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AN EMBEDDED SYSTEM DESIGN IN AUTOMATION OF STREET LIGHTS USING ATMEGA 8535L MICROCONTROLLER

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***Abstract*-The main aim of the paper is to automate the streetlights using the AVR Microcontroller with the help of a clock and intensity sensor. In this paper, we are using ATmega8535 microcontroller chip, which is having the inbuilt ADC, and this is the heart of this project, a Real Time Clock (RTC) DS1302, which counts the time, week, date &year etc., a Light Depending Resistor (LDR) where the resistance of it varies with intensity of light, 7 segment displays for time & intensity indication and a key pad.**

An LDR and an RTC are interfaced to the microcontroller. An LDR sense the light and the variation of its o/p resistance is given to the signal conditioning circuit. Where it is converted in to a Voltage signal and is given to the microcontroller through the ADC. We can modify/set the time using the key pad. We can set the time period during which the lights are to be turned On/Off. The Microcontroller has programmed in such a way that both the criteria are considered i.e. time & intensity and accordingly the street lights will be switched on/off.

***Index Terms*- ATMEGA 8535, DS1302, LDR, & Real Time Clock.**

1. INTRODUCTION

The present human life is being dominated by automation very much. There is no office, school, companies, factories, industries etc., without this automation. Any work is done automatically in all fields in this fast era. Here it reduces the human work, it produces the more output with accuracy, and the system works efficiently. Every controlling action is taken automatically. We have taken the project to control one of the day-to-day activities automatically i.e., street lights control, where human mistakes leads to loss of power.

Without power, we cannot expect the human life in the present days. It became as one of the basic needs to lead a human life. Power consumption increased drastically and the need to save the power is very essential. However, the power is wasted in number of ways in our day-to-day life. In that one is wasting of power through street lights. Generally, streetlights are controlled by two methods: Manually & Automatically.

In the Manual operation, we have to come across many disadvantages. In this the common human mistakes like not switching off the lights during the day times, neglecting the timings of switching On/Off the lights and in the rainy seasons with the irresponsibility of workers even a life can be lost. So it’s all lead to the automation of street lights.

In the automation of streetlights, the control action based upon (i) Intensity & (ii) Time. In the Intensity, based method control action is done considering the light intensity. The lights will glow whenever there is less intensity and puts off when the light intensity is more. However, the disadvantage we encounter here is, during cloudy days the intensity is very less all over the day. Here the lights always glow. Loss of power is more. There is always chance of false triggering in case of lightening also. Therefore, this is not recommendable.

When coming to the Time based, we fix up the time during which the lights should be On/Off. However, the disadvantage here is during the summer the days are long and during the winter, the nights are long. So the lights should be switched off quickly during summers and switched off lately during winters in the morning times. In the evening times it takes vice versa. But the time is preset, it can’t be changed.

Here the problem arises and function irregular of seasons.

In order to overcome these disadvantages, we are controlling the streetlights using the micro-controller where the two parameters are taken into account. Here we are interfaced the LDR and RTC to the micro-controller, where the control action is taken through the program written to the micro-controller using the both parameters at a time. This is easy to operate and we can rewrite the program according to our requirements.

2. BLOCK DIAGRAM

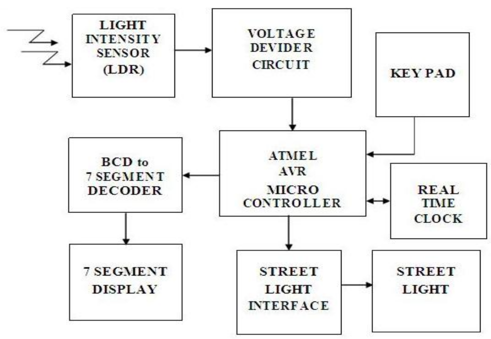

Fig 1.Block diagram of Automation of street Lights using ATmega 8535 MC

The module consists of 8 major blocks:

1. Light Sensor
2. Voltage Divider Circuit
3. AVR Micro-Controller
4. Key Pad
5. Real Time Clock (RTC)
6. 7 Segment Decoder
7. 7 Segment Display
8. Street light interface

1. Light Intensity Sensor:

A Light sensor is an electronic component that responds in some way to light and converts it in to variation in one of its Electrical characteristics. Photosensitive elements are versatile tools for detecting (radiant energy) light. They exceed the sensitivity of the human eye to all the colors & intensity of the spectrum and operate even into the ultraviolet and infrared regions. "**Light Dependent Resistor**" is one among the photosensitive devices that is mostly used in engineering applications. The same device is used here.

