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RESEARCH ARTICLE

DESIGN AND IMPLEMENTATION OF HIGH EFFICIENCY REMOTE CONTROL SYSTEM FOR INTELLIGENT STREET LIGHTING

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Abstract

This paper is aimed to design a system which has a special feature that could help to reduce the consumption of the electric and human energy to the maximum ways possible. The system is designed in such a way that it can be controlled and monitored and can be used even in remote areas to avoid wasting of human power and money. The controlling features present in the system helps in optimizing power management and the efficiency of the street lamp usage to have a maximum output. The system uses microwave wireless devices which enable more efficient street lamp-system management and plays a vital role for interfacing the street light with control monitoring section. There is a sensor combination to control the desired system parameters. The information is transferred by MIWI transmitters and receivers to check the status of the street lamps and take preventive measures in case of failure. This information analyzes the vehicle counts for survey mode.

Keywords-Street lamp; Power management; sensors; efficiency; MIWI transmitters

1. INTRODUCTION

A multifunctional street light control system, which conserves electricity, is presented here as people put more attention to energy conservation and environmental protection. Thus effort has been made to conserve energy. Lighting systems, especially in public sector, are still designed according to the old standards of reliability and they

often do not take advantage of the latest technological developments. In many cases, this is related to the plant administrators who have not completed the return of the expenses derived from the construction of existing facilities yet. However, the recent increasing pressure related to the raw material costs and the greater social sensitivity to environmental issues are leading manufacturers to develop new techniques and technologies which allow significant cost savings and a great respect for the environment.

Designing an intelligent street lighting system which will solve the current problems in an efficient manner at low cost is the main motive of this project.

The system can be set to run in automatic mode, which controls street lighting according to sunrise and sunset algorithm and light intensity. This control mechanism can make a reasonable adjustment according to the seasonal variation also. Figure 1 shows the schematic diagram of the system.

Figure 1 Schematic diagram of the system [4]

2. OUTLOOK OF THE SYSTEM

The intelligent system developed here uses low power matrix LEDs as street light which automatically turns on by sensing ambient light condition. There are two LDRs (light dependent resistor) in the system. One is to detect the ambient light and another one for detecting the light failure. When ambient light is lower than the threshold level, the microchip 8 bit PIC18F series microcontroller triggers the street light and controls the brightness half the level. Later if any human or vehicle movement is detected by motion sensor, the microcontroller triggers the LED's to their full brightness and after some time it adjusts the brightness to its previous level. With the help of another LDR the microcontroller knows about the light failure and alerts the EB station through IEEE802.15.4 standard wireless communication protocol. In survey mode it counts the road users both human beings and vehicles, and transfers the counted value to control room. Turn on/turn off can also be controlled also manually from EB station through the same wireless medium.

In the existing system, solar powered LED based street lighting system is used. Even though it consumes low power, it is not capable of solving our problems. The medium used here is MIWI transceiver which involves of two ways to transmit a message namely broadcast and unicast. IEEE 802.15.4 defines a specific short address as the broadcast address and the message device can be notified by the radio. Designing an intelligent street lighting system which will solve the current problems in an efficient manner at low cost is the main motive of this research.

3. DEVICES AND METHODS

Figure 2 shows the block diagram of street light unit.

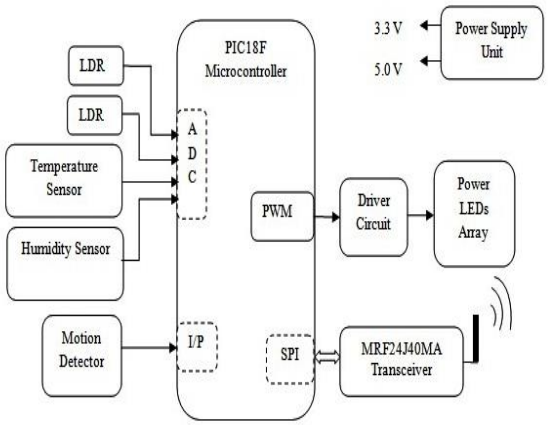

Figure 2: Block diagram of street light unit

3.1PIC18F2420

The PIC controller used here is necessary for both street light control and base station monitoring. Three programmable external interrupts and four input change interrupts are available. The PIC18F46J11 family has additional prescalers and postscalers, which have been added to accommodate a wide range of oscillator frequencies. The operation of the oscillator in PIC18F46J11 family devices is controlled through three Configuration registers and two control registers. Configuration registers, CONFIG1L, CONFIG1H and CONFIG2L, select the oscillator mode, PLL prescaler and CPU divider options. The data memory in PIC18 device is implemented as static RAM. Each register in the data memory has a 12-bit address, allowing up to 4096 bytes of data memory. The memory space is divided into as many as 16 banks that contain 256 bytes each. The PIC18F46J11 family implements all available banks and provides 3.8 Kbytes of data memory available to the user.

3.2 PIR SENSOR MODULE

Compact and complete, easy to use PIR sensor is used for human body detection. Incorporating a Fresnel lens and motion detection IC, suitable for a wide range of supply voltages and with low current drain. Adjustable delay time with high sensitivity and low noise. Output is a standard TTL output signal.

