Design for intelligent control system of curtain based on Arduino

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Abstract. With the development of smart home industry, smart curtain is going to come into the life of people. An intelligent control system of curtain was developed in the paper based on Arduino. Throughout detecting and analyzing the factors that include the sunlight illumination, time, temperature, humidity and outdoor environmental conditions, the microcontroller automatically determines the opening and closing of curtains. By experiments, it is proved that the intelligent control system of curtain has the high practicability and good manipulative.

1. Introduction

Smart Home was one of the hottest topics in the modern society. The development of the internet of things and embedded technology provide the basis for rising of the smart home. With the transformation of the consumption concept and development of the industry, the smart home market is rapidly gaining momentum [1]. More and more companies and organizations are devoted to the research and development of the smart home[2]. Taking a panoramic view of intelligent home solutions, we must complete the intellectualization of typical products to achieve the whole solution of the intelligent home[3]. Curtains have an irreplaceable role in our daily life, taking intellectualization of curtains as a breakthrough of the whole intelligent is a good choice.

This paper introduced the design of an intelligent control system of curtain and the reasonable solution for existing problems in the control system of curtain. These problems are mainly reflected in the single function, the rigid control method limited to the infrared remote control, and the meager controllability[4-7].

In this paper, an intelligent control system of curtain was designed. Based on the controller of Arduino, the practicality of the curtains was increased by adding features such as the infrared remote control, timing control, and the APP control by the smart phone. Communication of the Bluetooth and WIFI was established to achieve a variety of control mode and Human Machine Interface[8-10] Aiming to improve the autonomous of curtain control system, the detection module of the sunlight illumination and control algorithm based on fuzzy control theory was developed[11].

2. System design

Fig. 1 presents both a block diagram and a photograph of the control system, which includes several components: the sunlight illumination detection, the temperature and humidity detection, time detection, outdoor environment detection and the microcomputer based on Arduino. The microcontroller of this system was designed to detect the factors that influence the opening and closing state of curtain and provide the control signal to the actuator.
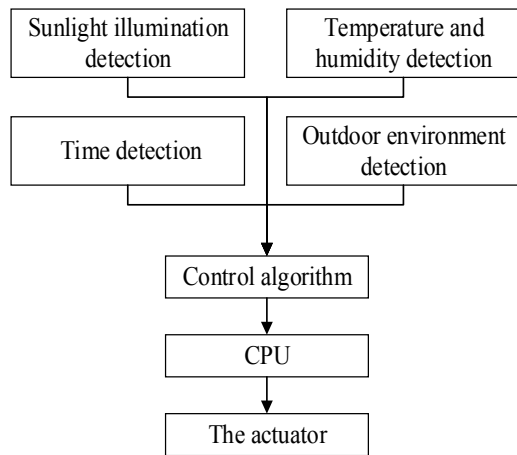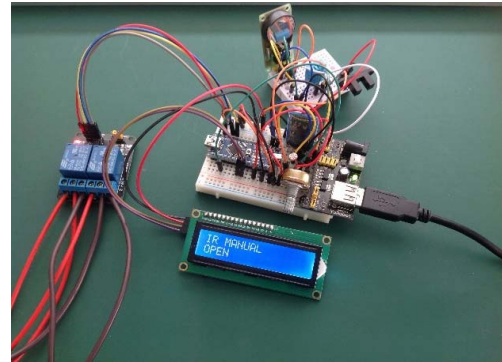
(a)   (b)

Fig. 1 Block diagram (a) and photo (b) of intelligent curtain control system

2.1 Sunlight illumination detection

The bridge photoelectric detector made by photosensitive resistance can reduce the influence of temperature on the sensitivity of sunlight illumination detection. Covering a layer of filter on photosensitive resistance makes the photoresistor accept more ultraviolet ray in sunshine, so as to achieve the improvement of the detection accuracy. In the Fig.2, the bridge photoelectric detector uses two same type of photosensitive resistance as the bridge arm, which is used as temperature compensation to shield one of the photosensitive resistances.
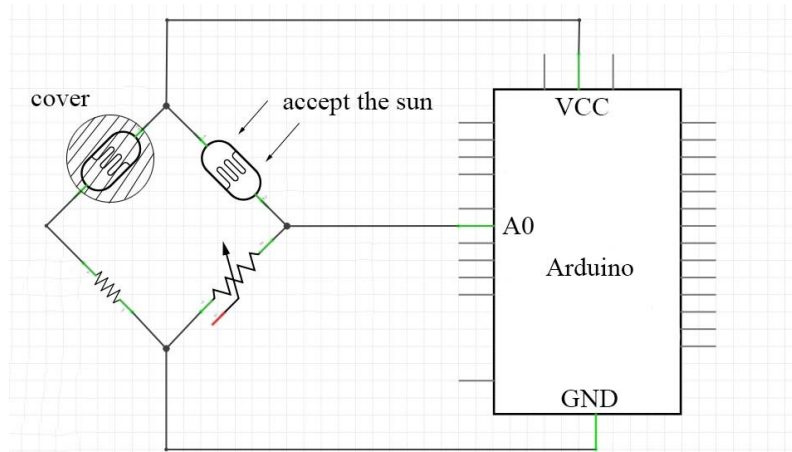

