DESIGN AND CONSTRUCTION OF A MICROCONTROLLER BASED AUTOMATED INTELLIGENT STREET LIGHTING SYSTEM

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ABSTRACT

This Paper Presents a Microcontroller based Automated Intelligent Street lighting System which is utilized for power conservation, intelligence and fault detection. The main objectives are to automatically switch the street light to an ON/OFF state utilizing the Light Dependent Resistor, to save power and increment the life time of the LED utilizing Infrared Sensor(IR) to dim and brighten up the LED at intervals and to create a system where a fault is detected and a fault location message is sent to an assigned GSM number or control centre. This is achieved using a PIC18F26K22 microcontroller. The PIC microcontroller on the main board serves as the brain house of the system where every activity is coordinated from. The module used for lighting is the LED. The system automatically turns ON the light according to the degree of darkness and turns OFF the light according to the intensity of light. A Light Dependent Resistor (LDR) sensor, an Infrared Sensor (IR) and a GSM module are used for this research work. This system works at night. Street light will come to an ON state when the LDR senses a high degree of darkness but remains in a Dim state which is still bright enough for motorist to see clearly. Full ON is activated when movement is detected within the proximity of the IR but the Dim state is reactivated back after the movement is no longer sensed. The GSM module sends a fault detection message to a control centre or assigned GSM number stating the location of the faulty LED when a fault is detected with the LED or the LED does not come up. This design can save a considerable amount of Power because of the Dimming of the LED through the Infrared Sensor. However maintenance and personnel cost is reduced and lifespan of the LED is increased.

Keywords: - PIC Microcontroller, IR Sensor, LDR Sensor, LED, GSM Module, Fault Detection, Automated, Intelligence

1. Introduction

A well outlined street lighting system should allow Road users to move around evening time with great visibility, in wellbeing and comfort and improving the presence of the area. Inadequately composed lighting frameworks can prompt poor visibility which isn't useful for any person on foot or driver. Regularly road lighting is ineffectively designed and not appropriately maintained which suggests that there are a substantial number of flawed and dead lights and uses out of date lighting innovation which expends a lot of vitality and monetary assets. Providing street lighting is a standout amongst the most essential duties of a city.[7,8,9] Automated Intelligent Street lighting System is fundamentally utilized as a proficient method for power conservation and maintenance cost. The design of this Project is done in a way that that the Light Dependent Resistor sensors are fixed in all the road lights circuit and which are responsible for switching automatically. Once the LEDs are switched on, GSM module reports status of faults to the control centre. With this set up in place, the worker now can without much of a stretch find the specific light to be taken

care which limits search and repair time. This Project makes utilization of a LDR sensor which detects light to go to an ON state, IR sensor which detects movement variations and takes the LED to a FULL ON and when idle takes the LED to a HALF ON state. The current sensors report issues to the Microcontroller which at that point sends a message to an assigned GSM number/control unit. This street lighting system is a vital method for increasing street wellbeing around evening time. It enhances the personal satisfaction by preventing wrongdoing and by influencing individuals to feel more secure. Lighting is likewise used to enhance the atmosphere of regions, which is monetarily advantageous to the environment.

2. METHODOLOGY

Design of the architecture

The system development starts from the design architectural of the system.[7,9] The block diagram for the system is showed in Figure 1 below. The system design section below describes the components used for this project. The methodology is summarized as follows:

- Design of an Automated Intelligent Street Lighting based on PIC18F26K22
- Construction of the model
- Prototype testing
- Prototype Validation