The principle of LDR is the resistance varies inversely with the light intensity i.e. more the intensity, less is the resistance and vice versa. In almost all ,the LDR the resistance changes from millions of ohms to hundreds of ohms under maximum illumination. The dark resistance of LDR used here is about 5 MΩ.

2. Voltage Divider Circuit:

It is a resistive circuit arrangement with one reference resistor and a variable resistor which is the LDR here and the supply given across the terminals. As the Resistance of the LDR changes the voltage across that change as the supply voltage is divided in between the two resistors. The variation in voltage can be calibrated in terms of intensity.

3. Micro-Controller Unit:

Microcontroller is the heart of the Project. Where every action is under the control of the Microcontroller. The micro-controller used here is ATmega8535L.It is an 8-bit low power high performance AVR micro-controller. It has 8K Bytes of Flash memory, 512 Bytes of SRAM and 512 Bytes of EEPROM.

The program for controlling the streetlights is written in the micro-controller. The real time clock, output voltage from the signal conditioning circuit, key pad & Display sections are interfaced with the microcontroller. Microcontroller communicates with the different sections and performs the action according to the given program.

4. Key Pad:

Key pad is a device which provides the interface to the user in order to provide input to the microcontroller for different purposes. Here this key pad provides the interface to the user with the system in order to view different sections i.e. Hours& min, Month& Date and Intensity etc. And the time can also be changed using the same key pad.

5. Real Time Clock (RTC)[3]:

Real Time Clock is a device which counts the time in real manner with the help of accurate crystal. The RTC used here is DS1302. It is an 8-pin RTC with simple 3-wire interface. It counts seconds, minutes, hours, date of the month, month, day of the week, and year with leap-year compensation valid up to 2100.

It is interfaced to the micro-controller via a simple serial interface and programmed according to our requirements. The time can be accessed &modified using the microcontroller.

6. BCD to 7 Segment Decoder:

This decoder converts the given BCD data to the 7 segment display data required in order to display the data using the 7 segment display. Using the decoder saves a lot of work and pin usage for the microcontroller because in the absence of the decoder the BCD data in turn has to be converted by the microcontroller and 7 output pins are required. With this decoder only 4 pins are required.

7. 7 Segment display:

This one of the basic display devices. With the help of 7 segments all the digits are displayed by using the segments in different combinations. In order to display the digit '8' all the segments are used. Basically there are two types of 7 segment displays namely "Common Anode" & "Common Cathode". Difference lies in the supply to be given to the common pin i.e. either Vcc or GND, the inverse signal has to be given to the data pin.

8. Streetlight Interface:

Generally street lights are the analog high voltage devices. So, the control signal from the Microcontroller has to be given through an interface. Here the interfacing between the micro-controller and streetlights is done by relays for low power devices and with some other interfacing for high power street lights.

3. STEPS FOR IMPLEMENTATION PROCEDURE

The process execution can be divided into two parts

Part A: Control action:

1. Microcontroller reads the time from the RTC.

2. Checks weather the time is in the output toggling region or not. Toggling region is the duration of time during which the lights should be toggled i.e. switched on/off.

3. IF the time is not in the toggling region microcontroller returns to the first step, else continues with the following steps.

4. Microcontroller checks weather the output toggling has been taken place in the same time region before or not.

5. If the toggling action has already been taken place Microcontroller returns to the first step, else continues with the following steps.

6. Normally the light is allowed to fall on the LDR. The resistance of the LDR varies inversely to the intensity.

7. The resistance is given to signal conditioning circuit and the o/p is voltage signal and it is given to the micro-controller through ADC for measurement of Intensity

8. Microcontroller reads the intensity and compares it with the predefined value.

9. If the intensity was higher than the required value in the morning time then the Street lights will be switched off, if the intensity was lower than the required value in the afternoon time then the Street lights will be switched on. In the other condition no control action takes place and the execution returns to the first step.

Part B: Setting the time:

1. There are 5 key for setting the time Edit, Up, Down, Right, & Left.

2. In normal the time will be displayed with Hours and Minutes. If we just want to see the others i.e. seconds etc. we need to press the 'Left' or 'Right' Key the display will rotate between Hr-Min, Date-Month, Year, Min-Sec and back to Hr-Min the display mode is indicated by 4 LED's separately.

