SMART AUTOMATIC CONTROL LIGHTING SYSTEM（SACLS） USING MICROCONTROLLER

A Thesis

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Ping Deng

Thesis Committee Approval:

David Cheng, Department of Electrical Engineering, Chair
Jidong Huang, Department of Electrical Engineering
Zhu Yun, Department of Electrical Engineering

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ABSTRACT

This paper brings forth a smart automatic lighting system (SALS) by expatiating on designing theories together with implementation approaches. This system was designed to realize the goal of cutting down the amounts of electricity usage in people's daily life. The main enhancement deals with controlling lights that depend on current light intensity inside room and human existence for the purpose of gaining the optimal efficiency of power saving. In respect of automatic control technology, this paper segregates the central control unit into five modules: automatic control module, PIR detection module, lighting intensity detection module, modes switching module, and LCD 1602 display module. System takes AT89S51, a typical 51-type microcontroller as its controlling core. AT89S51 performs the function of turning on/off the lighting unit by receiving the signals from PIR sensor as well as lighting intensity sensor. This paper covers the hardware design together with its corresponding software application on each module, including electronic circuits and software codes. On simulation modeling stage, I have put to use software of Proteus and Keil C51 for realizing all of the fundamental actions of this system on screen. This testing processing aims at making sure that all design structures and circuits are correct and reasonable.

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ACKNOWLEDGMENTS

During my entire education career, this thesis is the one that is most time-consuming, involving most of the knowledge, and with the largest workload which includes all aspects, including circuit design, programming, system simulation, hardware welding and system debugging. Along the way, I gathered a clear idea about my gains at school. It would be almost impossible to complete this design successfully. The main fact that my graduation design can be satisfactorily finished is inseparable with my tutor Dr. Cheng's help. The meticulous, rigorous and sophisticating academic attitude has always been my model. During the readjustment of the paper, Dr. Cheng always carefully reads my thesis and then finds out the mistakes in my paper, even the wrong-spelling words that are rare and hard to be noticed. All of these have deeply impressed and inspired me. And I'm sure it will greatly help me with my work in the future.

Thanks to this graduation design, I deeply understand the endlessness of the knowledge and the importance of learning professional knowledge well. At the same time, I realized what is easy to know but put it into action is another thing. There is a big gap between theory and practice. This is also a test for the academic outcomes of my past years' study. Although I have not perfectly mastered the professional knowledge and there are still many areas which is bemused for me, I have learnt from the Dr. Cheng what is meticulous. As long as there is a sincere heart and determination, nothing is impossible.

Now, graduation is around the corner. I am going to bid farewell to the campus where I hang out with my peers and study. What facing me next is stepping into this society. looking back, the nostalgia is overwhelming. But nobody can live the life twice. Certainly there is too much memory that I cannot bear to let go, but the departure is going to happen at the end. Only the memory is what we can hold on and savor in the future. And this is the most precious treasure in our life. Finally, I sincerely appreciate the help and instruction from Dr. Cheng and those classmates who helped me. May all things go smoothly.

CHAPTER 1

INTRODUCTION

Background of Smart Automatic Control Lighting System

The rapid development in electric technology has introduced enormous improvements into the lives of people. Nonetheless, a considerably detrimental effect is scarcity of resource and deterioration of environment because of the large consumption of electricity. In contemporary societies, people are unable to live without electricity, whereby lighting consumption has been taking a sizeable proportion of electricity use in modern life, both in commercial and residential buildings. As of now, the requirement of lighting consumption is growing fast with the expansion of globalization. Taking into consideration the energy consumption summary of United States in 2016 as an example, the construction industry accounted for approximately 41 percent of initial power usage in the year of 2010, showcasing 44 percent rise in comparison with the transportation industry in addition to 36 percent rise as compared with the manufacturing industry (DoE, U. S., 2011). Despite the fact that the power use by different building systems varies on the bases of the building's size, occupancy, and operation function, the lighting energy use is the largest contributor to the commercial buildings' energy consumption, the average of 38% (DoE, U. S., 2011). Fundamentally, with some certain amount of lighting fixtures, it is expected to bring forth a sizeable amount of heat that will increase the building's room

temperature that is likely to cause the buildings to expend more energy on heating.

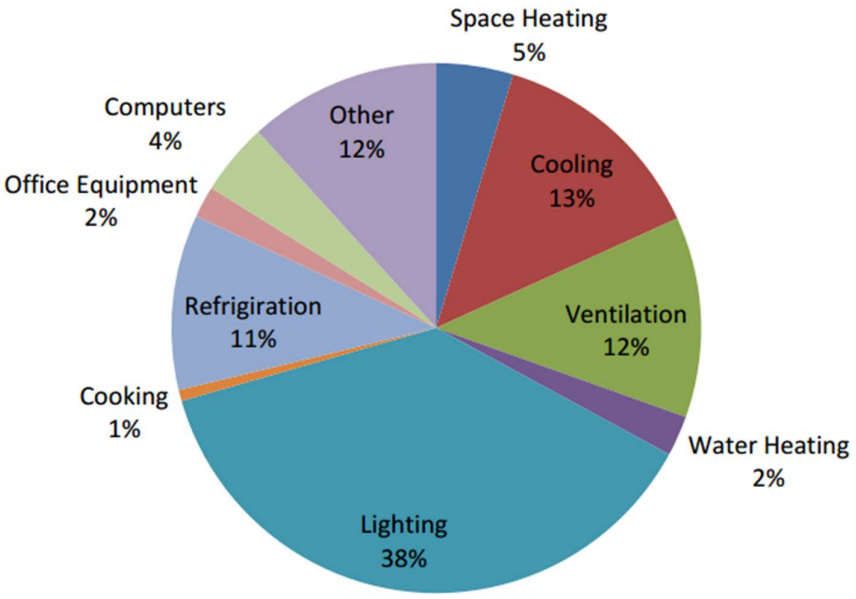


Figure 1. EIA 2003 CBECS - Site electricity consumption in U.S commercial buildings by different end uses.

China, featuring the largest energy consumption throughout the past five years, should be put under more consideration so that we can be quite clearer about the strikingly huge consumption of energy, especially on electricity. In the backdrop of China, approximately 30.7% of the aggregate power use is made in buildings whereas almost 36.4 percent of that power is used by lighting systems together with electric channels. One thing should be figured out is that nearly 35% of the electricity consumption on lighting is made throughout the daylight. The more detailed rates of energy consumption can be found in Figure 2. Another quintessential issue is an extensive waste on lighting consumption that is required to be given a good amount of consideration, if we constraint our vision within academic areas that are also the most relevant to both the educators and

the students. It doesn't pose to be an infrequent situation, whereby, sometimes most of lamplights in rooms are still left turned on despite no activity inside at all or during the daytime, all because of the weak management, the huge amount of waste of electricity should not be overlooked. Furthermore, in China as well, in accordance with a survey in 2016, in respect to average over all colleges and universities in China, lighting is responsible for 37% of the building sector's entire electrical energy consumption. Approximately half of lighting is put to use on unnecessary situations. Conversely, half of lighting is fully wasted.

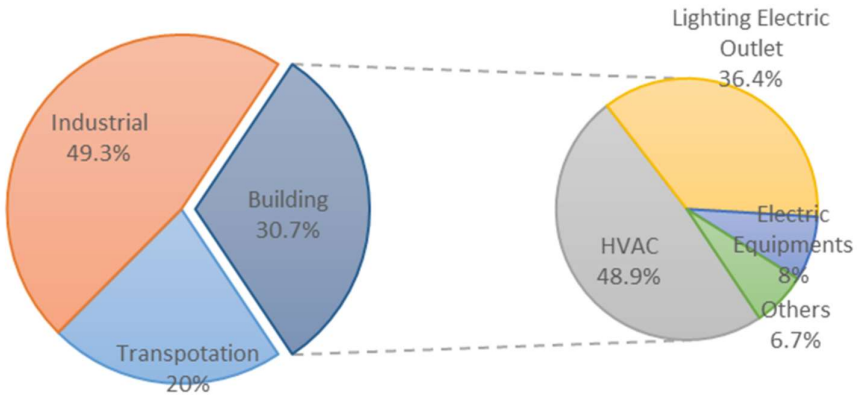


Figure 2. The diagram shows each composition of Energy Consumption in China 2016, and lighting electric outlet accounts for 36.4% which is a considerable amount.

In addition, the demand of reducing energy consumption has become extremely emergent issue from across the globe, as of now. Considering the angle of economic view, there are lots of reasons, for instance, the steadily increasing oil prices in addition to an elevated reliance on the imports of power resources from other countries in those facing the short shortage of energy. Conversely, ecologically, a global warming problem exists

that deals with the huge environmental deterioration because of the use of fossil power. Furthermore, heat increase because of electric lighting showcases considerable part of the aggregate building cooling burden (Li & Lam, 2001). On the bases of all of these aspects, an energy-saving and environment-friendly lighting system is urgently required for all of us.

Considering all of this, all of the above-mentioned issues trigger us to find a solution for the purpose of improving the efficiency of lighting electricity together with reducing the unnecessary waste. It is quite crucial to save energy and protect our earth. Under this concern, the automatic lighting system, having the function of controlling the status of all lamplights based on the daylight intensity and human activity, has been taken into consideration, for the purpose of overcoming the weakness of the traditional lighting system. In a conclusion, an automatic lighting system possesses a great valuable potential on both energy saving and economic saving.

That is why any improvements on cutting down the power use of the lighting systems in buildings are extremely needed. In respect of the concern of energy saving as well as environment protection, we are required to think about the solutions to solve the waste of energy. The first consideration deals with clearly making efforts for the enhancement of the efficiency of usage for daylight. If we have a highly-effective approach to treat and control the daylight, then it definitely can enhance the saving of energy use on lighting. Normally, it possesses the ability to reduce the lighting energy by up to 75% in commercial and educational buildings (Boyce, Hunter, & Howlett, 2003).

These savings are able to be realized only with the use of complex daylight harvesting systems that combine time schedules, photoelectric sensors, dimmable luminaries, and a central lighting control (Tabibzadeh, 2014).

Recently, smart automatic lighting systems are experiencing the rapid growth owed to the progress of microcomputer controller technology together with human-computer interaction techniques. The lighting system of the office has, therefore, also been responding to the usage demand for the improvement of smart automatic lighting systems, thus, reducing the waste of electricity on lighting and increasing the efficiency of sunlight usage.

Fundamentals of Smart Automatic Control Lighting System

The enhancements in the fields of lighting, sensing, microcontroller devices make it possible to develop a smart automatic control lighting system. The system has so many advantages in economy as well as environmental friendly.

Lighting Retrofits

Lighting Technology has a huge revolution. The lighting technology has been actually running a considerable revolution during the past years. The breakthrough of new materials on devices has introduced to an entirely new world for lighting usage across the globe. A new type of lighting device has appeared that brings forth an enormous innovation to the lighting industries. The new lighting devices are based on semiconductor chips that are known as Light-Emitting Diodes (LEDs) nowadays. It has led to an overturning change in the lighting technology that definitely causes the

traditional bulb made from tungsten gradually starting to step down from the stage of history. The advances of LED technology have brought a fresh blood in lighting market because of its higher energy efficiency, longer lifetime, good illumination, etc. LED has already been applied in a variety of aspects in our life and industries.

Primarily, there are some deficiencies housed within LEDs that prevent them from being commonly used for lighting and indicator applications, for instance, their low power and illumination of LEDs. Nevertheless, there has been experienced the great invention and success in development of the blue LEDs, somewhere in the1980s that was also capable of being converted to white illumination through the combination of red, green and blue LEDs or with the help of part photo-conversion of blue light to yellow light with the use of phosphors. The use of white LEDs has turned industrial and house lighting possible, in the meantime, opening fresh corporate opportunities to the enterprises. As a consequence, the key point is to increase its efficiencies together with its intensity of illumination. Consequently, the key point is to increase its efficiencies and intensity of illumination.

All these efforts have already been realized because of the rapid improvements in the fields of optics materials science and electronic technology, leading to considerable innovation in the technology of LEDs. Lighting based on LEDs is a new technology recently, but LED deployments in this department of implementation seem to be indispensable currently. Furthermore, the LEDs have appeared to be a reliable substitute of luminous lamps. It is quite tough to reject that LEDs will finally substitute the

traditional lighting devices that are going to be eventually abandoned for their substandard power efficiency. Numerous benefits together with prominent performance of LEDs have made them outstanding in comparison with fluorescent lamps and tubes. Another reason could be the reduction in the cost of manufacturing the same. White LEDs with high brightness have become a reality now (Khan, Bodrogi, Vinh, & Winkler, 2014).

LEDs showcase a lot of advantages. The daily life of everyone on this earth has received changes from the electrical lighting in more of a direct manner. It couldn't be argued that our life and manufacture will be struggling to move on without it. LEDs have had a huge success in saving energy. Estimates have been made that this planet is putting to use approximately 30 billion lamps that further consume an aggregate of 2,650 TWh of power annually, which makes almost 19 percent of the aggregate power generated across the globe[1]. Figure 3 shows the comparison among the existing lighting solutions.

[1] As of today, electricity represents approximately 16% of the total energy produced worldwide (20% for industrialized countries); lighting therefore consumes 3% of the energetic resources per year.