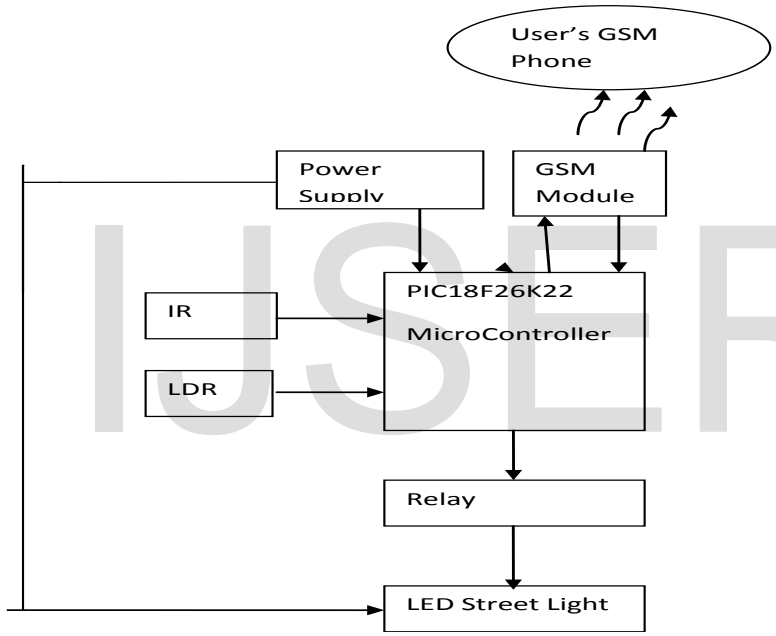

Figure 1: Block diagram of the system architecture

3. SYSTEM ANALYSIS

Automated Intelligent Street Lighting System is a system which is designed to increase the accuracy and efficiency for the street light by timed controlled Switching. The street lighting system comprises of a GSM Module, Light Dependent Resistor, Infrared Sensor, PIC18F26K22 Microcontroller and LED [15]. The circuit diagram for the main board and the circuit diagram for the street light is shown in Figure 2 and figure 6 below