3. If we want to modify the time go to the required mode using 'Left' & 'Right' keys and then press 'Edit' key, use 'UP'& 'Down' arrows to set the required value. Use 'Left' & 'Right' keys to edit more parameters. Once Modification is complete press the 'Edit' Key again to come back to normal display mode.

The total circuit can be divided into sections & Sub sections as

1. **Atmel AVR® Microcontroller Atmega8535[2]:**
   a. Normal Port IO operation
   b. ADC single ended channel voltage measurement.
2. **Real time clock:** Interfacing with microcontroller
3. **Display:**7 segment decoder & 7 segment display arrangement
4. **Key pad:** Reading a key
5. **Intensity Measurement:** Light Dependent Resistor & Voltage Divider Circuit
6. **Street Light Interfacing:** Current Buffer

4. CIRCUIT DIAGRAM AND ITS FUNCTIONALITY

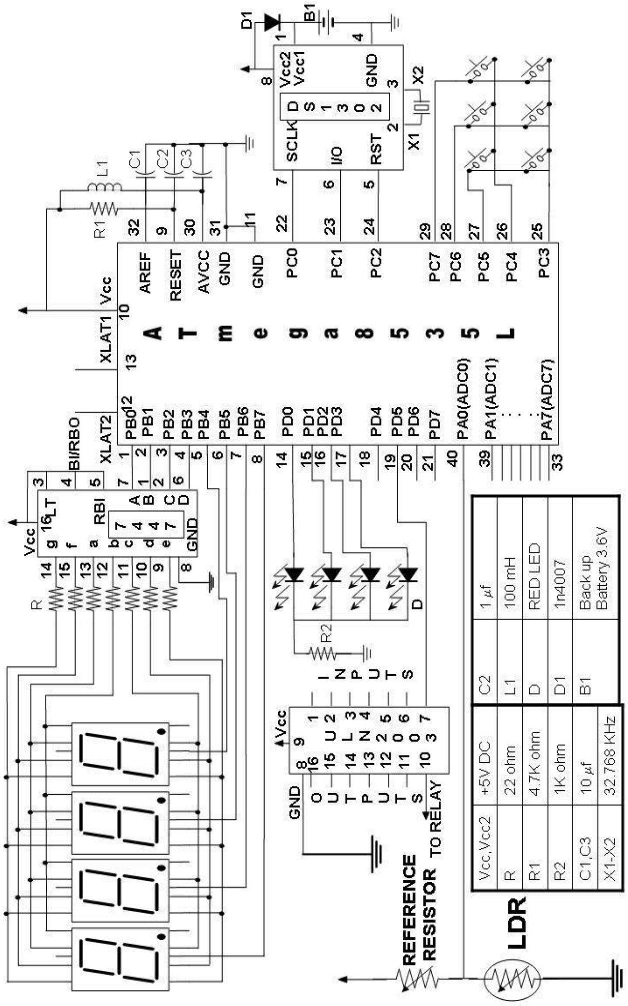

Fig 2. Interconnection of different modules for automation.

Basic Features of ATmega8535L[4]:

1. High performance, low power 8-bit microcontroller
2. Advanced RISC architecture with 130 powerful instructions & Upto 16 MIPS throughput.
3. 8Kbytes of In system self programmable flash
4. 512 Bytes EEPROM & 512 Bytes of internal SRAM
5. Programming Lock for software security
6. Two 8-bit Timer/Counters,
   One 16-bit Timer/Counter
   Four PWM Channels
7. 10 bit ADC 8 single-ended channels
8. On chip analog comparator
9. Programmable serial USART
10. Master/Slave SPI serial interface
11. Programmable watchdog time with separate on chip oscillator
12. Operating voltage 2.7 to 5.5V and Operating speed 0 to 8 MHz
13. It has Power on reset and Programmable Brown out detection and internal calibrated Interrupt sources
14. It has External 7 internal interrupt sources.