Fig. 2 Detection circuit of the sunlight illumination.

2.2 Timing Control

The timing control of the curtain includes two modes. One is the time control, such as, opening the curtains at 8 Am. The other one is time-delay control, such as, opening the curtains for you in several hours later. DS3231 clock chip was used to build a clock circuit, which promises the time error in a year is about 1 minute. The mode of timing control can be reset by the remote controller or software in the mobile.
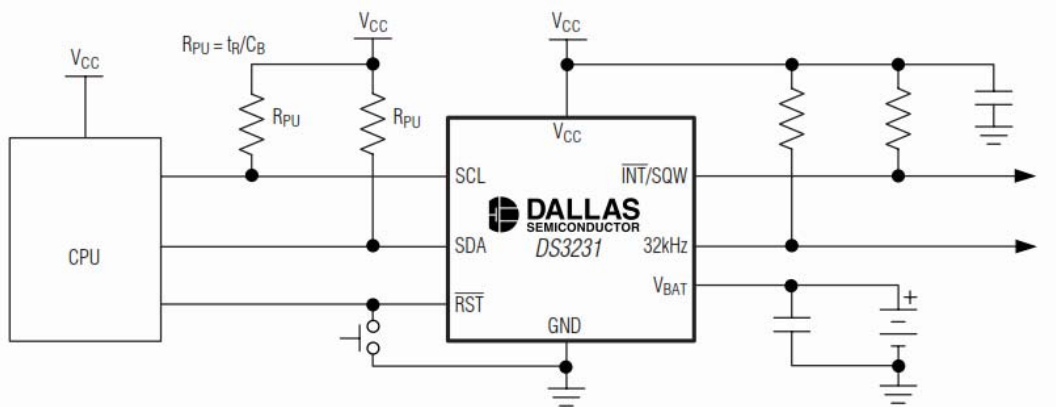
Fig. 3 DS3231 clock typical circuit

2.3 Remote control

In the development of smart home, real-time monitoring and remote controlling must be worth heeding in the industry. W5100 Arduino network was used to build a simple Web server whose function is sending the curtain of real-time information to the mobile phone APP or other terminal and receiving the control signal from the mobile phone.

3. Software design

3.1 Control Algorithms

The key to increase the curtain humanization is writing the high intelligent algorithm. People open and close the curtains not only affected by sunlight, also analysis a variety of external conditions. For example, at night, we will draw the curtains to ensure privacy of space; when it is raining and blowing hard outside, we will close the curtain too. It can't meet people's need to determine the curtains opening and closing only by detecting the sunlight illumination simply.

The intelligent control algorithm was written base on fuzzy control theory. The main core idea of the control algorithm is obtaining membership of opening and closing the curtains, to control it opening and closing by detecting variety of environmental factors. By detecting the sunlight illumination accurately, the membership degree of opening and closing the curtains was calculated and regard as the basic data. We can set different weights according to the influence degree for human, including the house temperature and humidity, wind and rain outside. By modifying those factors' degree, the open and close of curtain can be realized in a more humane way.

