The collected information will be temporarily stored in the data buffer of the base station, and then upload to the PC through serial communication module, finally store in the PC-side data storage area. PC port will analyze data, generate corresponding processing instructions based on the analysis result, also transmit to the base station through the serial port instructions, finally transmit to the node via the wireless communication module on the base station.

3 Embedded Operation System

In the original vision, we take the mobile terminal as the central role in the whole system clearly, thus one of the problems that how to select a suitable embedded operating system for the device also needs to be considered. Based on the current mainstream embedded operating system , each has its own characteristics and the final choice should be selected by specific needs.

Windows Embedded Compact (Windows CE) is an embedded operating system based on Microsoft Windows 95, and has a good Microsoft graphical user interface. Because Windows CE is not an embedded operating systems to which all hardware platforms are applicable on the same standards, and without open source GUI, so Windows CE more often appears as a customized system, and is not suitable for academic research.

μC/OS(Micro Control Operation System) is RTOS(Real Time Operating System) typical model, which has good cropping and portability and also has basic advantage of the real-time operating system. We select μC/OS , but in this study, we also need to find a friendly and humane graphical user interface, as the disadvantage of μC / OS in graphical user interface is significant. Considering the entire design, if real-time requirements are not strict, the advantage of μC / OS as RTOS also does not work out.

Linux is open source software, there is no black box technology, anyone can modify it or use it to develop their own products[1].Compared the advantages and disadvantages with the latter, linux is a relatively newer Windows operating systems. Advantage of the entire Linux operating system is open source. When the application have been done, it can be very conveniently transplanted to a variety of hardware platforms. Embedded Linux overcomes customization and porting troublesome problem of Windows CE[4]. The disadvantage of it is that it does not have excellent GUI like Windows as the mainstream operating system for many years. And the advantages like running out of memory at this level of study are also not well revealed.

Compared three main advantages and disadvantages of embedded operating systems, we selected embedded Linux operating system as a terminal device finally. Because portability is important to note in the research and development of embedded, we can only give up Windows CE which with not good portability. However, compared to μC/OS GUI fatal flaw, QT is not inferior to the development software existing of Windows on graphical user interface. The shortcomings of an embedded Linux GUI is also up to a large extent compensate [5].

4 Hardware Design

Each garment has a large number of same sensor nodes with light-emitting module. The sensors collect data and send it to the mobile terminal through a wireless sensor network. Then the data will be uploaded to the PC, stored and managed by the PC port. The system generates a corresponding warning and control strategies based on the collected data, sends commands to each node through the network and forms a control circuit. The basic process is shown on Figure 2:

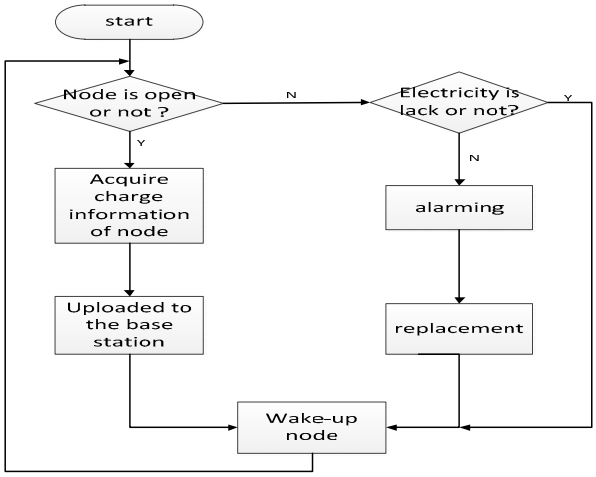

Figure 2 Data acquisition system flow chart

At the start, detecting whether a node is open, if it is not, checking whether the electricity is shortage. Under electricity enough, it is judged sufficiently node is not open for some mishandling, therefore, node can be woken directly. If electricity is lack, system will present a warning signal with the specific node ID information to facilitate artificial replacement of battery. In the case of node open, it will gather information immediately, after the information is transmitted to the mobile terminal via wireless sensor networks. The information collected mainly contains the node number and capacity, number of nodes is not determined in the practical application, so node numbers are represented by 2 byte. The charge information is converted into digital information with 10 to 12 digits, thus charge information is represented by 2 byte also. Generally, the number of people attending gymnastics performance is controlled in 103 by basic magnitude, information is collected within 4KB in an acquisition cycle, therefore, all data collected is not immediately transmitted to the PC port by the base station until all sensor nodes accomplished. PC port is responsible for storing and processing information. According to the flow chart, design of the sensor circuit is shown in Figure 3 :