Pin assignment for ATmega 8535L Microcontroller: It has 32 programmable IO lines 40 pin PDIP

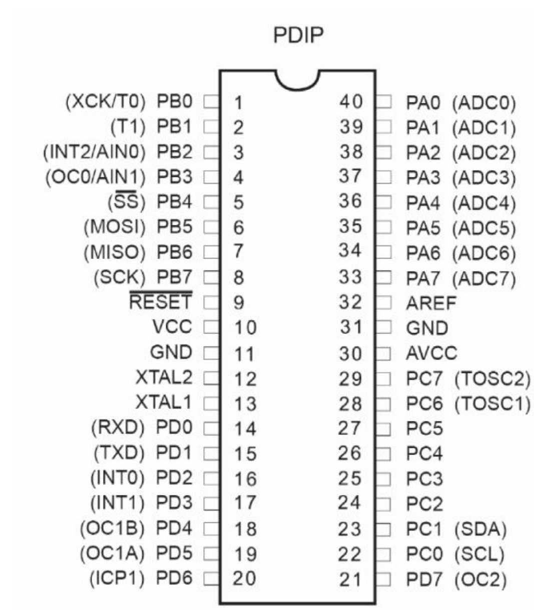

Fig 3. Pin Diagram of ATmega 8535L

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5.DESCRIPTION OF PINS FOR DIFFERENT FUNCTIONALITIES

VCC Digital supply voltage.

GND Ground.

I/O Ports – (PA0– PA7, PB0– PB7, PC0– PC7, PD0– PD7)

All the ports serve as an 8-bit bi-directional I/O port. Port pins can provide internal pull-up resistors (selected for each bit). The Port output Buffers have symmetrical drive characteristics with both high sink and source capability. When pins are used as inputs and are externally pulled low, they will source Current if the internal pull-up resistors are activated. The Port pins are tri-stated when a reset condition becomes active, even if the clock is not running.
Apart from this all the ports have their own alternate functions they will be explained later.

RESET :

Reset input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. The minimum pulse length is 1.5 µs. Shorter pulses are not guaranteed to generate a reset.

XTAL1:

Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

XTAL2 :

Output from the inverting Oscillator amplifier.

AVCC:

AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

AREF:

AREF is the analog reference pin for the A/D Converter.

Port A Alternate functions:

Port A acts as the input for the ADC

Table I. Port A functions

Port Pin	Alternate Function
PA7	ADC7 (ADC input channel 7)
PA6	ADC6 (ADC input channel 6)
PA5	ADC5 (ADC input channel 5)
PA4	ADC4 (ADC input channel 5)
PA3	ADC3 (ADC input channel 5)
PA2	ADC2 (ADC input channel 5)
PA1	ADC1 (ADC input channel 5)
PA0	ADC0 (ADC input channel 5)

Port B Alternate functions:

Port B pins have the alternate functions of SPI interface, Analog comparator inputs, Timer/Counter external clock input.

Table II. Port B Functions

Port pin	Alternate Functions
PB7	SCK (SPI Bus Serial Clock)
PB6	MISO (SPI Bus Master Input/Slave Output)
PB5	MOSI (SPI Bus Master Output/Slave Input)
PB4	SS (SPI Slave Select Input)
PB3	AIN1 (Analog Comparator Negative Input) OC0(Timer/Counter0 Output Compare Match Output)
PB2	AIN0 (Analog Comparator Positive Input) INT2(External Interrupt 2 Input)
PB1	T1 (Timer/Counter1 External Counter Input)
PB0	T0 (Timer/Counter0 External Counter Input) XCK(USART External Clock Input/Output)

Port C Alternate Functions:

Port C pins have the alternate functions of Timer oscillator& Two wire serial interface.

Table III. Port C Functions

Port Pin	Alternate Function
PC7	TOSC2(Timer Oscillator Pin2)
PC6	TOSC2(Timer Oscillator Pin2)
PC1	SDA (2 wire serial bus data IO line)
PC0	SCL (2 wire serial bus clock line)

Port D Alternate Functions:

Port D pins have the alternate functions of external interrupts, USART, Timer match outputs, capture inputs.

Table IV. Port D Functions

Port pin	Alternate Function
PD7	OC2(Time/Counter2 Output compare match output)
PD6	ICP1(Timer/Counter1 Input Capture Pin)
PD5	OC1A(Time/counter 1 Output Compare A Match Output)
PD4	OC1B(Timer/Counter1 Output Compare B Match Output)
PD3	INT1(External Interrupt 1 Input)
PD2	INTO(External Interrupt 0 Input)
PD1	TXD(USART Output Pin)
PD0	RXD(USART Input Pin)

The features & connections that we use in the microcontroller are

1. Normal port I/O operation.
2. ADC single ended channel measurement.

1. Normal Port I/O Operation:

In order to interface with the devices used like RTC with the microcontroller we need to use the normal port operation of the micro controller. Normal port operation means the I/O ports will act as either input or output. For the port I/O operation the microcontroller has inbuilt pull up resistors, which are most useful when using the pins as the inputs.