3.2 Development of mobile APP

Although the intelligent curtains were controlled by infrared remote, it cannot satisfy people's needs now. With the popularity of smart phones now, more and more functions can be done by phones, so the choice of smart phone design interactive interface is very appropriate. This paper presents a mobile phone APP based on Android, which establish communication with phones by connecting Bluetooth or Wi-Fi. It improves the controllability of the curtains to set the timing mode of the curtains, which can be done by the phone.
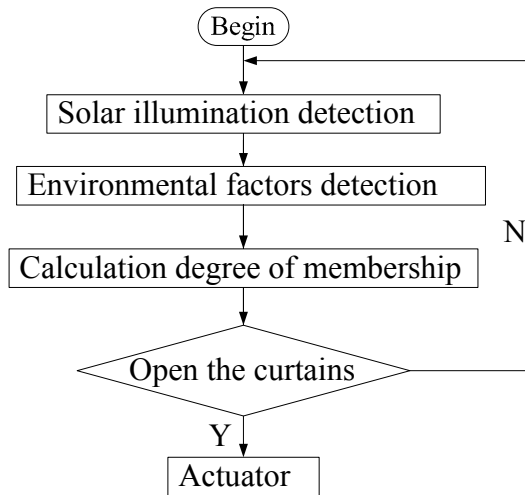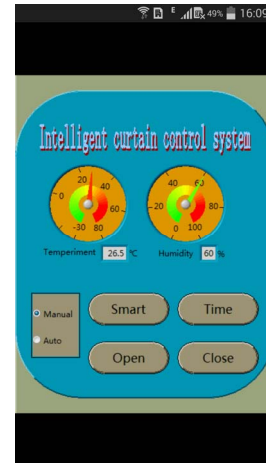
Fig. 4 Flowchart for writing control algorithm   Fig. 5 Interface of APP in the mobile
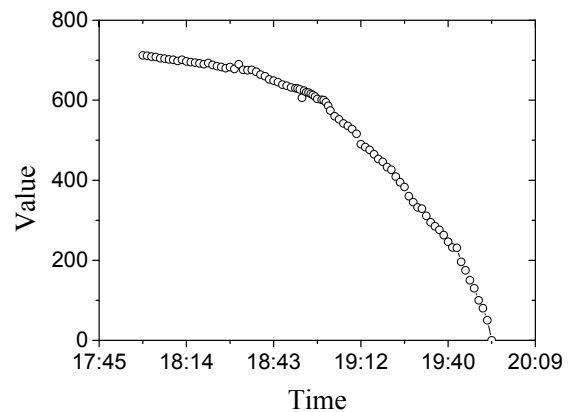
4. Experiment and Results

The experiment was carried out to detect the sunlight illumination. The measured value proportional to the intensity of illumination within 24 hours was shown in the Fig. 6(a). The value measured in the time range of 6:00-8:00 Am and 18:00-20:00 Pm was shown Fig. 6(b) and (c) respectively.
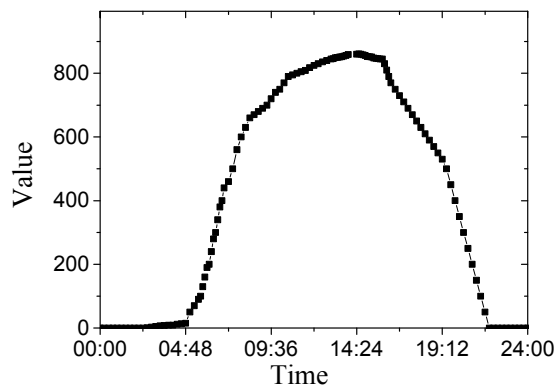
(a)
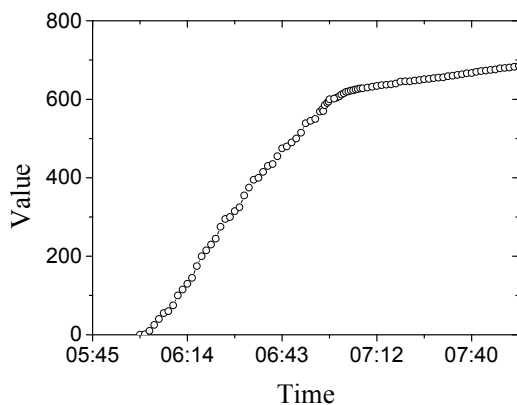
(b)   (c)

Fig. 6 Detection value of the sunlight illumination within 24 hours (a), 6:00-8:00 (b) and 18:00-20:00 (c).

The experimental data were analyzed, during 6:00-8:00, the system control the curtain opening after detecting sunlight illumination is 600. In the experimenter the curtain was opened at 7:05 when the sunlight illumination is 624. During 18:00-20:00, the system control the curtain opening after detecting sunlight illumination is 600. The curtain was closed at 18:50 when the sunlight

illumination is 613.
The intelligent curtain control system is basically consistent with the subjective judgment. Within a certain error range, the intelligent curtain control system can realize automatically opening and closing the curtain.

5. Conclusions

By detecting and analyzing the factors that include the sunlight illumination, time, temperature, humidity and outdoor environmental conditions, the designed control system of curtains has the characteristics of high intelligence, compact, multi-functionalization, which are expected to have been widely used in high-grade office buildings, convention centers, hotels and other places.

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