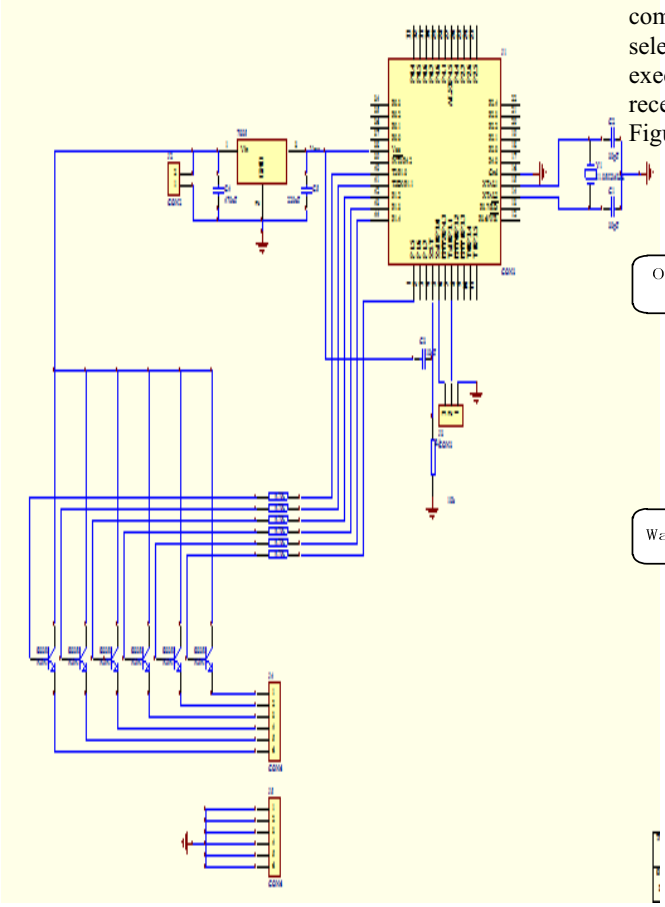

Figure 3 Sensor node hardware circuit

Microcontrollers adopt STC 89C54RD (SCM), the device includes a central processing unit (CPU), timer/counter, serial ports (UART), I/O interface, EEPROM, Watchdog module and so on. The most modules that realize data storage and control can be said a chip system. Here are three important functions in this design: data storage capabilities of EEPROM, serial communications functions and the timing function of timer T0, T1.

5 Software Design

According to the initial functional design of group control system, the mobile terminal needs to achieve the wireless communication with the lower node. Send a command to the sensor node which is related to the collected data. When performing on the stage, nodes need to generate a series of instructions based on the expected overall visual effect to emitting module and send it to the node.

There are two more feasible specific communications strategies to solve different magnitude of each node. The first scheme is that broadcasting a signal before starting communication with the sensor, if the sensor receives the signal, then returns a signal and it is able to judge whether the node is needed to wake up. The sensor will create a feedback executable signal when commands a base station (mobile terminal) sent. If the executable is not considered that part of the data has been lost, then will re-send commands. As described above, node will automatically select the next command waiting for gathering instruction execution end, click to cycle until the entire network node receives the instruction. The specific process is shown in Figure 4 :