The ports are bit operable, means some pins can be used as input and the others can be used as outputs. When the pins are used as inputs the pull-up resistors are to be enabled in order to read/sense the input.

The pins used as normal IO as PBO-PB7 is Display Unit,PCO-PC2 is RTC, PC3 – PC7 is Keypad, PD0-PD3 is Display Mode Indication & PD5 is Output Interface.

2. ADC Single ended Channel Voltage Measurement:

Analog to Digital Converter is one of the main advantages of this Microcontroller. This was most useful for the measurement purposes. In the absence of which a large interfacing circuit and a critical program is required to use an external ADC.

Port A pins can be configured as inputs for ADC using the Special function I/O Register. ADC in the microcontroller is the 10 bit 8 channel ADC with 8 single ended measurements or 7 differential measurements. ADC Conversion process can be Controlled By using the two Registers ADMUX, ADCSRA. This can be operated in different modes i.e. Free running, Single conversion and Auto triggering on Interrupt Source. In free running mode the operation can be repeated to measure the voltage continuously. Full input voltage range up to Vcc is accepted. And a choice of different voltage references is available.

Real Time Clock (RTC):

The RTC used here is DS1302. The DS1302 Trickle Charge Timekeeping Chip contains an RTC/calendar and 31 bytes of static RAM. It communicates with a microprocessor via a simple serial interface. The RTC/calendar provides seconds, minutes, hours, day, date, month, and year information. The end of the month date is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or the 12-hour format with an AM/PM indicator.

Data can be transferred to and from the clock/RAM 1 byte at a time or in a burst of up to 31 bytes. The DS1302 is designed to operate on very low power and retain data and clock information on less than 1 microwatt.

6.SCHEMATIC DIAGRAMS

Display Arrangement:

All the four 7 segment displays are connected in parallel with the outputs of the decoder but the common pins are connected to the four control outputs of the microcontroller.

Here the data to be displayed in the first 7 segment display is placed on the data inputs to the decoder and then the common pin for the first segment is raised and placed at high level and then it was made low

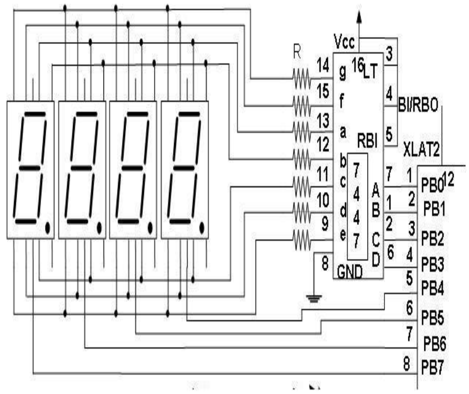

Fig 4. Schematic Interface with 7 Segment Display

Then the data on the data lines of the decoder will be displayed[5]. After that the same thing was made to happen with all the other displays. This whole process is completed in terms of micro seconds t milliseconds. Actually the display is discrete but due to high speed of operation the display will be looking continuous. Thus a 4 digit display was achieved using only 8 pins.

Key Pad Arrangement:

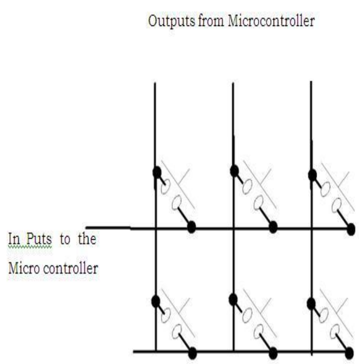

Fig 5. Push button key press diagram

Key pad is one of the input devices to provide input to the microcontroller. Keys are arranged in the matrix form to minimize the usage of I/O pins and some of them are made as inputs and the others are outputs. Scanning is required to find the key pressed.

The key pad arrangement used here is a 3 X 2 key pad. In which 3 lines are outputs from the microcontroller and 2 keys are inputs to the microcontroller. As it indicates 6 switches are connected. As the port pins are pulled up for the microcontroller internally it can detect only an active low signal. To read a key only one of the line is made low and the other two lines are made high using the outputs from the microcontroller. Then the inputs are detected for a low signal. If any low is detected depending upon the line where the low signal is detected the key was recognized. If no key press was found the other line is made low and the process repeats for all the three output lines from microcontroller. Thus the key pressed was detected.

Intensity Measurement:

Intensity measurement was required to decide the intensity of light sufficient or not in order to switch on or off the street lights. The Light intensity sensor used is an LDR.