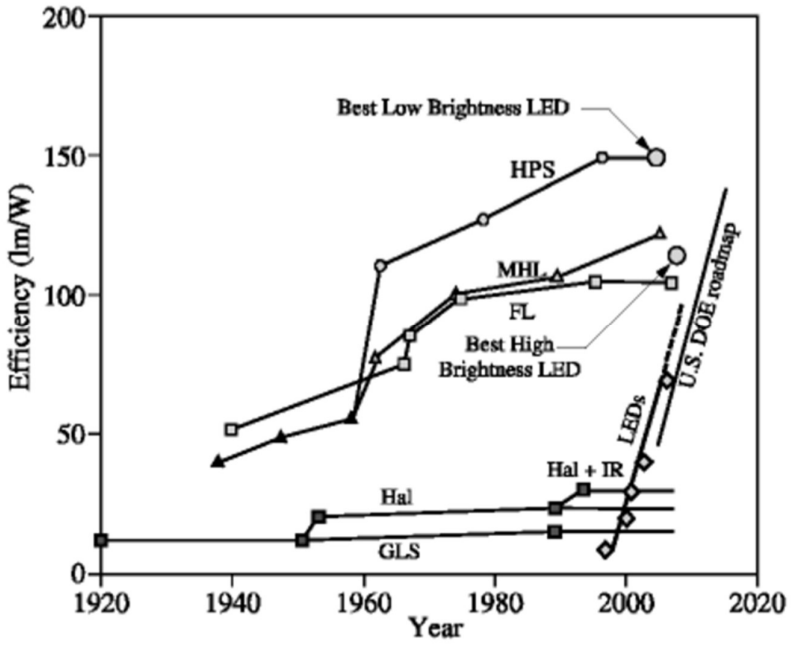


Figure 3. Luminous efficiency of the main technologies for light sources versus time. HPS: High Pressure Sodium (yellow - pink light); MHL: Metal HaLogens; FL: Fluorescent Lights; LED: white LED; GLS: General Lighting System lamps; Hal: Halogens; Hal+IR: Halogens with infrared reflector; DOE Roadmap: goals of the American "white LED" program.

The design enhancement together with mass manufacture of fresh as well as more effective means of light poses scientific, technical, economic and environmental challenges, meanwhile, they appear to be reliable solutions as well. Nonetheless, even though there have been numerous scientific as well as technical advancements in the department of electrical discharge light means, there has been seen a steady growth of the optimum efficacy of these systems since the era of 1970s approaching approximately 100-110 lm/W[2]. Conversely, LEDs possessing a continued advancement in their lighting efficacy, have developed themselves to be state-of-the-art solutions.

[2] Only good quality white light sources are considered here.

This power conservation would also indicate a considerable decrease in CO_2 release, by above 270 million tons annually. In addition to that, the utilization of white LEDs in lighting systems is also expected to considerably reinvent this field owed to its several benefits in comparison with the conventional lights:

– elevated power efficacy of the lighting systems;

– elevated life span and, thus, less maintenance requirements;

– decrease in the size of the tools;

– elevated suppleness as well as control of the degree of both light and color change;

– less use of energy (battery operated autonomous systems, user applications in a case the security is essential);

– lacking ultraviolet as well as infrared emission of the topmost significance in respect to the preservation of breakable things, for instance in museums (Mottier, 2010).

LED features quite a simple build. They are electronic gadgets permitting the energy to move just in one direction. They give birth to the illumination as electric current is passed across them.

In the same way as that of a usual diode, the LED comprises a chip of semiconducting material, either saturated or doped with adulterations for the purpose of creating a p-n junction. Subjected to a consistent scenario, opposite sign carriers (electrons and holes) aren’t capable of penetrating the junction area because of the development of a space-charged field.

In the case the junction of a LED showcases the forward bias, like in the scenario of other diodes, the smooth flow of the current from the p-side, or anode, to the n-side, or cathode is experienced, whereas, it isn't in the backward course. As the electrons get across the junction from the n- to the p-type material, the electron-hole re-grouping mechanism gives birth to some photons in a phenomenon, which is termed as electroluminescence. Thereafter, an exposed semiconductor façade is capable of emitting light. The basic LED structure has been presented in the figure 4.

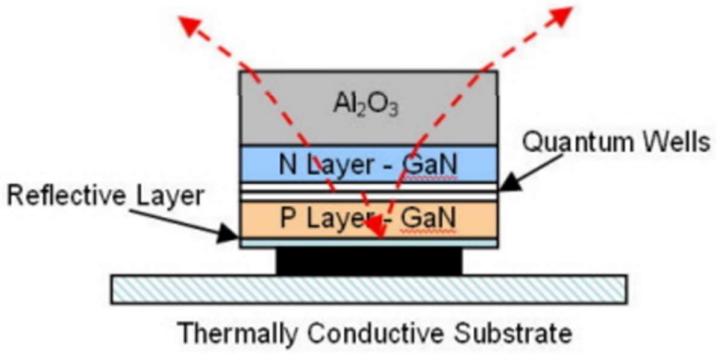


Figure 4. P-N junction is the main structure od LEDs.

LED possesses extensive applications all over the world. LED light bulbs having elevated power LEDs deliver lasting life span. Moreover, they also bring forth the unsoiled and unadulterated white light in addition to variety of colors! They also come with both shock and vibration resistance, in addition to being the direct screw-in substitutes for luminous bulbs. As presented in Figure 5, the key uses of High Brightness LEDs are made in cellular gadgets, screens and automobiles. As of now, the market share of LEDs in overall lighting has reached approximately 6 percent that may touch 10 percent figure in the year of 2010. Even though the general optimistic views because of

the exceptional scientific advancements achieved and put forth by some, this question still continues to be unsolved due to the fact that there are some technological problems that are still seeking the solutions.

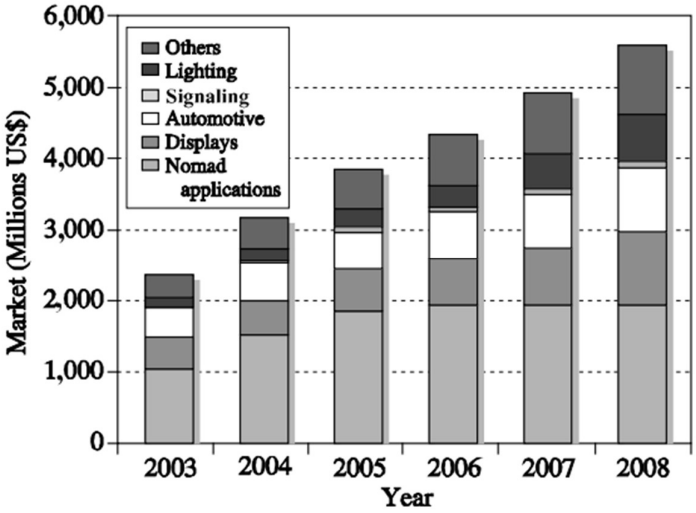


Figure 5. Applications of High and Ultra High Brightness LEDs.

In addition to lighting, there have come out lots of genuine fresh applications, for instance the lighting of high-rise buildings in Hong Kong or lively illumination of the old stone “Pont Neuf” bridge situated in Toulouse (France) as presented in Figure 6. LEDs are growingly making entries to this talented industry of the “architectural illumination”, whereby they are not only able to make it possible to view but they throw might emphasis on the artistic characteristics of key buildings.

Figure 6. Left: LED illumination of the Canon tower in Kowloon (Hong Kong) 14 lines with 30 LEDs per line.

Sensor Technology

Industrial mechanism control was primarily carried out in a manual way by operator with the help of their senses of see and feel, driving the control action that is fully dependent on people's activities. It goes without saying that it cannot fulfill the requirements that people usually want to realize some actions into automation, being a method to save time or energy, for instance, controlling the switch of lights we mentioned earlier. This poses to be a motivation for pushing the industrial process control to convert into automatic development. Manufacturing mechanism control has met lots of innovation together with evolving into the intricate contemporary microprocessor-controlled system. The sensor poses to be the fresh key constituent. The breakthroughs in the semiconductor sector have given birth to precise sensors for the measurement of temperature, time, light severity, human-body thermal infrared, etc.

Certain specific sensors can be put to use for sensing physical characteristics. Most of sensors can be combined with an electronic device to realize the automatic operation on the bases of some properties of the real world nowadays. With this, people are capable of performing measuring, calculation and recording. It accords the possibility

to control the industrial process automatically on the bases of detecting the environment conditions, for example, light intensity, human existence, temperature and humidity.

Usually, a sensor is termed as a gadget, which transforms a physical mechanism to an electrical signal. In another word, with this standpoint, sensors build up a “bridge” between the material world and the galaxy of electrical gadgets. With this foundation, we are capable of realizing the automatic control by connecting sensors with the other microprocessors. This “bridge” means a lot to contemporary industrial automation. Nowadays, huge potential for information processing has been established within the electronics sector. The most considerable instance of this potential is the automatically controlled lighting system. In addition, the availability of controlling automatically based on the light intensity and human motion is exerting an enormous effect on the saving energy.

Sensors are the crucial fundamentals of the new technological revolution and modern information social, that are termed as the most basic and momentous high-tech across the globe. It can’t be denied that all modern equipment and automatic controlled system are relying on sensors. Sensor technology is put to use in wide range in the field of manufacturing that can be shown by a sheer number of products found in our daily life everywhere. For instance, the lots of applications of sensors on smart cell phones: gravity sensors are put to work on some mobile games for the purpose of gravity-sensing, like car racing game, which is the perfect implementation of application of gravity sensors in the field of electronic devices; The shaking function of mobile phone is based on acceleration

sensors that detect the property of acceleration; Light intensity sensors and distance sensors make it possible to adjust the light intensity of screen in accordance with the distance between phone and the human body for the purpose of reducing the dangers of cell phone radiation to humans. It implies that when a phone gets close enough to humans' ears, its screen would turn off. In the meantime, when it distances from human's ears, the screen will turn on again. There are numerous illustrations of realizing varied functions on mobile phones benefiting from different sensors (Wilson, 2004).

In this research paper, our lighting system adopts the Thermal Infrared Sensor. As regards an infrared sensor (IR sensor), it poses to be an electronic sensor that calculates the infrared (IR) light emitting from the items that fall in its observable circle.

Infrared (IR) emission poses to be an electromagnetic radiation that falls in the wavelength ranging between observable radiation (mostly shortened as VIS; λ=380 – 780 nm) and microwave radiation (λ= 1 mm –1 m). IR radiation possesses few physical attributes as well, which turn them especially appropriate to be used in several technical applications.

An IR-based motion detector is put to use for the purpose of sensing the motions of people, animals, or other items. As regards the thermal infrared sensors, they are those radiation identifiers, which encounter a variation in temperature because of the soak up of infrared radiation together with transforming this variation in temperature into an electric output signal. For the purpose of getting capable of detecting the low-power infrared radiation, there are required the photon sensors to be cooled down to a substantial level

under the ambient temperature. Contrarily, thermal infrared sensors are capable of working at ambient temperature. This is the reason that they are especially adequate when it comes to tiny, light and moveable applications (Budzier & Gerlach, 2011).

Thermal radiation sensors transform the radiant flux F_S into an electric signal (voltage V_S or current I_S). The measuring chain has been brought to light in Figure 7 whereas the Figure 8 makes identification of the fundamental build of all of the thermal IR sensors.

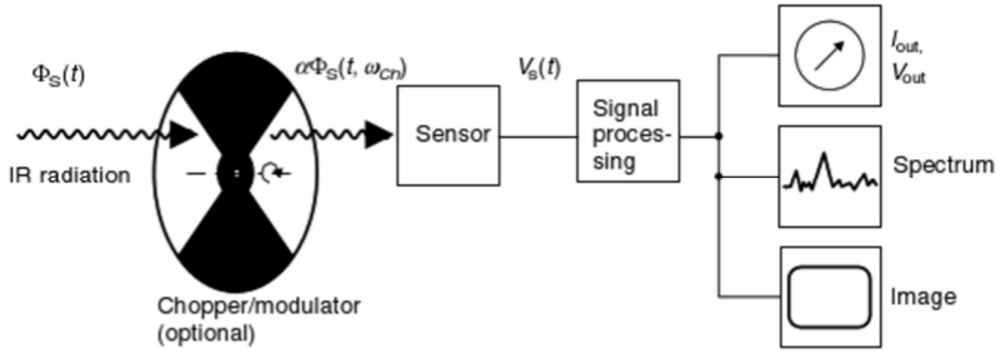


Figure 7. Measuring chain for determining infrared radiation.

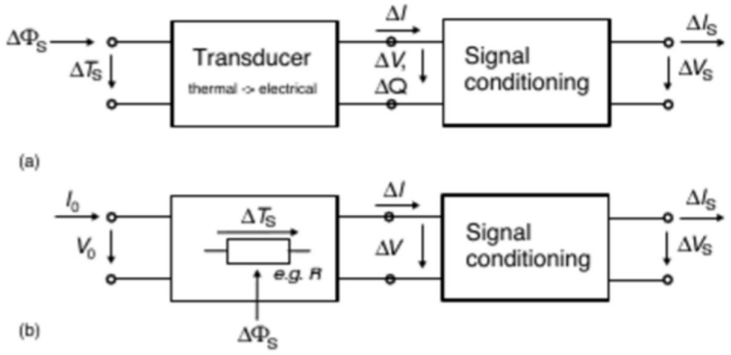


Figure 8. Mode of operation of thermal sensors (a) with thermoelectric energy conversion and (b) with electric signal modulation in parametric transducer.

Lighting Intensity Sensors have also been applied in this system. Frequent utilization of the semiconductor gadgets is made as photo-intensity sensors. The commercial availability of photodiodes, phototransistors, and integrated photo-sensors is also prevalent. Incorporated gadgets feature on-chip temperature compensation together with elevated responsiveness, in addition to being able to be adjusted for having a voltage, digital, or frequency yield, which is relative to the severity. Furthermore, the gadgets can also be developed to be responsive to visual or infrared frequency spectra. Photons give birth to junction leak in photodiodes, which is relative to the light severity; in this way, the backward leak is a calculation of light severity.