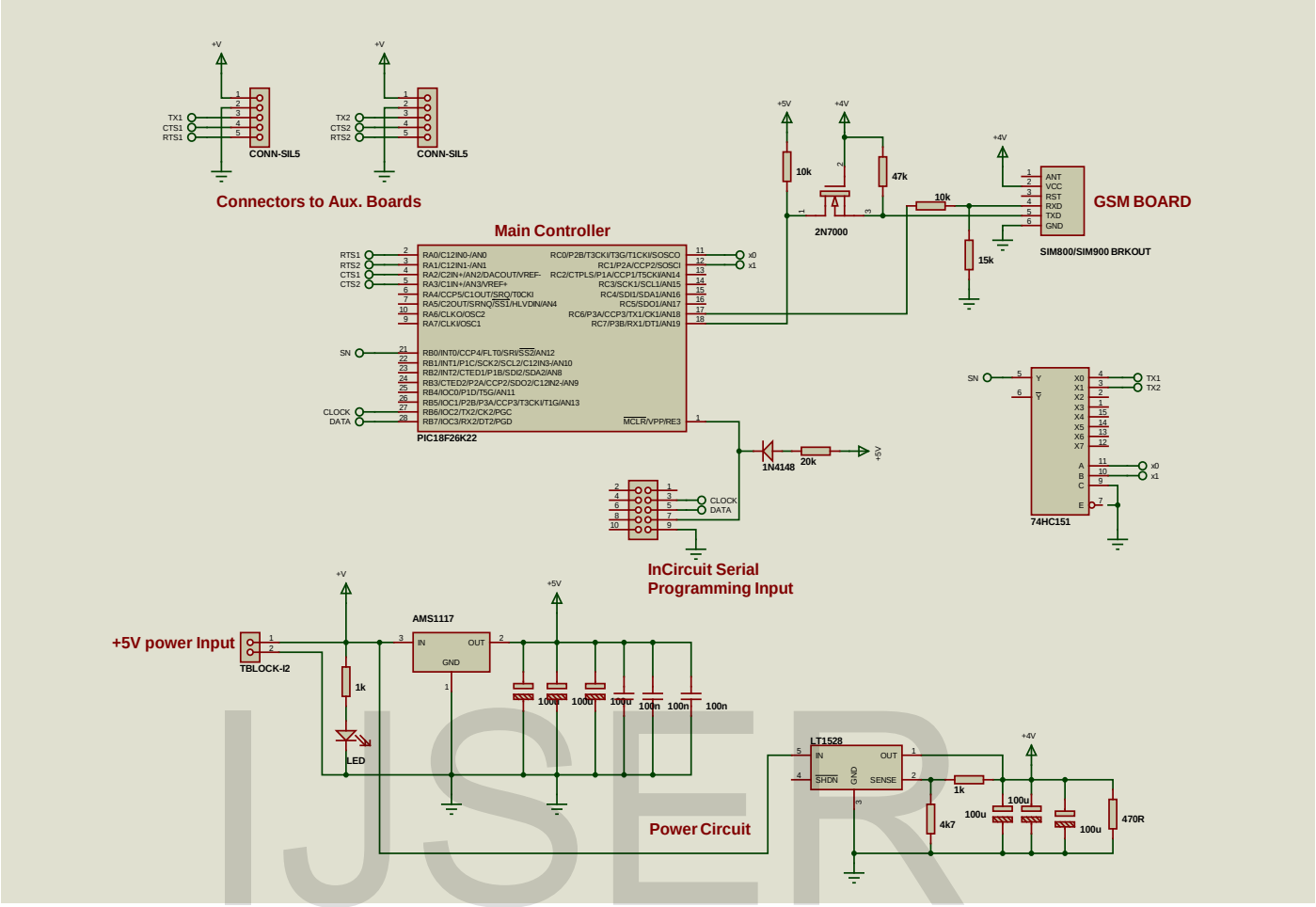

Figure 2: Circuit diagram for the main board PCB of the system

4. PIC18F26K22 Microcontroller

PIC18F22K26 is used as the controller for this system due to its large number of input and output pins, compactable in size and easy interfacing. The PIC18F26K22 microcontroller is designed to coordinate the activities of the system such as; Powering up the Light Dependent Resistor and Infra Red Sensor once there is a considerable degree of darkness, diming LED at Start up, diming LED when no movement is detected, taking LED to a Full ON state when movement is detected, sending fault detection messages to a control centre or a designated GSM number when an LED does not light up, cuting OFF power to the sensors once a considerable intensity of light is detected.[2,4,5] The diagram of the PIC microcontroller used is shown in the figure 3 below

Figure 3: Diagram of the PIC18F26K22 microcontroller

5. GSM MODULE

SIM 800 GSM module uses a kind of protocol that is used for mobile and radio communication. It is popularly used because of its low cost and its long wireless communication channel. It sends messages to the designated GSM number when a fault is detected. The GSM only needs network to be available on the preferred GSM network and credit card available on it.[5,6] The diagram for the GSM module and pin description diagram are shown in Fxigure 4 and figure 5 respectively.

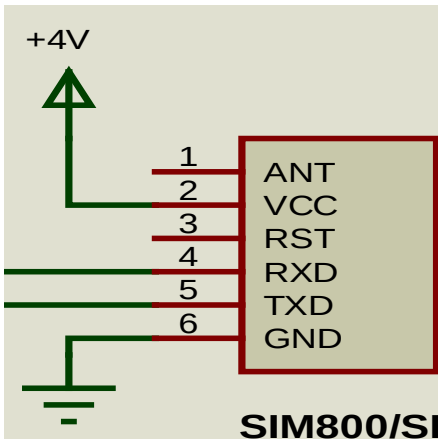

Figure 4: Pin description of SIM 800 GSM module

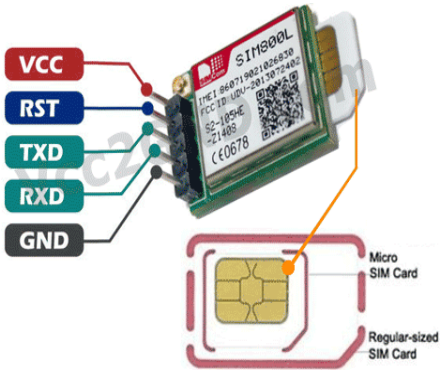

Figure 5: Diagram of a GSM module[13]