Light Dependent Resistor:

The intensity of light will be constant during the day and night. But it will change drastically most probably between 5-7 AM/PM. Typical plots of Intensity& Variation of resistance of the LDR are given below.

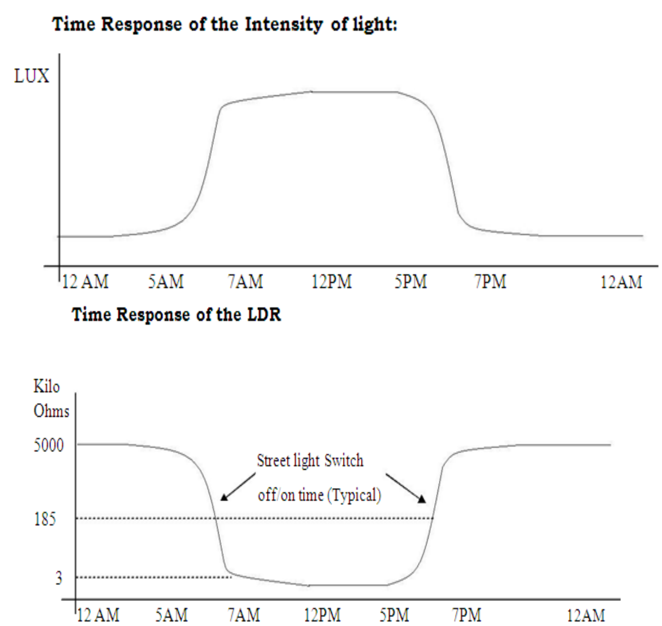

Fig 6. Graph showing time response of LDR & street lights switch ON/OFF

Voltage Divider Circuit:

Voltage divider circuit is a sort of signal conditioning circuit for resistance as variable parameter. In which the variation in the resistance is converted into variation in voltage across the LDR. The response was non linear but by adjusting the reference resistor properly the circuit can be operated in the linear range.

Here the linear range required is about from 300 K ohms to 60 K ohms[1] so the Reference resistor was adjusted to around from 185-220 K ohms such that the response in the required range is linear.

The typical Voltage Response of the Voltage divider circuit was given below

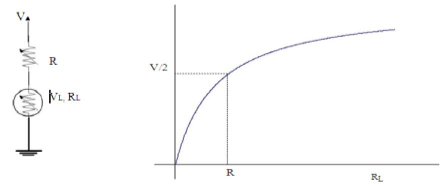

Fig 7.LDR schematic diagram & its response

7.RESULTS & CONCLUSIONS

Street Light Interfacing:

It was done by using a Darlington array IC named ULN2003.Because the maximum current rating of the microcontroller was limited to 47mA a current driving circuit was required in order to operate a relay. This IC buffers and amplifies the output current from the microprocessor in order to drive the relay connected from the relay the street lights can be interfaced to switch on/off. It has 7 channels of the same but we are using only one channel

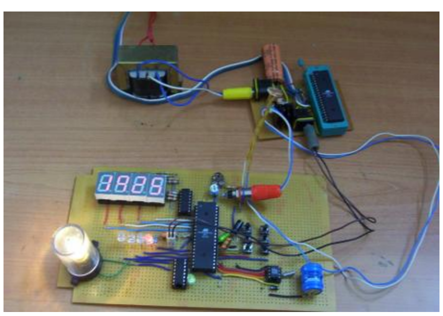

Fig 8. Showing street light ON at 19:25 hours

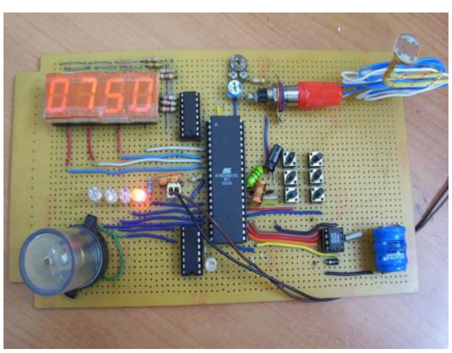

Fig 9.Showing a Street light is OFF at 07:50 AM hours

Applications:

The main area of applications will be controlling the devices according to the time and variable parameters such as climatic conditions.

Some of the examples:

Street lights. And Lighting control inside an office where they have to be operated time to time and whenever necessary.

Conclusion:

The street lights were controlled according to the time and intensity in order to minimize the power loss and accurate action was achieved. This can be used any where for the controlling of the street lights because of it's flexibility in adjusting the time and intensity measurement.

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