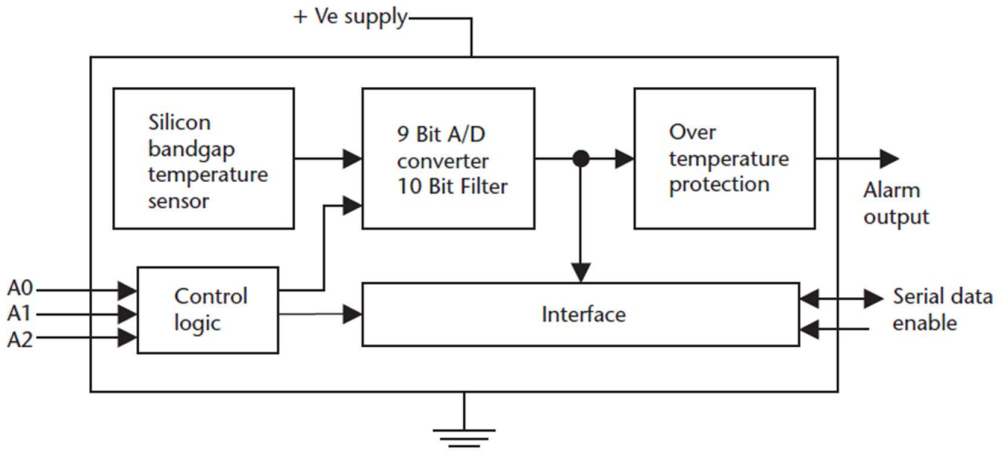


Figure 9. LM75 Block Diagram includes all the main parts.

Microcontroller Technology

Microcontroller owns a certain structure. Figure 10 brings to light the general build of a common general-purpose integrated system, conventionally popular as a microcontroller system. The figure brings to light the following parts: Input/Output Unit,

Memory Unit, Arithmetic/Logic Unit (ALU), Control Unit, Timing Circuitry, Bus Control Logic, as well as System Bus. The arrangement of arithmetic & logic unit in addition to the control unit is termed as the central processing unit (CPU) of the microcomputer. We call it a "microprocessor" unit (MPU) when implementing CPU as a single IC. The MPU poses to be a general-sense processor having the key objective of decoding the guidelines provided to it in addition to using them for the controlling of the operations inside the system. Moreover, microcontroller is capable of performing all of the arithmetic as well as logical operations (Dawoud & Peplow, 2010).

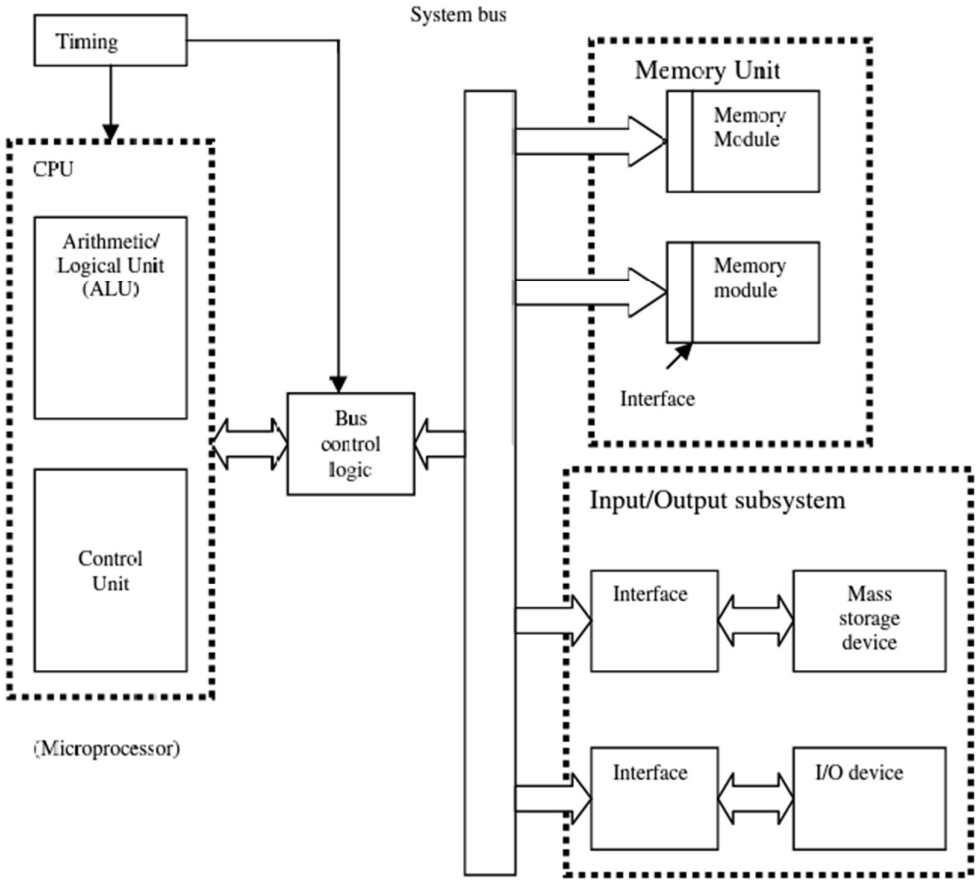


Figure 10. This organization of a typical microcontroller is most popular. (general-purpose embedded).

There are three core segments that are central processing unit (CPU), memory unit, and input/output (I/O) system that are joined together with the help of cohorts of electrical lines that are termed bus. The buses posing the responsibility to shift memory or I/O addresses are termed as the data buses. Furthermore, the buses, which have the responsibility of transporting the control signals, are termed as the control buses. The CPU is considered as the main unit of the microcomputer that is controlled by the program preserved in memory. The CPU performs the roles of fetching the guidelines that are kept in memory, interpreting the same and then executing them. The essential circuitry is also housed in the CPU that carries out arithmetic as well as logic activities with binary data. This specific circuitry is termed as the arithmetic and logic unit which is ALU (Valdes-Perez & Pallas-Areny, 2009).

The application of microcontroller has become quite extensive now. A microcontroller is a microcomputer designed on a single embedded circuit or chip that is generally called the single-chip microcomputer. Microcontrollers are put to application in diverse aspects from automotive industry, communication system, electronic tools, medical instruments, manufacturing sector tools as well as applications, domestic appliances, in addition to toys. The development of Microcontrollers has been done for the purpose of use in applications wherein they are required to perform few jobs having the minimum possible price. It is done by them through the execution of a program everlastingly preserved in their memory, whereby the input/output ports of the microcontroller are put to use for the purpose of interacting with the external world. This

is the reason that the microcontroller has turned out to be a component of the application; it works as a controller integrated into the system. Intricate applications are capable of using numerous microcontrollers whereby all of them throw focus on a tiny group of jobs (Valdes-Perez & Pallas-Areny, 2009).

Nowadays, the rapid development of electrical technology and microcomputer has brought forth a lot of benefits to every aspect of our life. It promotes the blooming development together with extensive application of microcontroller's measurement and control technology. Microcontrollers have exerted great effect on various aspects of industrial sections. Moreover, they have been playing a more and more important role. As of now, we come across several manufacturing and household items, for instance remote controllers, smart cell phone, printing machines, automatic power regulators, automatic or semi-automatic washing machines, microwave ovens, automobiles, engines, indicators and calculation equipment as well as other like items. There is a need of automation for the facilitation of the phenomenon or the mechanism in respect of its operation as well as control. Data storage and processing pose to be quintessential components of an automatic control system. What is required is a gadget, termed as "microcontroller" allowing the control of the duration as well as ordering of these gadgets and mechanisms. Additionally, through microcontroller, performing straightforward arithmetic as well as logic operations have appeared to be quite possible. Any system possessing a remote controller is definitely going to have a microcontroller.

CHAPTER 2

SYSTEM FUNCTION AND DESIGN SOLUTION

Function Description

My design targets at delivering a solution for an intelligent automatic lighting system to be used in our normal and housing lives, together with being applied in public lighting, even industrial lighting with some necessary modulations. This system is designed by four functions that are listed below in details:

1. *Turn on/off lights automatically.* This system is capable of collecting the information associated with the indoor people's activity or presentation with the help of thermal infrared detector. With the help of the analysis and comparison of the signals it receives, it is capable of recognizing whether there is anybody in room or not. Subsequent to this, the "smart" system will provide with the function of turn off (nobody inside) or turn on (somebody inside) the lights. Through this, system is able to realize the function of controlling the lights automatically for the purpose of effectively avoiding the waste of electricity.

2. *Two adjustable lighting solutions.* This system is intelligent enough to carry out the analysis of the current light intensity of the room or place, in addition to giving the best lighting solutions for users based on the lighting intensity. In this paper, the lighting solutions have been segregated into two levels: High and Low. In my demo, "High"

means two LEDs are lighted whereas “Low” means four LEDs are lighted. Normally, office’s lux is no more than 750, the playing place is 300 to 750. Based on this regulation, set lux value from 300 to 750 will be “High” level, lux value from 0 to 300 will be “Low” level, meanwhile, in order to save energy, if lux is more 750, all LEDs will remain off status.

3. *Two alternative control modes.* The system also puts to implementation the controller automatic and manual combination of lighting control. Two modes are capable of automatically switching at users’ preference. It is more comfortable for the users to choose the control mode at their convenience.

4. *LCD 1602 display monitor.* This paper also provides the introduction of the 1602 LCD display function. It aims showing the current operating conditions of the lighting system, for instance the current lighting illumination level, control mode etc., which turn it quite handier to monitor by users.

Design Solution

This paper primarily provides the design concept together with the specific solutions for the hardware and software of the smart automatic control lighting system. Figure 11 brings forth the functional block diagram of this system:

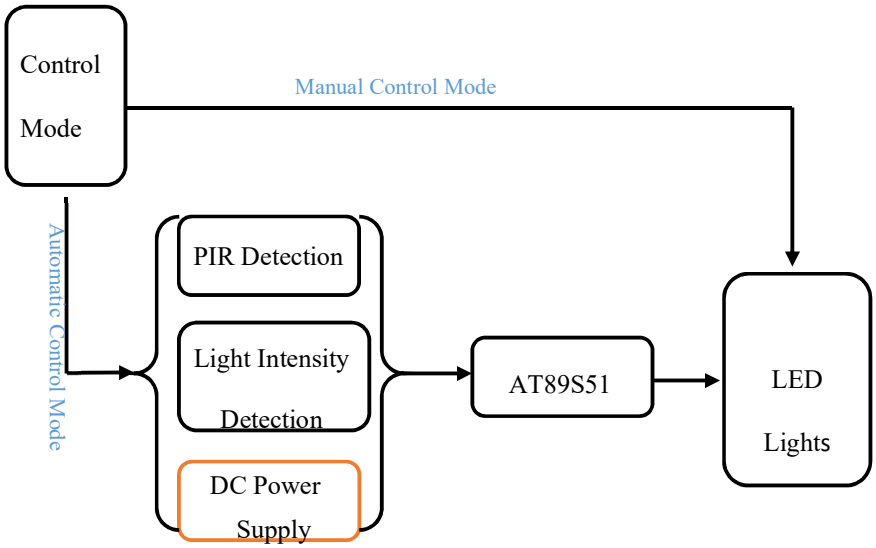


Figure 11. The functional block diagram shows the logic operating order of this system.

For the purpose of verifying and testing of the system design theory. In simulation, four LEDs lights are put to use to stand for the four illuminance levels. At "High" level all LEDs will be lit on. On the other hand, at "Low" level, only two will be lit on. In the actual application, the number of lights can be added in accordance with the personal preferences.

System Structure

For the purpose of achieving a more detailed look at this smart automatic control lighting system, it is going to be disintegrated into several modules. Figure 12 represent the block illustration of system structure in order to show the sequence about how to realize its function.

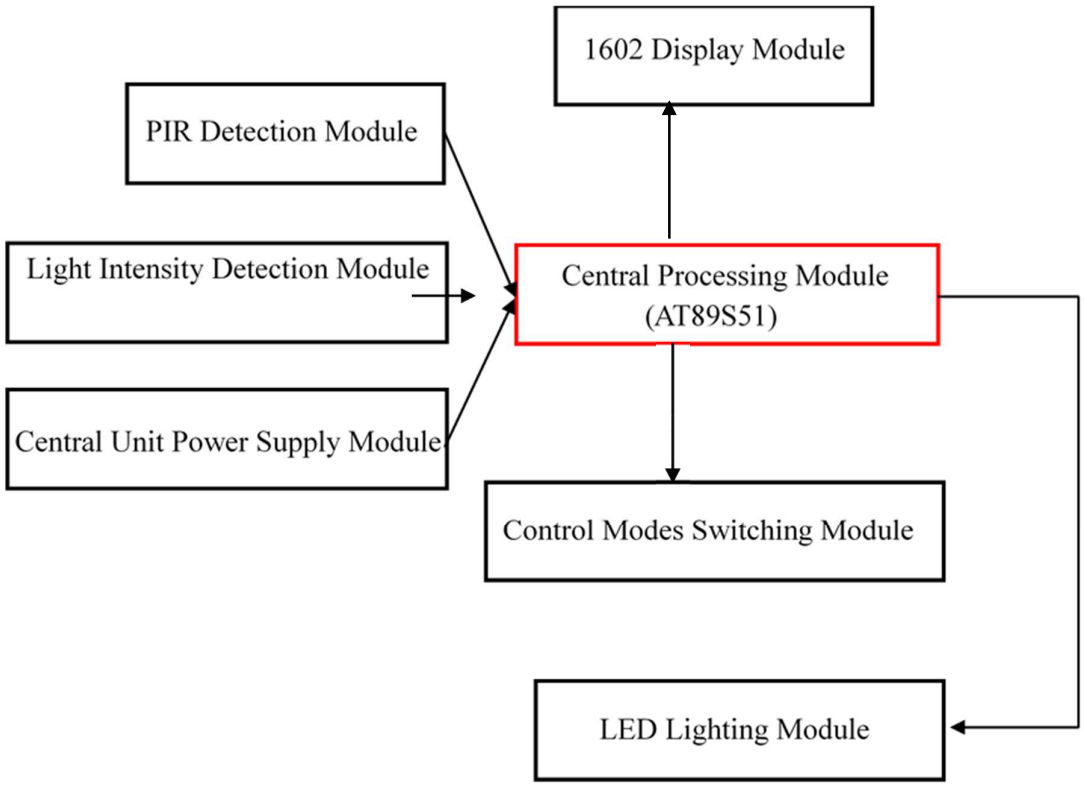


Figure 12. The block diagram of system structure contains seven modules.