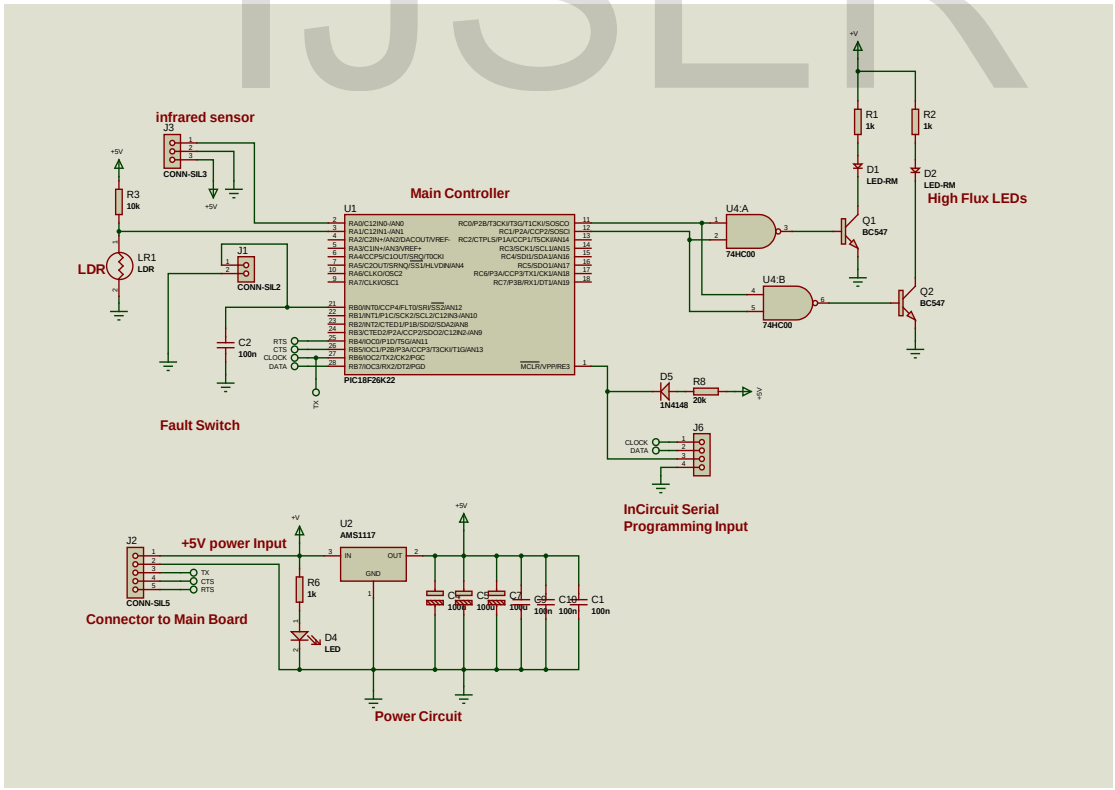

Figure 6: Circuit diagram for the street light PCB of the system

6. LDR Sensor

LDR sensor measures the intensity of the external light and when the degree of darkness is high, the LEDs goes to an ON state at night, the LEDs remain at an OFF state at daytime as it senses light intensity. Light Dependent Resistors (LDR) have high reliability and consume less power.[1,2,4] Below are diagram and circuit diagram of the LDR sensor

Figure 7: Diagram of the LDR[1]