3.3 MICROCHIP WIRELESS TRANCEIVER

There are two ways to transmit a message; broadcast and unicast. Broadcast packets have all devices in the radio range as their destination. IEEE 802.15.4 defines a specific short address as the broadcast address, but has no definition for the long address. As a result, broadcasting is the only situation where the MIWIP2P stack uses a short address. There is no acknowledgement for broadcasting messages.

In the MIWIP2P stack, only the messaged device will be notified by the radio. If the messaged device turns off its radio when idle, it can only receive a message from the device to which it is connected. For the idling device with the turned off radio to receive the message, the device must send a data request command to its connection peer. Then, it will acquire the indirect message if there is one.

3.4 MIWIP2P wireless protocol

The MIWI P2P protocol modifies the IEEE 802.15.4 specifications media access control (MAC) layer by adding commands that simplify the handshaking process. It simplifies link disconnection and channel hopping by providing supplementary MAC commands. However, application-specific decisions, such as when to perform energy detect scan or when to jump channels, are not defined in the protocol. The MIWI P2P protocol is a variation of IEEE 802.15.4 and supports both peer-to-peer and star topologies. It has no routing mechanism, so the wireless communication coverage is defined by the radio range.

3.5 Humidity Sensor

HIH5030/5031 series are the low voltage humidity sensors which operates down to 2.7 v. these sensors are covered integrated humidity sensor. The sensing elements multilayer construction provides resistance to any hazards like snow, dust, rain, etc. in the environment. The HIH-5031 is a covered, condensation-resistant, integrated circuit humidity sensor that is factory-fitted with a hydrophobic filter allowing it to be used in many condensing environments including industrial, medical and commercial applications. Hence humidity sensing is very important, especially in the control system for industrial processes and human comfort.

3.6 Temperature Sensor

The LM35 series are precision integrated-circuit temperature sensors used in this system to analyze the light intensity varies according to the certain environment atmosphere, whose output voltage is linearly proportional to the Celcius(centigrade) temperature. The LM35 does not require any external calibration or trimming to provide typical accuracies of (+/-)1/4 degree Celcius at room temperature and (+/-)3/4 degree celcius over a full -55 to +150c temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration makes interfacing to readout or control circuitry especially easy. The LM35 is rated to operate over a -55° to +150°C temperature range, while the LM35c is rated for a -40° to +110°C range.

3.7 Pulse width modulation

Pulse-width Modulation is archived with the help of a square wave whose duty cycle is changed to get a varying voltage output as a result of average value of waveform. In pulse width mode, the CCpx pin produces up to 10-bit resolution PWM output. Since the CCP1 pin is multiplexed with the PORTC data latch, the TRISC<2> bit must be cleared to make the ccp1 pin an output figure shows a simplified block diagram of the CCP module in PWM mode. For a step-by-step procedure on how to set up the CCP module for PWM operation.

4. Base station monitoring unit

The base station monitoring unit consists of pc to display the outputs send by all the sensors. Here also a PIC controller used, to send the digital outputs through pc's serial port. Figure 3 shows the block diagram of control and monitoring unit.

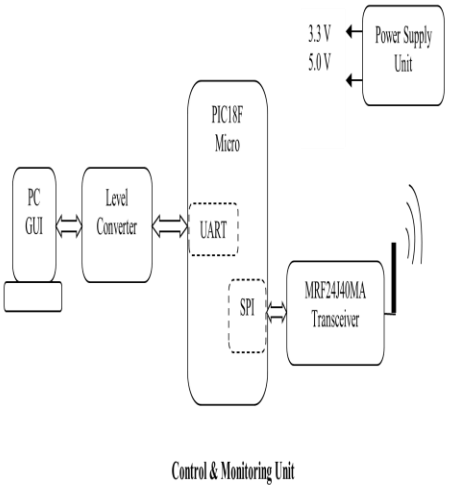

Figure 3 Control and monitoring unit

4.1 Level converter MAX232

The 18f2420 has a built in serial port that makes it very easy to communicate with the pc's serial port but the 18f2420 outputs are 0 and 5 volts and we need +10 and -10 volts to meet the RS232 serial port standard. The easiest way to get these values is to use the MAX232. The MAX232 acts as a buffer driver for the controller.

4.2 UART

UART is usually an individual integrated circuit used for serial communications over a computer or peripheral device serial port. It allows the controller to communicate with the pc by convert the transmitted bits between sequential and parallel form at each end of the link. After the start bit, the individual bits of the word of data are sent. Figure 4 shows the control mode circuit.