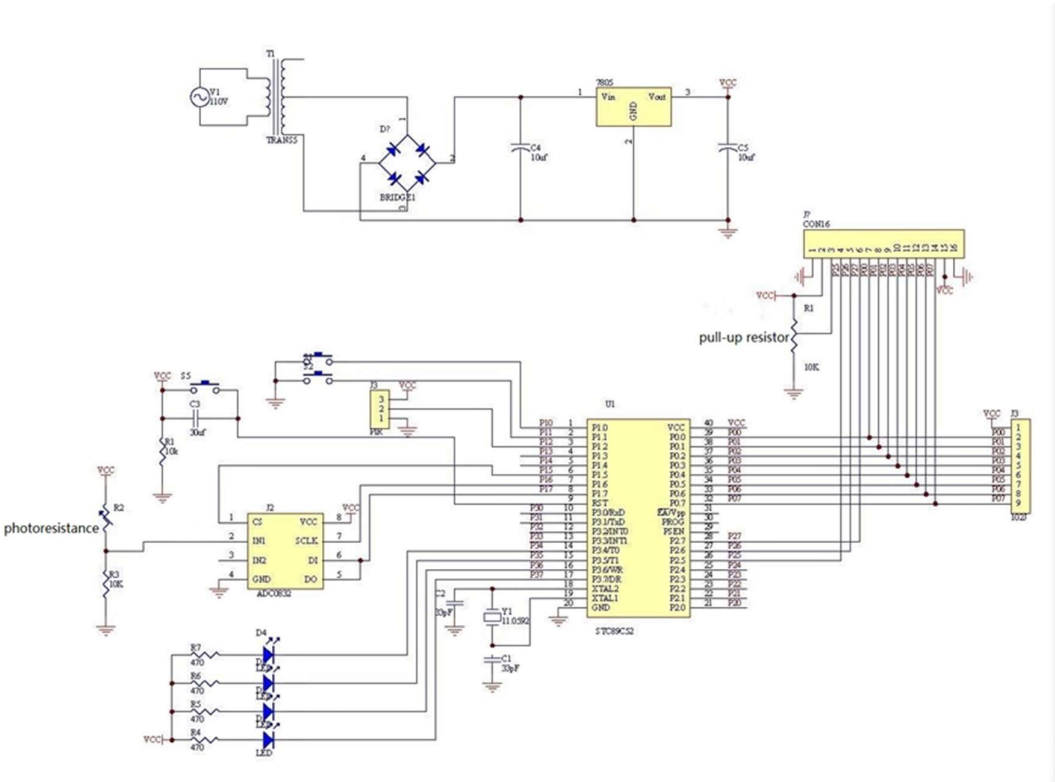


Figure 13. The entire circuit of this system is showing all functional parts of this system.

The entire system comprises seven modules on the aggregate: central processing module, PIR detection module, light intensity module, 1602 display monitor module, LED lights module, control modes switching module and central unit power supply module.

CHAPTER 3

SYSTEM MODULES ON HARDWARE IMPLEMENTATION

Central Processing Module

The core of the central processing module is AT89S51 that is a microcontroller of MCS-51 architecture associated with company of Atmel. The minimal system was designed including AT89S51, power supply circuit, clock reset circuit, and crystal oscillator circuit. The minimal system has been presented in Figure 14:

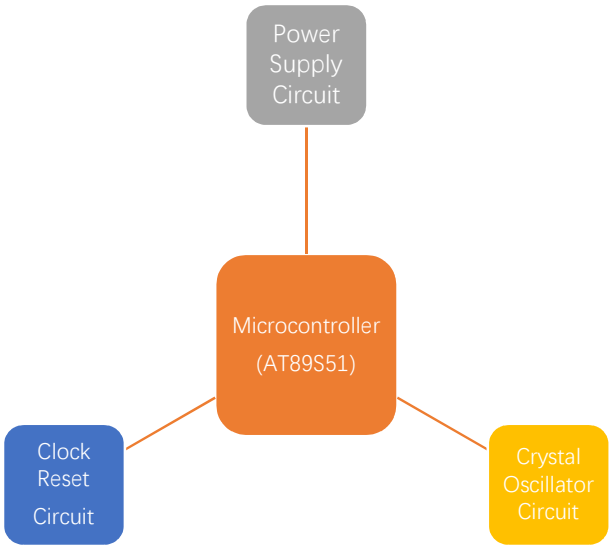


Figure 14. The minimal system for a microcontroller.

Figure 15 shows the schematic of central processing module, it contains the core ship AT89S51 and its indispensable external circuit:

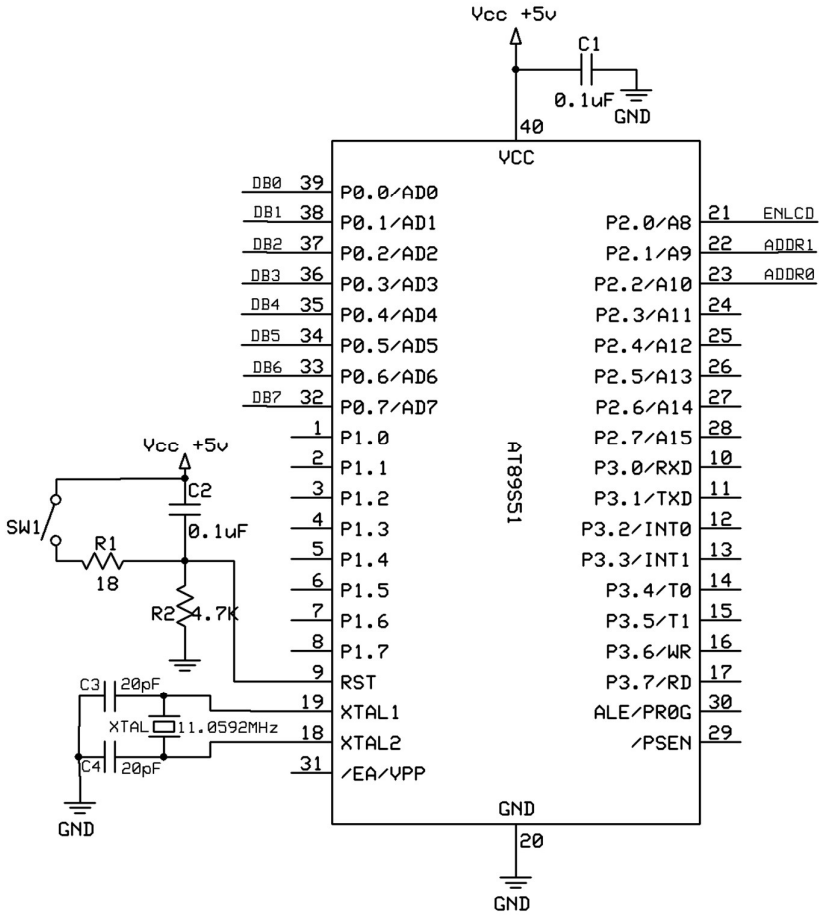


Figure 15. Schematic of central processing module contains the AT89S51, the driving circuit, clock reset circuit and crystal oscillator circuit.

AT89S51 Introduction

The AT89S51 poses to be a low-energy, top-output CMOS 8-bit microcontroller having 4K bytes of In-System Programmable Flash memory. With the use of Atmel's high-density nonvolatile memory technology, the gadget has been developed, which showcases compatibility with the industrial quality 80C51 guidelines set as well as pinout. The on-chip Flash accords the program memory permission for reprogramming in-system

or by a traditional nonvolatile memory programmer. Through the development of the combination of a flexible 8-bit CPU and In-System Programmable Flash on a monolithic chip, the Atmel AT89S51 comes out to be a robust microcontroller that delivers an extremely-flexible as well as affordable solution to lots of integrated control applications (Valdes-Perez & Pallas-Areny, 2009).

The Pin Configuration (40-lead PDIP) is shown in Figure 16:

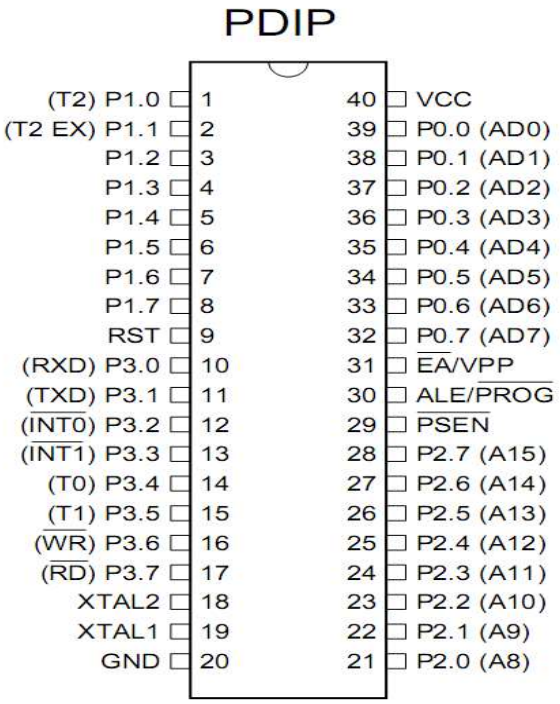


Figure 16. AT89S51 pin configuration (40-lead PDIP).

The AT89S51 brings forth the standard characteristics hereunder: 4K bytes of Flash, 128 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, two 16-bit timer/counters, a five-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and a clock circuitry. Furthermore, the AT89S51 is structured with static

logic regarding operation down to zero frequency together with supporting two software optional energy conservation ways. The Idle Mode inhibits the CPU, meanwhile, letting the RAM, timer/counters, serial port, and interrupt system continue to function. The Power-down mode conserves the RAM con-tents but freezes the oscillator, making all of other chip operations disabled till the subsequent exterior doesn't interfere or hardware reset (Atmel Inc, 2008).

Its main features are listed in Table 1:

Table 1. Main Features of AT89S51

Compatible with MCS-51 Architecture System	4.0V to 5.5V Operating Range
4K bytes of ISP Flash ROM Endurance: 1000 Write/Erase Cycles	Flexible ISP Programming (Byte and Page Mode)
Three-level Program Memory Lock	Fast Programming Time
128×8 bytes Internal RAM	clock circuitry
32 Programmable I/O Lines	Power-off Flag
Watchdog timer	Fully Static Operation: 0 Hz to 33 MHz
Dual data pointers	Six Interrupt Sources
two 16-bit timer/counters	Interrupt Recovery from Power-down Mode
Full Duplex UART Serial Channel	Low-power Idle and Power-down Modes

Power Supply Circuit

Each electronic device is required to be driven by a power supply, so does microcontroller. On the whole, there are two power supply systems for microcontroller: 5V and 3.3V. AT89S51 is associated with 5V system.

Figure 18 hereunder is the illustration of power supply circuit for AT89S51:

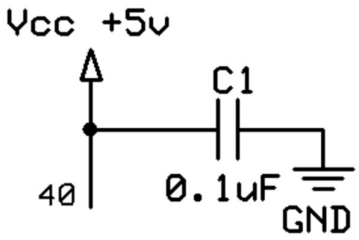


Figure 17. Power Supply Circuit for AT89S51 is a general connection.

Note: C_1 = 0.1 μF (From experience), it is placed near the power source and used to eliminate high frequency EMI.

Clock Reset Circuit

When a microcontroller is powered up, then, prior to its reach to the ultimate phase of supply voltage, it passes across the voltage ranges, whereby the gadget doesn't guarantee to function. Because of the fact that cells of some devices are expected to begin functioning at voltage levels lower than others, the gadget is likely to power-up in an unfamiliar phase. For the purpose of guaranteeing that the gadget works in a familiar phase, controlling the reset stage is quite essential. With the use of either external reset circuitry or by device's embedded program, it is possible to attain this. The reset circuit is put to application for placing the device into a default state that is the initialization of microcontroller. It is useful to keep microcontroller always that can be started at a familiar status. With this method, we are capable of making sure that microcontroller functions at a steady condition all the time in addition to reducing the system cost and increasing system reliability. In general, there are three different reset sources: Power-on Reset Circuit, Manual Reset and Internal Watchdog Reset.

The reset pin of AT89S51 is active at high electrical level. While resetting the chip, the reset pin is mandatorily required to reach high level and remain at least two machine cycles. AT89S51 will be capable of completing the system reset action, resulting into all SFR set to a known state, together with executing the program at the location 0000H. Here, AT89S51 joins together the power-on reset and manual reset, as presented in Figure 18:

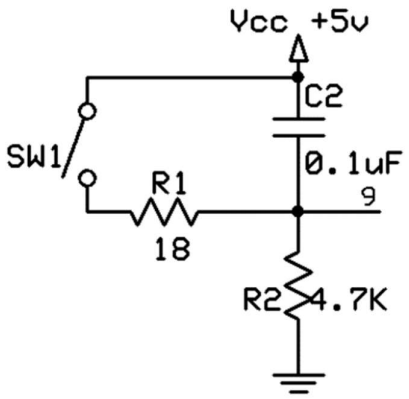


Figure 18. Reset Circuit for AT89S51 is needed for ensuring system to go smoothly.

Both the value and function descriptions of each component have been summarized in the Table 2 below:

Table 2. The value and function description of each component.

Label	Name	Data	Usage
K_1	Switch on-off Button	none	Manual reset button
C_2	104 Ceramic Capacitor	0.1 μF	Adjust the voltage on RST and determine the reset time
R_1	Resistor #1	18 Ω	Avoid EMI effect when capacitor discharging
R_2	Resistor #2	4.7 KΩ	Determine the voltage on RST and the reset time

As evident from Figure 18, its reset procedure is the combination of power-on reset and manual reset. When the pin VCC is powered on (now the switch $K_1$is off), the capacitor C_2 kicks off to charge. Now, the capacitor performs as a wire, so the circuit has a current passing through from the VCC to GND. Resultantly, there should be a voltage V_2 across the R_2, implying that the voltage of pin RST is no longer zero (low level) and it has the voltage V_2 that is high level, and the chip will be rest. This is the procedure of power-on reset.