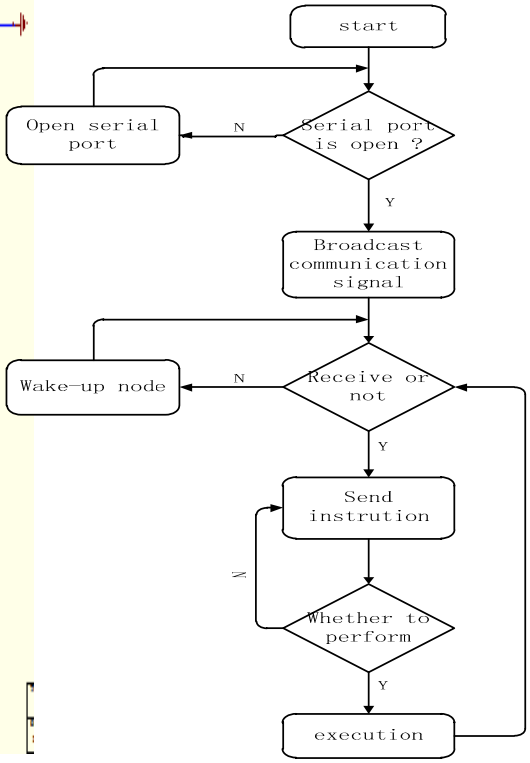

Figure 4 Flow chart (option one)

The second program requires instructions pre-passed all nodes before performing, as well sensor node will open the serial port interruption before the start of communication, then judge the data or command based on the header data received, which will be different treatment appropriately. For data, it will be performed storage operation. The performance data format is shown in table 1, it must be continuous data that greater than 3 bytes and less than 44K bytes. Delete EEPROM command must be sent before sending the performance data, otherwise, performance data will occur confusion

Table 1 Data frame format of performance

1	2	3	4	5	6	7	…
55H(U)	55H(U)	53H(S)	**H	**H	**H	**H	**H
Boot code	Boot code	Data Labels	Data Content	Data Content	Data Content	Data Content	…

For instructions, the appropriate action is executed. Control command frame format is shown in Table 2. The contents of the command currently have two kinds:

(1) Delete all performance data commands of EEROM: 44H (ASCII code corresponding to 'D').

(2) Execute command of performance: 52H (ASCII code corresponding to 'R').

Command content can be extended as needed.

Table 2 Control command frame format

1	2	3	4
55H(U)	55H(U)	55H(P)	**H
Boot code	Boot code	Instruction labels	Instruction content

To ensure the instruction can be executed, a node will close the global interrupt when it receives a command. Specific flow chart is shown in Figure 5.:

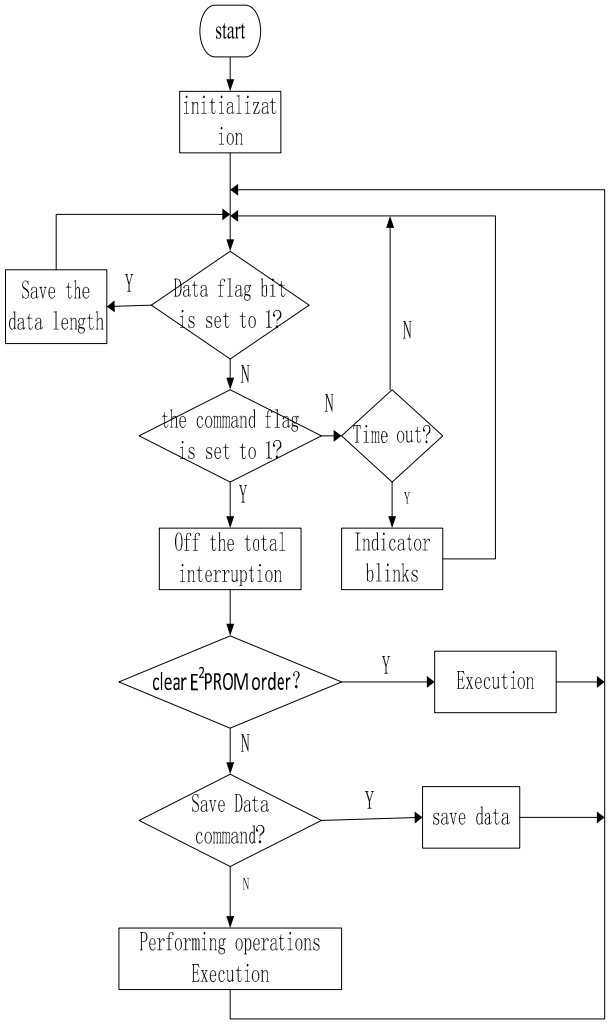

Figure 5 Sensor main program flow chart

This scheme can avoid serious lag between performances and expected, which caused by the large number of sensor nodes and a relatively long instruction completing cycle . In the process, sensor nodes interrupt program flow is shown in Figure 6:

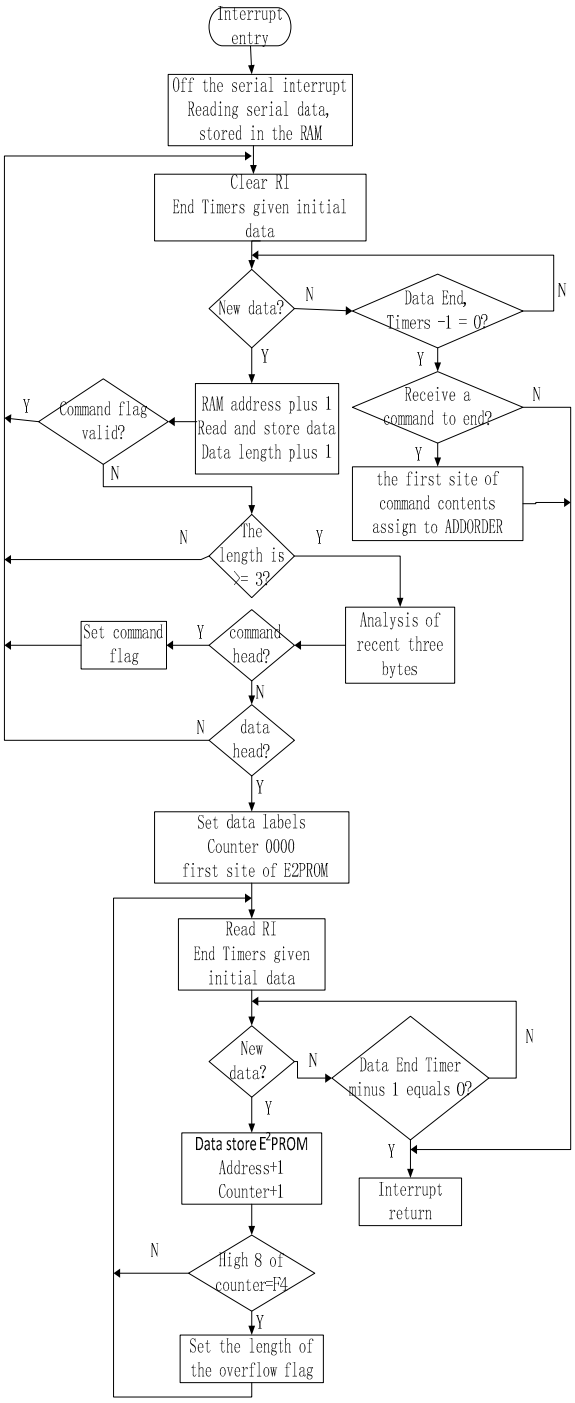

Figure 6 Sensor interrupt program flow chart

Conclusion

This paper presents an optimization strategy based on emission control method of optical gymnastics performance and sensor node energy, which is better to solve a single photoelectric effect and difficult to detect efficient power and other issues of group calisthenics performance than others. The core of wireless sensor networks--function of the base station integrate in the mobile terminal makes the group control system much

more flexible, so that the control can easily real-time monitoring of the performance process within any effective communication distance. Subsequent research will be based on relationship of the number of sensor nodes, communication distance and sensor nodes distributed, considering group control system energy consumption, design appropriate routing algorithms for wireless group control system--optimizing energy. It may also occur sync issues among nodes after running relatively long situation, the follow-up to this will discuss and propose a suitable solution.

References

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