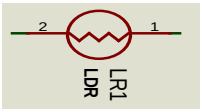

Figure 8: circuit diagram of the LDR

7. IR Sensor

The IR sensor identifies the presence of a person or an obstacle in its detection range which causes the switch to switch ON and OFF the LEDs. Infrared Sensor sends invisible infrared light beam in a straight way. A photo detector on the proximity switch detects any reflections of the light.[2,4]. These reflections allow infrared proximity sensor to determine whether there is an object nearby. This is achieved when a warm body or object goes in the infrared line, the infrared radiation discharged by the warm/hot body movement is detected and a signal is sent for the LED to go to a full ON state.[9]
Below are the diagram for the IR sensor used and the pin circuit diagram

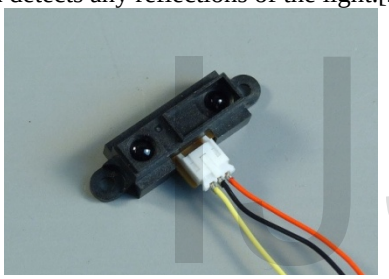

Figure 9: Diagram of the IR sensor

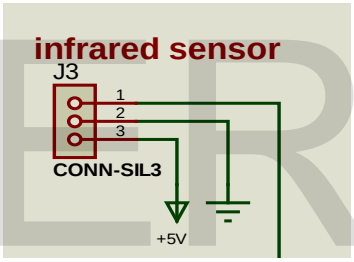

Figure 10: Pin diagram of the IR sensor

8. RESULT AND DISCUSSION

Hardware testing

Street light Automation prototype for the system was built. The design for the prototype is shown below in pictorial form. The system design was built using 2 pairs of LED, 2 pairs of IR sensors and 2 LDR sensors. Wiring and connections were connected to the main board PCB. During the day, the LEDs and IR sensors are switched off. At night, the LEDs come to an ON but DIMs state after the LDR sensor senses a high degree of darkness. The LEDs come to a full ON state when a moving body is detected within the IRs proximity. The diagrams for the complete street light prototype is shown below

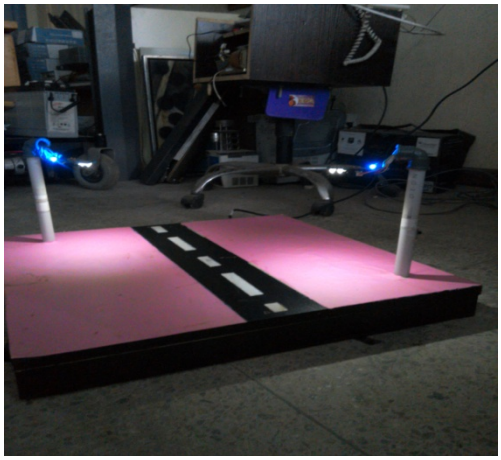

Figure 11: Complete Prototype

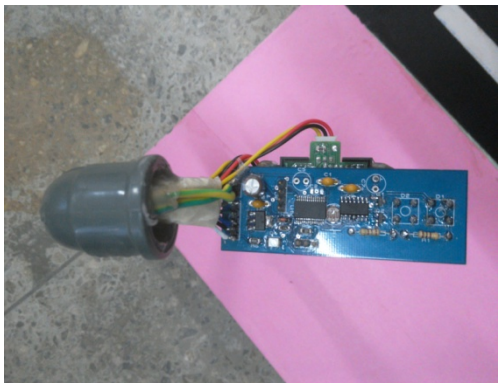

Figure 12: Complete Prototype for the LED PCB

Figure 13: Complete Prototype for the LED PCB

9. CONCLUSION

The prototype works well by turning the LEDs to an ON/OFF state. LDR sensors, IR sensors and the GSM module are the three main modules required for the perfect working of the circuit. This paper solves the problem of automation with the use of LDR, fault detection with the use of the GSM module for sending fault detection messages stating the location of the faulty LED, and power saving and Intelligence with the use of the IR sensors for Diming the LEDs at dusk and taking it to a full ON when a body is detected after which it goes back to a dim state. Fault detection can also be classified as intelligence also.

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