In respect of manual reset, as the switch K_1 is turned on, the capacitor C_2 discharges immediately. In the meantime, there is a current passing through the R_1 and R_2, a voltage V_2' is generated on R_2 that makes pin RST get a voltage V_2' which is a high level, thus, the chip is reset manually.

The consideration of reset time should be taken. As evident from experience, T_{rst} = 1.2RC.

Here, R = R_2 = 4.7 KΩ, C = C_2 = 0.1 Mf. So, $T_{rst} = 1.2\times4700\times0.1\times10^{-6}$ = 564 μsec

≫ Two Machine Cycles (Usually equal to 2 μsec)

Crystal Oscillator Circuit

Approximately, all of the digital circuits require clock pulses to function. A microcontroller requires one as well. Clock pulses are required for the synchronization of the operations between various peripherals of the MCU. They also deliver the timing for the execution of operations.

Crystal oscillators are meant to deliver stable clock pulses to the digital circuit. A clock pulse (CP) is a string of alternating 0's and 1's as presented in the Figure below:

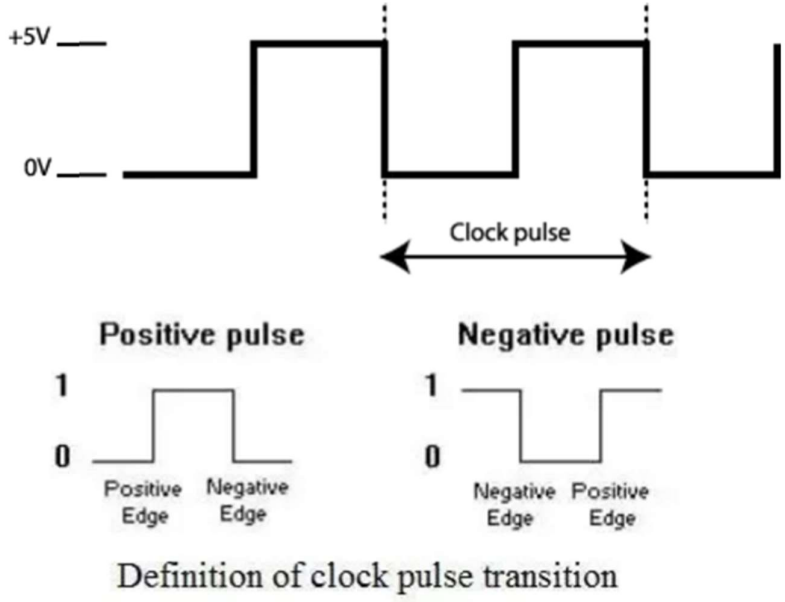


Figure 19. Clock Pulse Definition is above.

XTAL1 and XTAL2 perform the function of input and output, correspondingly, of an inverting amplifier that is capable of being adjusted to be used being an on-chip oscillator, as presented in Figure 21.

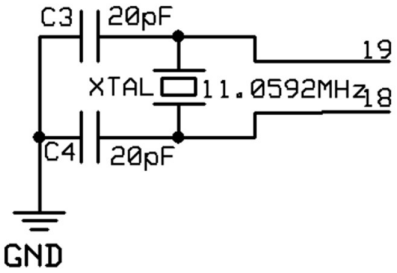


Figure 20. Oscillator Connection for AT89S51 is above.

Note: C_3, C_4 = 20 pF for Crystals

$Y = f_{crystal} = 11.0592$ MHz

PIR Detection Module

PIR Sensor

All of the items having a temperature more than absolute zero release heat energy in the shape of radiation. Different objects are capable of generating different wavelengths. Normally, a human body can release an infrared radiation at a wavelength of 10 μm. PIR sensor (passive infrared sensor) is able to distinguish humans on the bases of this principle. It consists of three parts: two balanced sensors, impedance transistor and element window. PIR sensor features two balanced sensors inside it whereby both of them are made of a specific material, responsive to IR, in addition to having a detection area. As soon as a warm physic, for instance a human or an animal walks nearby, it, firstly, develops interception of one half of the PIR sensor that gives birth to a positive differential variation between the 2 halves. As soon as the temperate body goes away from

the sensing field, the opposite takes place and the sensor brings forth an adverse differential variation. These are the variation pulses that are identified as presented in Figure below:

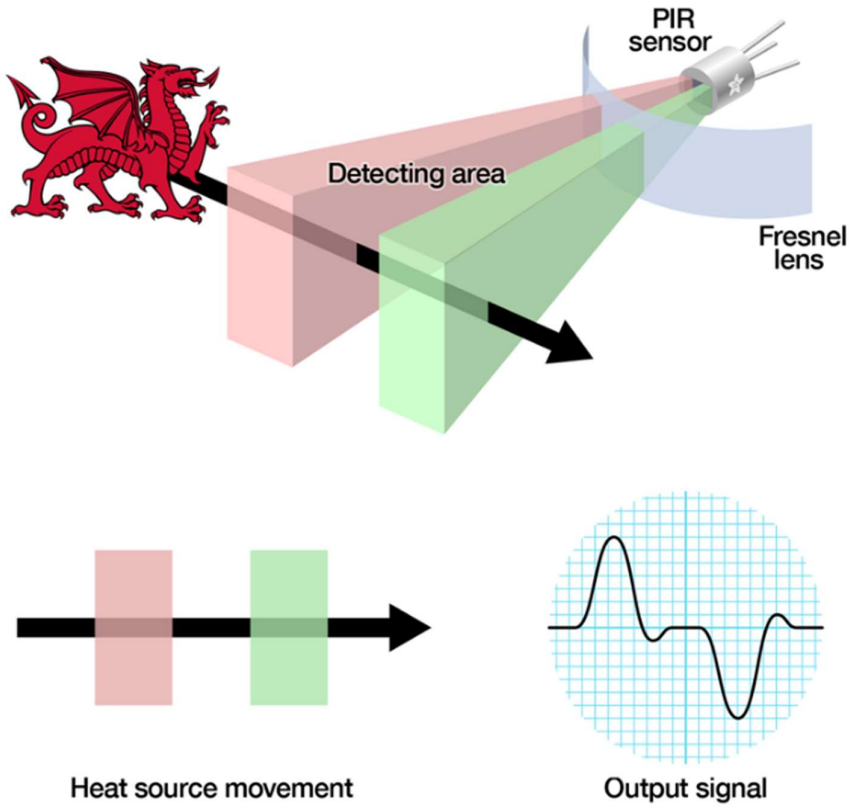


Figure 21. Basic Operation and output wave of a PIR Sensor is above.

There is actually a hermetically sealed metal case kept outside the sensors, which is put to use for the protection of the internal parts. In this scenario, we can take into notice a rectangle area that is made of IR-transmissive material. It can do away with noise/temperature/humidity immunity but it is typically coated with silicon since that allows IR easily comes by, as illustrated in two figures below.

Figure 22. Element Window is the sensing part of a PIR sensor.

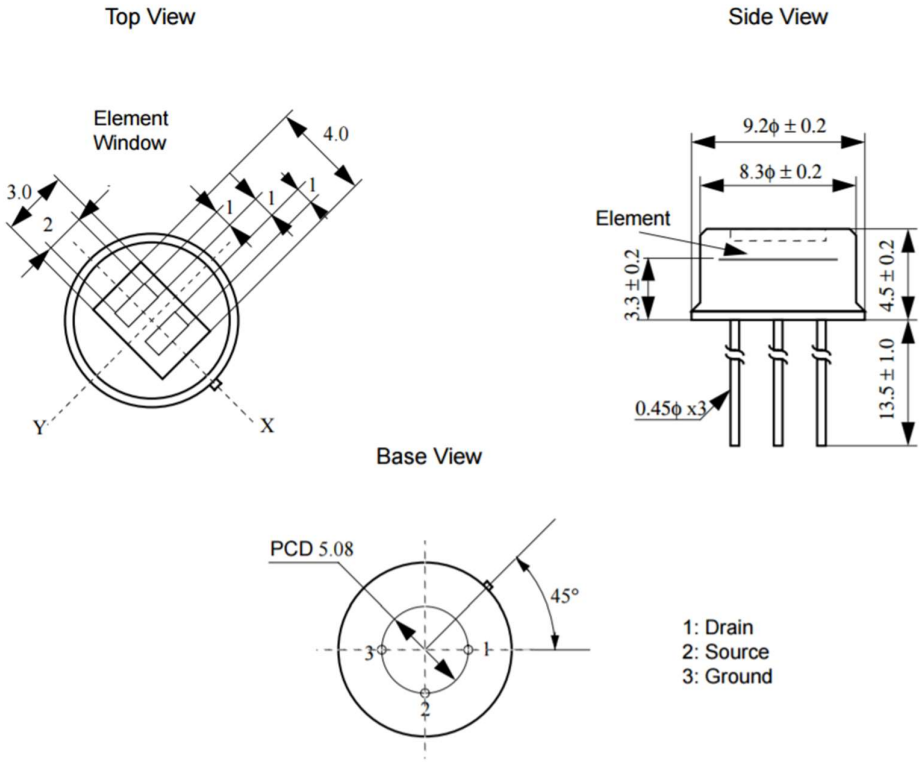


Figure 23. 3- Views Diagram of RE200B's Element Window is outlooking observing from three different direction.

Figure below throws light on the internal schematic. In fact, there is a JFET within (a kind of transistor) that showcases quite a very low-noise together with buffering the extensively elevated obstruction of the sensors into something that is an affordable chip

(for instance the BIS0001) is able to sense.

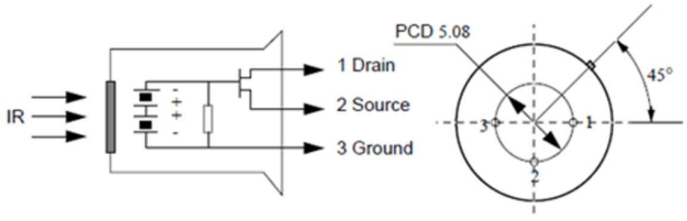


Figure 24. Internal Schematic of RE200B can be applied on general PIR sensor.

As of a common, we shall be interested in having an identification region, which is quite extensive. In order for this, we utilize a straightforward lens, for instance those discovered in a camera: they compress an extensive area (for instance a landscape) into a tiny one (on either film or a CCD sensor) that are termed as Fresnel lenses. The Fresnel lens compresses the light, bringing forth an extensive series of IR to the sensor.

In respect of indoor, on account of the constraint in the pyro-electric infrared sensor detection range, it is usually not possible to detect the existence of the human body in every corner even with Fresnel Lens, so, are mandatorily required to place sensors in every different region for the purpose of controlling the lighting of the respective area. In this design, we only simulate one single detection region.

As soon as someone enters the area, the human body infrared rays are received by the infrared sensor and the presence of the human body will be sensed together with generating a high level. As soon as the people enter the most insensitive direction of movement, the signal won't satisfy the requirements that would, thereafter, produce a malfunction. Because of that fact, we are required to pay attention to the detection

direction of PIR sensor while installing.

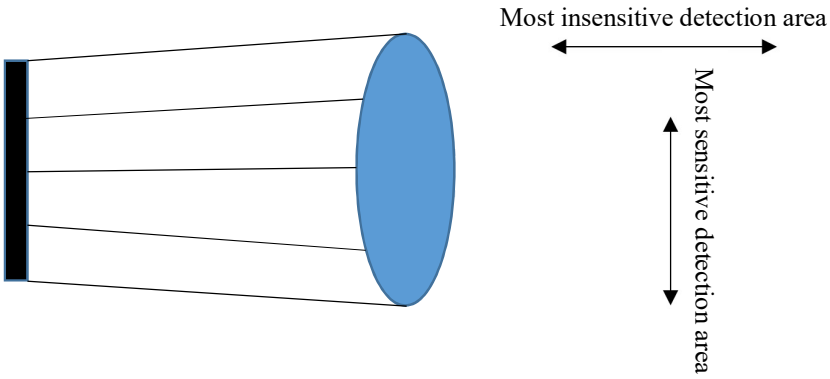


Figure 25. PIR sensor has different detection sensitivity in different direction.

PIR Sensor Structure

Because of the weaknesses of the output signal from PIR sensor, for instance the insensitive signal differential, the small amplitude (less than 1 mV), signal is required to be adjusted with a processing module before it heads towards controlling the lighting system. This signal processing circuit transforms the output from PIR sensor into a digital signal, which is appropriate for microcontroller. On the bases of this requirement, the block diagram of a PIR detection system has been presented in Figure 26.

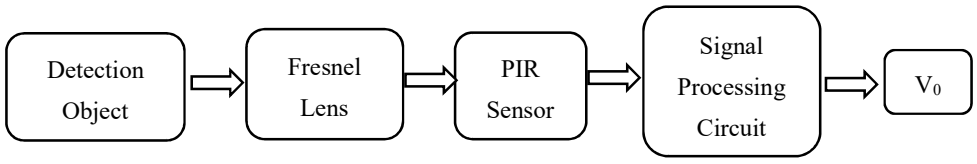
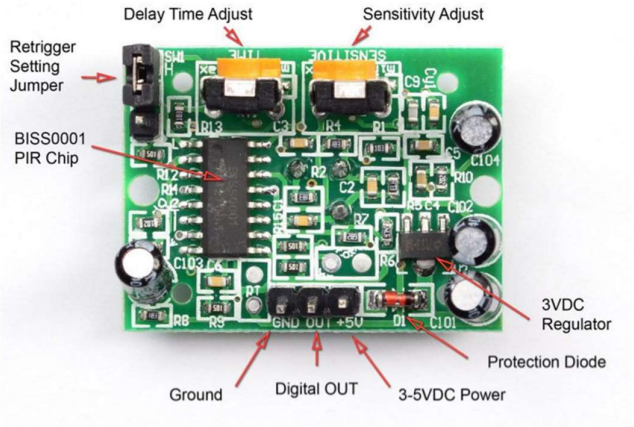
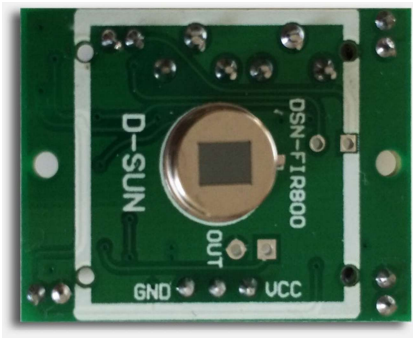


Figure 26. Block diagram of a PIR detection system shows the floating consequence of the PIR detection module.