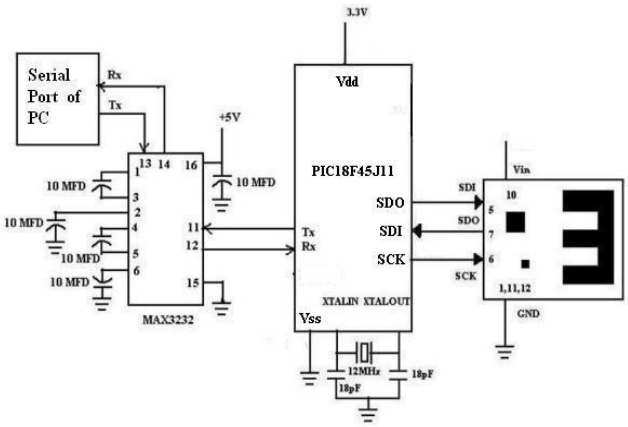

Figure 4 control mode circuit

4.3 Serial port interface

SPI is an interface which connects the external chips to microcontroller. Its a four wire synchronous protocol with one master and many number of slaves.

5. Designing of software

5.1 Software required

- Microchip MPLAB integrated development environment IDE
- Microchip C18 compiler
- Peripheral device drivers
- PIC kit 3 programmer and its driver

The programming langue used here is embedded C, the above modules are insisted for any other devices of hardware section. MIWI wireless devices act as both transmitter and receiver which passes the information between streetlight unit and control base station unit. The MIWI P2P stack supports only non-beacon networks. MPLAB IDE integrates a compiler, an assembler, an editor a debugger, a simulator and an assortment of other tools with one window application. The IDE provides the flexibility for development and debug the firmware for microcontroller. This software runs on PC to develop the microcontrollers and digital signal controllers.

The programmable peripheral devices are designed to perform various input/output functions and specific routine activities. Every programmable device will have one or more control registers. The programmable devices can be set up to perform specific functions by writing control words in to control registers. The format of the control word will be specified by the manufacturer of the device drivers. PIC kit programmer is a debugger system provided for both hardware and software with PIC controller.

6. RESULTS

Figure 5 shows the simulation for led blows corresponding to the two LDRs. The on position occurs by sensing the temperature using the temperature sensor. The temperature ranges used for the system can be 55 to 125 degree Celcius. The operating voltage range varies up to +2.7 to +5.5 v. The result shown as build succeeded for no errors else build not succeeded, if the code runs with errors. Figure 5 shows the LED on position during the sun set.

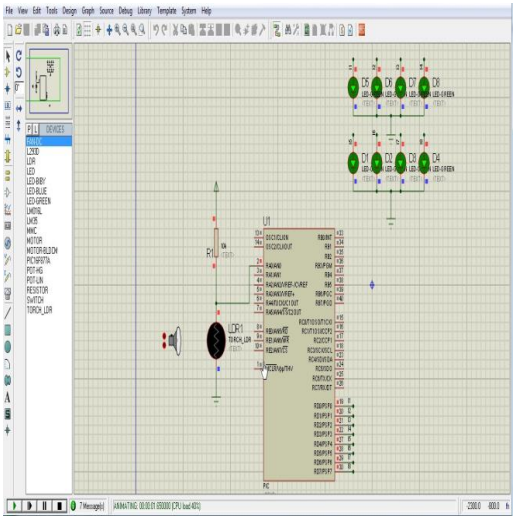

Figure 5 LED TURNS ON

At night time, the LDR2 exhibits the information through sensors. Then microcontroller triggers the led to its half brightness and under any vehicles presence then it changes the light to its full brightness automatically. Under atmosphere changes, the led can perform in its operation and leads to any damage. With the help of another LDR the microcontroller knows about the light failure and alerts the EB station through wireless communication protocol. In survey mode it counts the road users both human beings and vehicles, and transfers the counted value to control room. A power supply provides a constant output regardless of voltage variations. The below figure shows the LED off position during the sun rise.

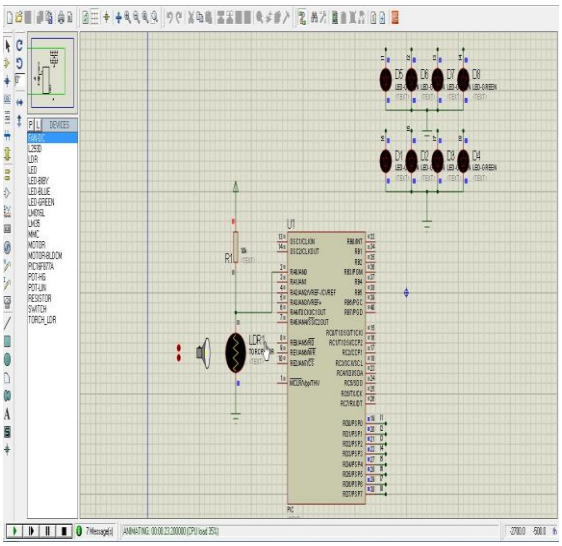

Figure 6 LED TURNS OFF

The LDR interface with PIC controller and simulate it to trigger the LED by the collected parameters. The output shown here results in animating method were the LED blows under the source code of controller.

7. CONCLUSION

This paper describes a new intelligent street lighting system which integrates new technologies available to offer higher efficiency and considerable savings. This can be achieved using the highly efficient LED technology. The proposed system is particularly suitable for street lighting in urban and rural areas where the traffic is low at a given range of time. The system is always flexible, extendable, and fully adaptable to user needs. It also can report the malfunctioned light automatically and count the passing vehicles.

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