In practice, we put to utilization PIRs that possess more modifiable configurations (front side) together with having a header (back side) that is installed in the 3-pin ground/out/power pads, as presented hereunder:



a. front side



b. back side

c. Integrated PIR Sensor with Fresnel Lens

Figure 27. PIR Sensor Detector has development board in current market which is ready to be used, specially including the Fresnel Lens.

External Circuit of PIR Module

Pin 1 poses to be the pin that gets the positive DC voltage. The PIR motion sensor is in need of between 5V-9VDC of energy for the purpose of functioning. In respect to our

situation, we are going to employ approximately 6V. Pin 2 works as the output pin of the PIR module. Pin 3 functions as the negative DC voltage or ground pin of the gadget. We develop a connection of the negative terminal of the energy source with this pin, in respect of a return path. For the purpose of improving the reliability of this circuit, a 680PF capacitor is added between pin 1 and pin 2. Pin 2 is connected to the P 3.3 on AT89S51 that possesses a 100 KΩ pull-up resistor. With this way, we are able to make the output signal more stable. Its connection has been presented hereunder:

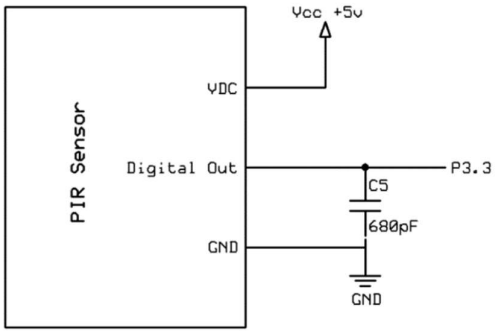


Figure 28. External circuit of PIR module is able to generate a digit signal directly.

Light Intensity Detection Module

Photoresistor and Light Intensity Sensor

In general, we identify light intensity using the light sensor. In the current market, there are lots of several types of light sensors. Here, my goal is to choose one that possesses the advantages in respect to both its function and price.

Photoresistor (or light-dependent resistor, LDR, or photocell) poses to be a light-controlled variable resistor. The resistance of photoresistor varies on the bases of the

changes of incident light intensity, leading to the change of the voltage on itself. In accordance with the different light intensities, the input voltage on the positive terminal of voltage comparator positive is expected to change. Thereafter, it is compared with the negative voltage in order to control the operating states on LED. We can take into notice the number of lighting LEDs for the purpose of determining the current illumination.

Light intensity sensor converts optical signal into current, and then transforms current into voltage output with ADC or DAC. Owed to the fast paced development of electrical technology, light intensity sensor possesses an enormous advance on integrating the ADC inside. Conversely, when we design the sensor circuit, no external ADC or DAC is required. Light intensity sensor is capable of converting the analog input into digital output that can connect to the microcontroller in a direct manner. It can make our system easier to build as well as maintain.

Owed to the low cost together with high stability of light sensor, here, we have used the light intensity sensor OPT3002 made by Texas Instruments.

OPT3002 Light-to-Digital Sensor

The OPT3002 light-to-digital sensor brings forth the function of an optical power meter inside a sole gadget. This optical sensor goes a long way in improving the system output in comparison with photodiodes as well as photoresistors. The OPT3002 features an extensive spectral bandwidth that ranges from 300 nm to 1000 nm. This is how it has high precision. Measurements can be taken from 1.2nW/cm2 up to 10mW/cm2 with requirement of no manual selection of the full-scale ranges with the use of integrated full-

scale setting attribute. This potential lets have light calculations of more than a 23-bit efficient dynamic range. Compensation of the findings is made in respect of dark-current effects, together with other temperature changes. It has broad applications in many fields:

- Intrusion and Door-Open Detection Systems
- System Wake-Up Circuits
- Medical and Scientific Instrumentation
- Display Backlight Controls
- Lighting Control Systems
- Tablet and Notebook Computers
- Thermostats and Home Automation Appliances
- Outdoor Traffic and Street Lights

The OPT3002 is completely incorporated and delivers optical power reading in a direct manner from the I^2C- and SM Bus well-matched, two-wire, serial interface. There are either consistent or single-shot calculations. The OPT3002 fully-functional energy use stands as low as 0.8 μW at 0.8 SPS on a 1.8-V supply. Its main features have been summarized in Table 3 hereunder (Texas Instruments, n.d.):

Table 3. Main Features of OPT3002 Light-to-Digital Sensor.

Wide Optical Spectrum: 300 nm to 1000 nm	Automatic Full-Scale Setting Feature Simplifies Software and Configuration
Measurement Levels: 1.2 nW/cm2 to 10 mW/cm2	23-Bit Effective Dynamic Range With Automatic Gain Ranging
Flexible Interrupt System	Low Operating Current: 1.8 µA (typ)
Operating Temperature: –40°C to +85°C	Wide Power-Supply: 1.6 V to 3.6 V
5.5-V Tolerant I/O	12 Binary-Weighted, Full-Scale Range Settings: < 0.2% (typ) Matching Between Ranges
Small Form Factor: 2.0 mm × 2.0 mm × 0.65 mm	

OPT3002 showcases a relatively simple structure inside. In the meantime, its Pin configuration has been presented in Figure 29 as well as Figure 30.

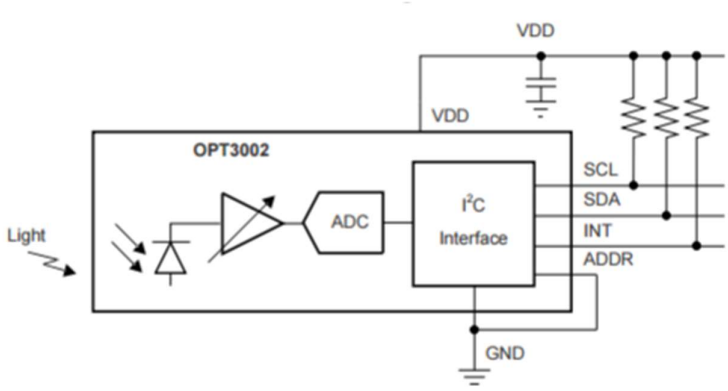


Figure 29. Block diagram of OPT3002 shows that OPT3002 owns the ADC which is so convenient for users.

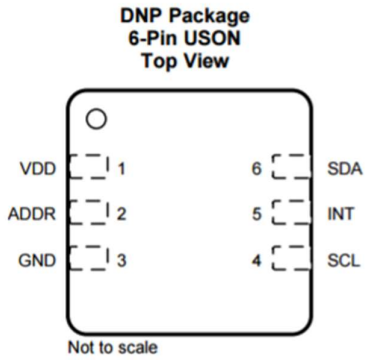


Figure 30. OPT3002 has six PINs.

Table 4. Description of Pins.

PIN		I/O	Description
NO.	NAME		
1	VDD	Power	Device power. Connect to a 1.6-V to 3.6-V supply
2	ADDR	Digital Input	Address pin. This pin sets the LSBs of the I^2C address
3	GND	Power	Ground
4	SCL	Digital Input	I^2C clock. Connect with a 10-kΩ resistor to a 1.6-V to 5.5-V supply
5	INT	Digital Output	Interrupt output open-drain. Connect with a 10-kΩ resistor to a 1.6-V to 5.5-V supply
6	SDA	Digital Input/Output	I^2C data. Connect with a 10-kΩ resistor to a 1.6-V to 5.5-V supply

Interface between OPT3002 and AT89S51

The electrical interface for OPT3002 is purely straightforward together with being completed through the connection of the OPT3002 I^2C SDA as well as SCL pins to the same pins of an application processor, microcontroller, or other digital processor. Herein, AT89S51 possesses no specific SDA and SCL. In this case, we are able to design SDA and SCL with two general I/O pins (SCL: P2.3; SDA: P2.4) with the help of

programming. Connect pull-up resistors between an energy source that is suitable in respect to digital communication as well as the SDA and SCL pins (owed to the fact that they have open-drain output builds). A common value in respect of these pull-up resistors amounts to be 10 kΩ. Connection has been shown in Figure (Texas Instruments. n.d.):

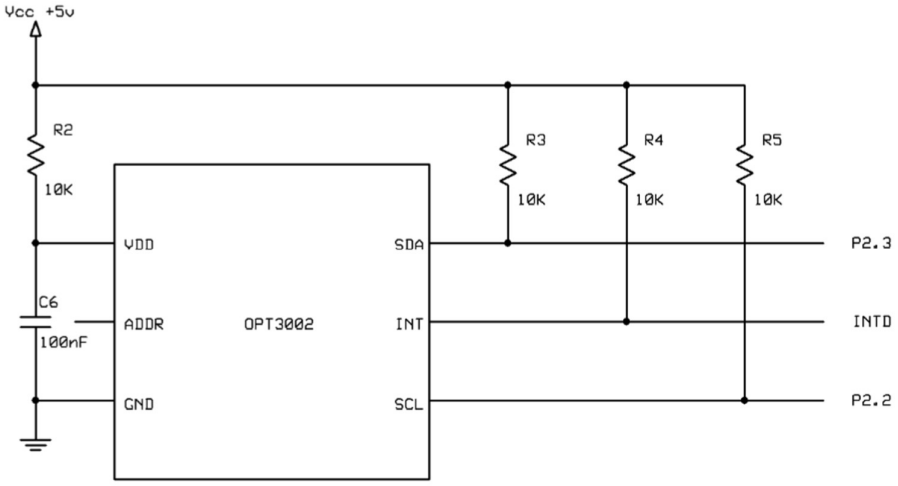


Figure 31. Interface between OPT3002 and AT89S51.

Despite the fact that the OPT3002 features low sensitivity to power-supply problems, there are always suggested to follow the right practices. In respect of optimal output, the OPT3002 VDD pin is required to possess a steady and low-noise energy source having a 100-nF bypass capacitor proximate to the gadget as well as robust grounding. There are lots of options when it comes to providing power to the OPT3002 due to the fact that device current use degrees are quite low (Texas Instruments. n.d.).

LCD 1602 Display & Monitor Module

This module was designed in order to exhibit the findings on current working status of system, including the lighting on/off, the mode (Auto or Manual), lighting level (High Illumination or Low Illumination).

LCD 1602

The LCD-1602 is a low power 16 characters by 2-line liquid crystal display, with serial interface. It can display two rows with up to 16 characters on each row. Based on its datasheet, the details of Pin configuration are listed in Table 5 (Lumex Company, n.d.).

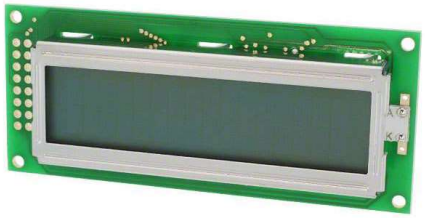


Figure 32. In this module, we use the LCM-S01602DSF/F (with backlight) coming from Lumex, Inc.

Table 5. Pin Configuration Description of LCD 1602

PIN NO.	SYMBOL	LEVEL	FUNCTION	
1	V_{SS}	—	Power Supply	GND
2	V_{DD}	—		5V
3	V_o	—		for LCD drive
4	RS	H/L	Register Select Signal H: Data Input L: Instruction Input	
5	R/W	H/L	H: Data Read (Module→MCU) L: Data Write (Module→MCU)	
6	E	H,H→L	Enable	
7-14	DB0~DB7	H/L	Data Bus-Software Selectable 4 Or 8 Bit Mode	
15	A	H	Positive Pole of Backlight Power Source	
16	K	L	Negative Pole of Backlight Power Source	

Its operating voltage ranges from 4.7V to 5.3V that asks for no voltage change on 5V. The details of electrical characteristics have been listed in Table 6.

Table 6. Electrical Characteristics of LCD 1602.

ITEM		SYMBOL	CONDITION	STANDARD VALUE			UNIT
				MIN.	TYP.	MAX.	
Supply voltage for logic		V_{DD}-V_{SS}	—	—	5.0	—	V
Supply current for logic		I_{DD}	V_{DD} = 5V	—	2.0	3.0	mA
Input Value	High	V_{IH}	—	2.2	—	V_{DD}	V
	Low	V_{IL}	—	0	—	0.6	V
Output Value	High	V_{OH}	—	2.4	—	—	V
	Low	V_{OL}	—	—	—	0.4	V
*LED Backlight	Voltage	V_f	I_f = 160 mA	—	4.2	4.6	V
	Current	I_f	—	—	160	—	mA
	Power Consumption	P_D	—	—	656	—	mW
	Luminous	L	I_f = 160 mA	70	—	—	Cd/m^2
	Color	—	—	—	—	—	nm

* Only apply to modules with backlight.

LCD 1602 Display Module Circuit

The external connection between LCD 1602 and microcontroller AT89S51 is quite simple that just connects data bus DB0~DB7 to the I/O ports P1.0~P1.7 of microcontroller. The RS pin goes with P2.0, WR pin goes with P2.1, and E pin goes with P2.2. The resistor 18Ω between Vo and GND is capable of maximizing the clarity of display and the value was attained on the bases of experience. The diagram of module has been illustrated in the Figure below.

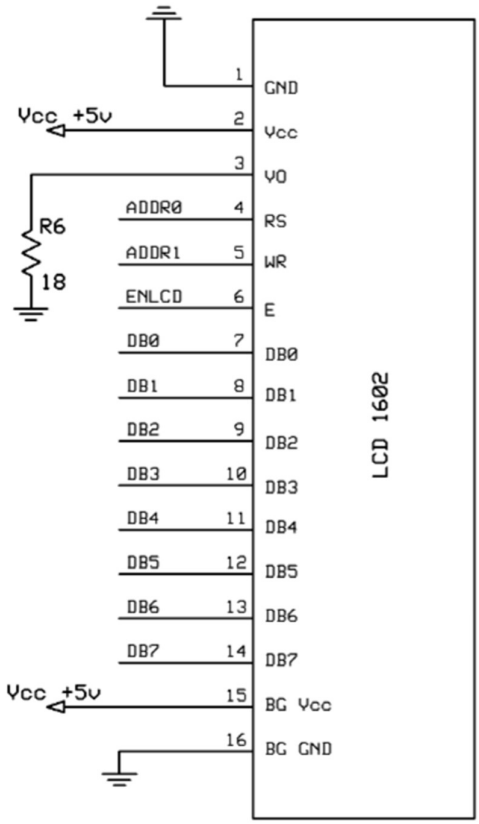


Figure 33. Diagram of LCD 1602 display module is normal.

Power Supply Module for Controlling Unit

This module is designed for the purpose of delivering a DC source for the support of the central control unit so that it could operate well (The operating voltage of central control unit is 5 DCV). The core of PSCP is a positive voltage regulator L7805CV that is employed for the generation of 5 DCV to bring forth the energy to central control unit and LED lighting unit (only for the practicum on demo, in normal life, LED lighting unit is powered by house supply). It houses three pins: input, ground, and output. The L7805CV is an affordable and user-friendly positive voltage regulator with 5V output voltage.

Figure 34. Pin configuration of L7805CV is general. (Output voltages of 5; 6; 8; 8.5; 9; 12; 15; 18; 24 V).

The maximum input voltage of L7805CV is 35V, and it is designed that input voltage should be larger than output voltage by at least 2V. Based on this rules, I set the input voltage as 9V. It is necessary to have a DC adapter to convert 110 ACV into 9DCV. The output port of adapter is connected to the input port of voltage regulator 7805. After voltage stabilization and filtering by monolithic linear regulator, the output of 7805 is 5DCV which is okay to supply power to the system. Additionally, I use a LED to be the power light which is able to indicate the power status of system.

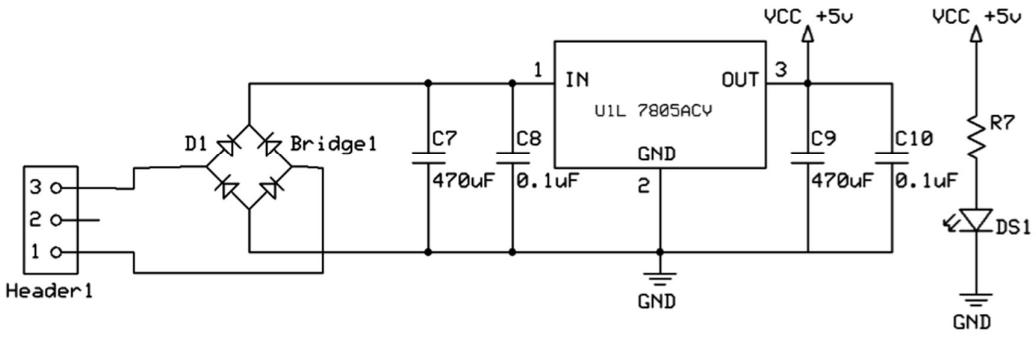


Figure 35. The schematic diagram of this power supply module is above.

As the Figure 34 showing above, the power supply of this system utilizes DC power supply. First, through the voltage transformation, rectification, first-time filtering, voltage stabilization and the second-time filtering, the 110V AC power will be transferred into a stable 5V DC voltage, and it will be supplied for the entire control circuit, the drive circuit and the display circuit power supply. The following content will describe the role of each part.

The circuit is analyzed as follows: As shown in Fig. 34, the 110 V AC (ie. mains) is input. In general, the DC voltage we need is very different from the effective value in terms of the mains. At this point, the voltage needs to be reduced by step-down transformer (12V), and then process the AC power afterwards, that is make a transformation from 12 ACV to 5 DCV. In the selection of the transformer we should also pay attention to the selection of the nameplate, which can avoid the impact on the follow-up circuit. The output AC voltage of the transformer secondary side also has a certain impact on the following DC.

Through the rectifier circuit, the voltage output by the secondary side of the transformer will be converted to direct current. The rectifier process can be achieved through four diodes. Since the DC power after rectification contains a large amount of AC components, this will cause a certain impact on the load circuit, for example, the AC component will be mixed into the input signal and be amplified by the amplifier circuit, even the AC component mixed in the output end of the power supply is greater than the useful signal, therefore, this DC power supply circuit cannot be powered.

In order to address the above problems, filter circuit and capacitor filter need to be used to smooth the output DC. In the ideal case, the AC component should be filtered out so that the output voltage is stable DC. However, due to the impact of passive filter circuit, the load on the filter circuit is bound to cause a certain impact.

After the AC voltage has been treated as described above, although the AC component in the DC voltage is small, when the mains fluctuation or the load changes, the DC voltage will change as well. At this point a voltage regulator circuit needs to be connected to make the output DC voltage basically not affected by the mains or load changes, so that the stability of the DC power supply can be greatly improved.

LED Lighting Module

Contemporary LED bulbs are mandatorily required to transform the standard household supply (for instance 110V AC in US) into a DC supply at a lower voltage (typically 12V DC to 24V DC) in respect to the LED array. This is performed on a per-bulb basis. This module achieves the electricity from the power supply system that has already been introduced in last section. For the purpose of simulating the system by creating a demo, I have used four LEDs to replace the house-used LED bulbs.

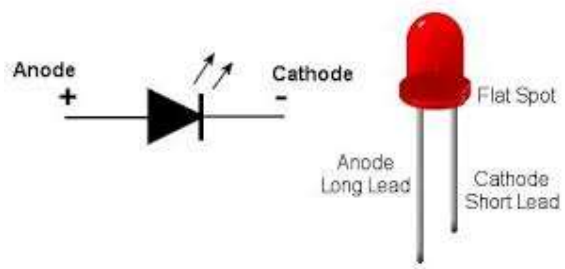


Figure 36. LED is very popular in current lighting market.

The schematic diagram of this module has been provided below. V_{out} +5V is the power from the power supply module, whereby each LED is connected with a pin on AT89S51 (DS 1 to Pin 3.4; DS2 to Pin 3.5; DS3 to Pin 3.6; DS4 to Pin 3.7). AT89S51 is expected to produce at a low level from its port to the negative side of LED based on the current scenario of system. In this case, LED will be lit on. Beside this, $R_8 \sim R_{11}$ are current limiting resistor which is added to each LED. The advantage of them is to help prevent any type of damage to LED.

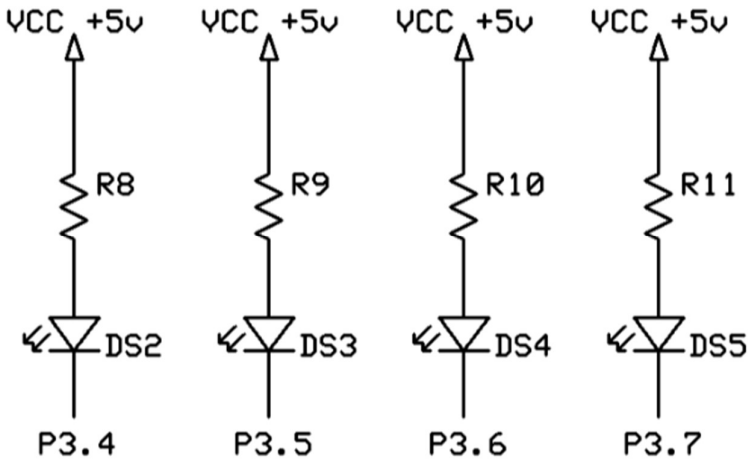


Figure 37. The schematic of this module shows connection of each components.

Modes Switching Module

This module is developed for the selection of the modes (Auto or Manual) flexibly in accordance with the preferences of the user. At times, people are looking to adjust the illumination intensity by themselves; in the meantime, the system isn't capable of delivering the perfect lighting solution. In such a scenario, the user is available to opt the manual mode and then light the number of LED as per the requirements. In another case, the system commits a mistake while organizing the presentation of people, that is, in fact, there are some people in this room but they are not involved in any activities. Due to the sensitivity of PIR sensor and limitation of PIR detection range, sensors aren't expected to deliver any effective output. At this time, the system will provide the wrong result to turn off the lights in the room. For the purpose of doing away with this inconvenience, user will prefer the manual mode to change the illumination level and turn on/off the lighting as per the requirements.

The module has been presented in the diagram below, whereby the default settings of system are "Auto Mode". When user presses the Key 1, modes is changed to "Manual Mode". As the Key 2 is pressed, the mode is changed back to "Auto Mode". Key 1 and Key 2 are connected to the Pin 1.0 and Pin 1.1 on AT89S51, correspondingly.

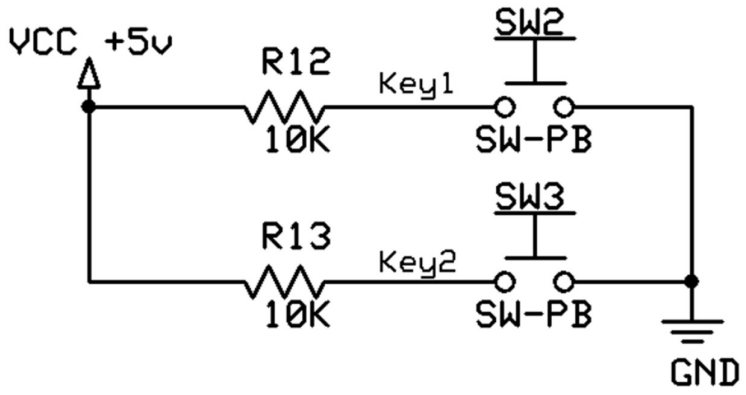


Figure 38. Circuit of Modes Switching Module shows operating principle about how to switch between two modes flexibly.

CHAPTER 4

SYSTEM CODES ON SOFTWARE IMPLEMENTATION

The Main Program Module System Monitoring

The system monitoring program can be divided into interrupt subroutine and monitoring main program according to the module. The core of the entire Lighting-Control system is main observation monitoring program. Through the feedback information the SCM received from the human body infrared sensor, with the program written by the user, the determination will be made and be displayed in the LCD1602 LCD screen.

System Self-Test Initialization

In order to ensure the normal operation of the entire control system, the system's self-test initialization is a very necessary condition. After the power-on reset, the system will enter a self-test initialization process, so the system's self-test initialization is completed. The initialization mainly refers to initial parameter settings and definitions to some data area, control registers and external chips. In this system， it mainly represents the initialization of the internal registers of the system, the detection of the interface chip and the initialization of the internal parameters of the chip.

The detection of the interface chip is mainly used to check if the chip is ready for

operation and is there any malfunction in the hardware. If the clock chip is in the active state, it is necessary to initialize the clock chip and start the real-time clock.

System internal register initialization generally refers to the data buffering, register SFR reset initialization of part of the special functions, and initialization assignment of partial user-defined data variables. When the microcontroller has been reset, the counter PC will point to the entry address of the program memory. The program status word register PSW will be cleared, the on-chip memory will select the working register, and the user's flag bit F0 will be 0. What's more, the stack pointer SP is set to 07H, and the other interrupt enable register IE, timer, accumulator ACC, and so forth are all 00H.

Timer Interrupting Handling Design

The timer interrupt is caused by used-up timer or the situation that the count value is full while using SCM internal timer. An internal timer counter can count the external pulse or internal clock input from an external lead T0 and T1. The overflow signal of the counter will cause interruption, and the bit flag of the bit overflow will be applied to interrupt the microcontroller CPU.

The timing interrupt is a periodic interruption, which will occur in certain interval. The timing interrupt set in this system is mainly used to construct the multi-tasking operating system. After the response is interrupted, it is not necessary to protect the breakpoint on-site. It can directly enter the multi-task time division work, so that the corresponding operational tasks are ready. The timing interrupt handler block diagram is shown in Figure 40:

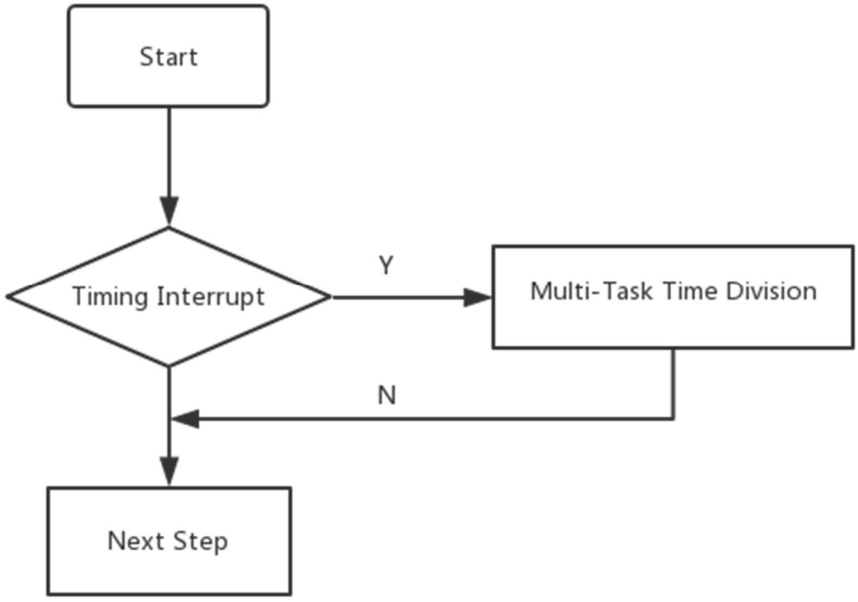


Figure 39. Timing interrupting handler block diagram is the necessary design.

The system also uses an external interrupt to determine whether there is an external signal input, if any, it will be collected and then processed; if not, the system will return to the main loop.

Electromagnetic Interference (EMI) Elimination for PIR Sensor

Human infrared sensor has many advantages, such as its low power consumption, the reasonable price compared to other products, and most importantly, it will not produce any harmful radiation on the human body. Its disadvantage is it is easy to be interfered by various types of light sources and heat sources. When there is a human body inside but has no activity for a long time, the human body infrared sensor will think there is no human existence. In order to avoid this phenomenon, the system software program is designed to

have the presence of the human body after the interval of 1 minute or longer before the collection of the relevant parameter signals.

The human body sensors are susceptible to external interference, so we have to pay special attention to how to eliminate the interference caused by the outside world.

(1) Small animal interference

The detector is mounted on a specific using height, and the small animals on the ground within the detection range of will not cause the sensor to produce a signal.

(2) Electromagnetic interference

Detector anti-electromagnetic interference performance is in line with GB1040 requirements, and the general mobile phone electromagnetic will not cause interference.

(3) Light interference

When the detector is within the range of normal sensitivity, the reach of the irradiation from H4 halogen lamp through the glass from 3 meters away will not causing any signal generation.

Data Acquisition Software Implementation

When the ambient light is strong enough (illuminance >= 750), no matter whether there is human or not, the system will not turn on the lights; when the ambient light is not insufficient, the light will turn on when there is human presence, otherwise no light will be turned on. The logical relationship table can be shown in Table 7:

Table 7. The logical relationship among room illuminance, person presence and LEDs operating status

Room Illuminance	Person Presence	LEDs operating status
0	0	0
1	0	0
0	1	0
1	1	1

CHAPTER 5

SIMULATION TESTING BASED ON PROTEUS

Keil C51 Software for Programming of AT89S51

Keil C51 Introduction

This system design uses Keil C51 software in programming. Keil C51 software is one of the best software for single-chip application development. The Keil C51 integrated development environment is a Windows-based software development platform. It contains source file editor, project manager, source program debugger and so on. It can compile, program, and simulate. In addition, it supports assembly and the programming design using PLM language and C language. With the user-friendly and easy-to-learn-and-use features, it greatly makes the system design more convenient.

Advantages:

(1) Keil C51 has a very high object code generate efficiency, and most assembly code generated by the statements are very compact, and easy to understand. The advantages of high-level language can be shown in large-scale software development.

(2) Compared with the assembly language, C language has obvious advantages in terms of the structure, readability, maintainability, and functions. Therefore it is simple and very easy to use. The advantage of C language is more obvious after using assembly

language.

Code of AT89S51

Based on the operation order of this lighting system, the logic of code should be followed as in Figure 40.

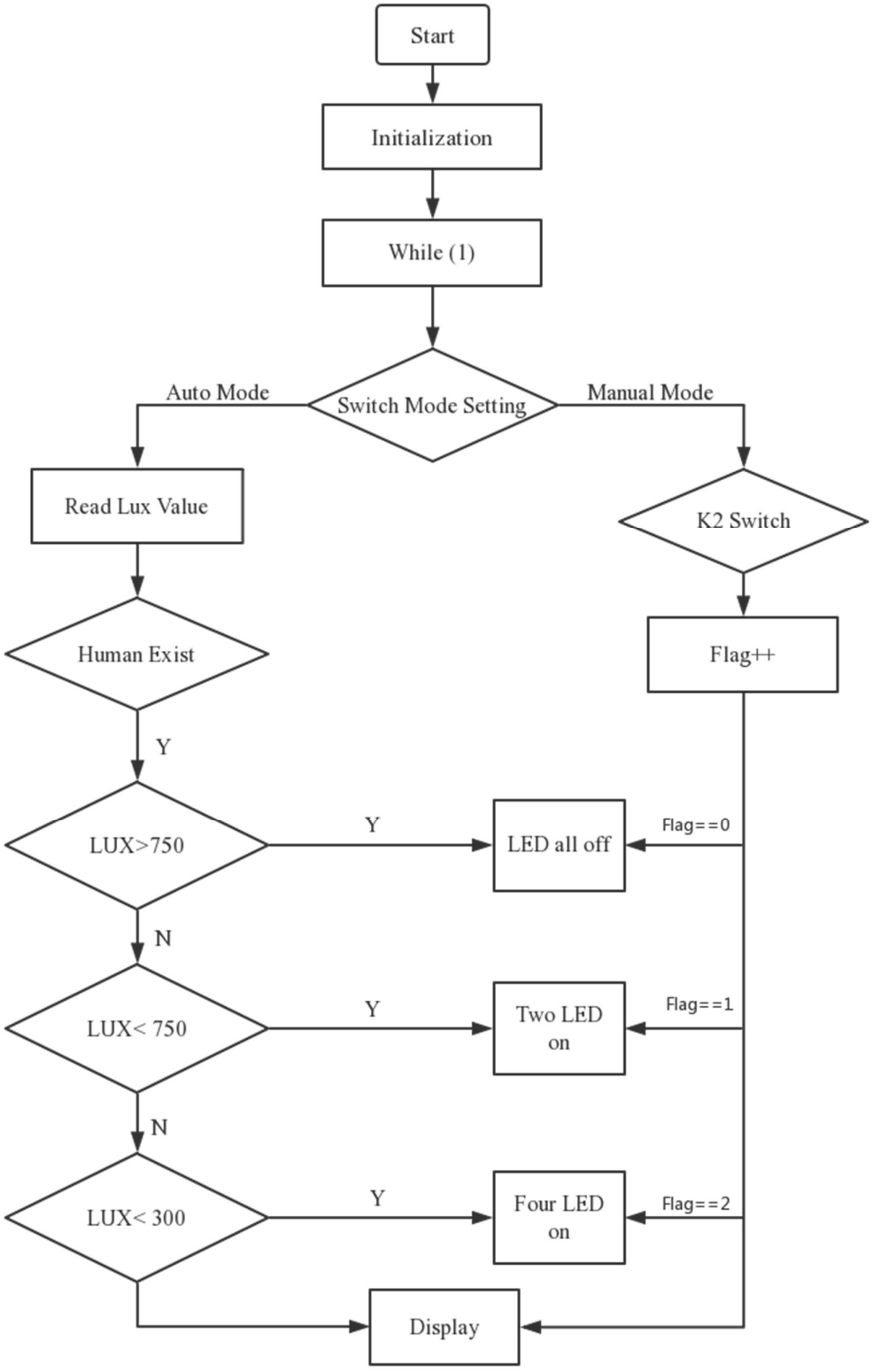


Figure 40. The flow chart of programming logic.

Simulation Solution on Protues

Protues Introduction

This study uses Proteus simulation. Proteus is the most economical and most complete electronic design automation (EDA) system (Jansen, 2010) produced by UK's Labcenter Electronics. It not only has other EDA tool software simulation functions, but also equipped with simulation of single-chip and peripheral devices. Proteus combines PCB design, advanced schematics, automatic routing, and mixed-mode SPICE simulations to implement a complete electronic design system. Among them, ISIS intelligent schematic input system is the center of the Proteus system (Wu, He, 2012). In terms of compilation, it also supports IAR, Keil, MPLAB and other editors. Therefore it is deeply favored by the microcontroller enthusiasts, the developers dedicated in single-chip microprocessors and the teachers specialized in single-chip teaching.

Proteus simulation also has the functions owned by other EDA tool software, which are: Principle layout, SPICE circuit simulation, PCB automatic & manual wiring. Protues has two Revolutionary features: (1) Interactive circuit simulation: Users can use real-time devices such as ROM, RAM, keyboard, motor, LED, LCD, AD / DA, some IIC devices, and some SPI devices. (2) Simulation processor and its peripheral circuits. It can simulate AVR, 51 series, ARM, PIC and other commonly used mainstream single-chips and carry on virtual prototype programming based on the schematic program. Companied by the display and output, the output and input effect can be seen after the operation

Simulation Solution

Simulation by Porteus is restrained due to the limitations of simulation equipment, and some features cannot be achieved. Such as human infrared sensor cannot simulate, so we use switch to replace the function. The overall simulation of the system is shown in Figure 41.

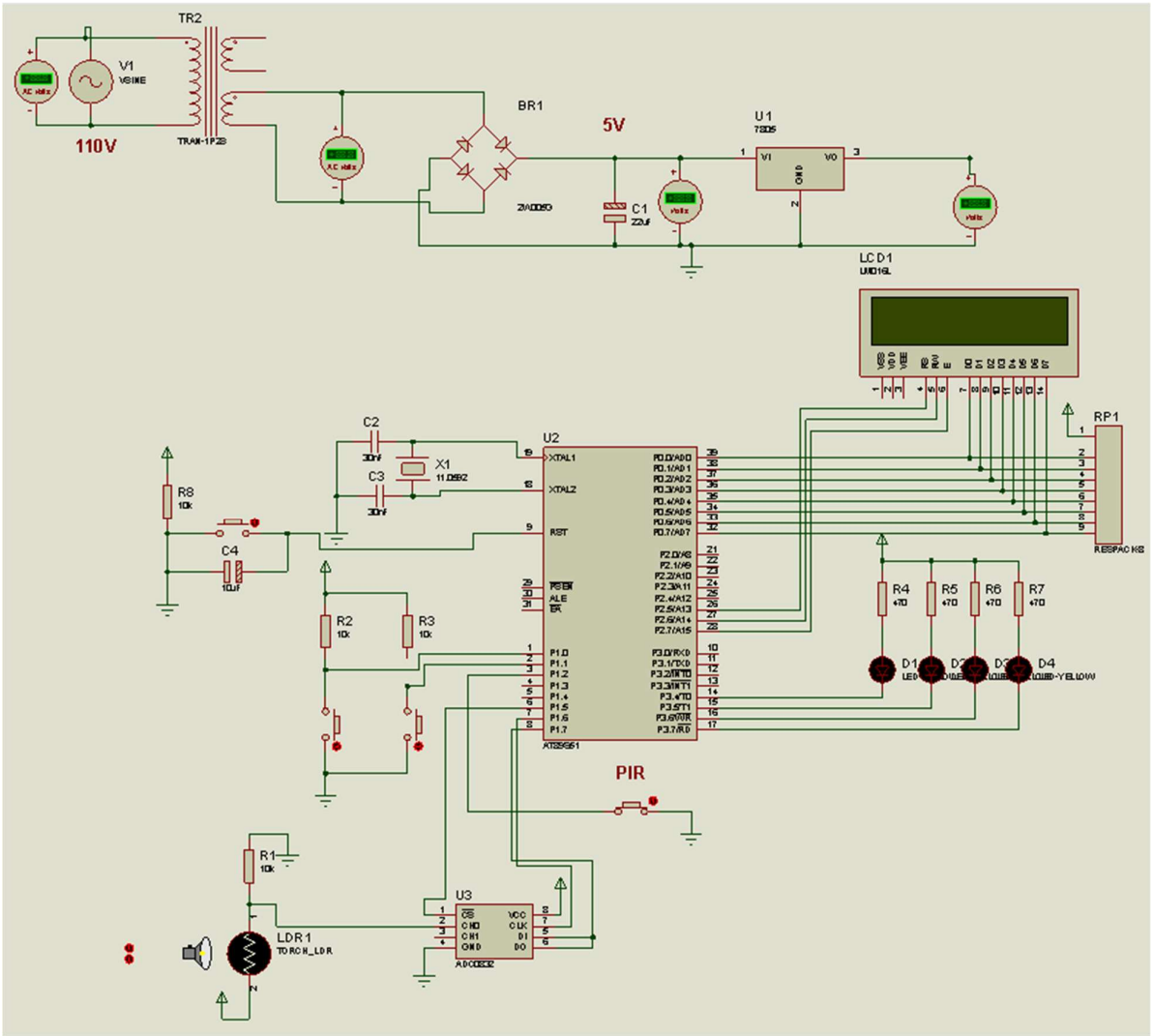


Figure 41. The overall simulation diagram of the system uses the a press key and photoresistance to replace PIR module and light intensity sensor because of the limitation of Protues.

CHAPTER 6

SUMMARY AND CONCLUSION

This article aims to research and improve the room interior irrational lighting system. From the original manual control room lights switch to the present intelligent control, we have better met the requirements resulted from the contemporary scientific and technological development through the existence of the human body and the analysis of the intensity of natural light at present. With it as an input parameter, through programming and debugging, the two elements that determine the brightness of the classroom and lights on/off will come into being. Through pyroelectric infrared sensor, this design detects the existence of the human body using the simple circuit of photosensitive resistor to detect the strength of the current ambient light. The design concept is easy to understand and bears high adaptability. The design is also applicable to office buildings and other places. In order to make the design more humane, the time control parameters are also added in, which makes the lighting system better meet the users schedule. Reducing the energy consumption, while at the same time allow the enjoyment of the warmth of life. It bears important practical significance and is worthy of schools to promote it. In the choice of hardware, the success completion of a stable operation of the system is required, as well as a low purchase cost. If the cost is too high,

coupled with the great amount of electricity consumption, the system is not easy to be popularized. In software design, this design adopts multi-task form to collect and process signals. In terms of the system installation, the design of the system is small and easy to install as well as to place, therefore the system does not necessarily require the room to reroute the lines.

As the difference on the area of rooms. Therefore, the number of the lights each room needs to be installed is not the same. There are two problems referring the human body sensor, one is the sensor sensing distance problem: too big a room will result in that many parts of the room cannot be covered by human infrared sensor, which is bound to cause the misjudgment of the system and harm the system in practice. In view of the infrared sensor sensing area is limited, a room is supposed to be equipped with multiple sets of automatic lighting systems. Second, the human body infrared sensor is the detector of moving human body, that is, only when the human body is in action, the infrared sensor can sense the presence of the human body, but when the human body stays still, such as someone in the sensor area is in sleep, the sensor will not input any signal. So the detection result is no human existence. On the ground of that, in the process of running the system, it would be better to make the human body sensor device swing to make up its shortcomings in operation.

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