

Energy Efficient Lightening System for an Indoor Environment using Wireless Sensor Network Based on IOT

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Abstract— The Wireless Sensor network (WSN) behaves as a digital skin, providing virtual layer where the information about the physical world can be accessed by any computational system. On the other hand, research on the indoor environment also has attracted a great deal of attention in recent years. It has been reported that the light environment affects the productivity of the users. In this paper we propose wireless sensor network-driven intelligent lightening system (WSN-ILS). WSN-ILS provides a light environment to each user by in-network processing in wireless sensor network. WSN-ILS achieves energy efficient lightening environment by performing an individual control to each lighting from the sensor node.

Keywords—Wireless sensor network, Intelligent lighting system, energy saving.

I. INTRODUCTION

In recent years, the wireless connection of multiple microcomputers possessing sensing functions, in order to form networks, has seen much research and development of the wireless sensor network technology required to collect exhaustive information about real-world spaces, and this promises to find application in various different fields. Research and development into indoor environments is also attracting a lot of attention. In these studies, there are reports that indicate that the lighting environment around office workers[3] has a great effect on their productivity [6]. Lighting equipment which can achieve this lighting environment in a straightforward way has been developed and commercialized as equipment that can perform this control wirelessly from mobile terminals similar to smart phones, and for instance, can adjust the output intensity in steps [10], [11].

Accordingly, in this study, against this background, we propose an energy-efficient lighting system by simply locating wireless sensor nodes to construct a network between sensors that can provide each office worker in the office with an individual lighting environment through the autonomous, decentralized control of each of the lights. With the proposed WSN-ILS, by means of controlling each light separately from the sensor nodes, the output intensity of each lighting fixture is optimized such that it is possible to

realize an individual illuminance which also considers energy-saving. Also, the method used by the sensor nodes to control the lighting in this WSN-ILS is investigated, both a lighting control scheme for all the lights, which sends controls to all of them, and a limited lighting control scheme, which sends controls to just the lights which are in the near vicinity, and we verify the WSN-ILS, and the accuracy of both schemes, by experiment. The energy consumption are increasing year after year, and if plans for using energy efficiently are not implemented then power consumption will increase[1].

II. PROPOSED SYSTEM

The proposed system can be viewed as three different phases, based on the functions carried out by the modules of the prototype. They are the processing phase, the data acquisition phase and the communication phase.

Wireless NODE:

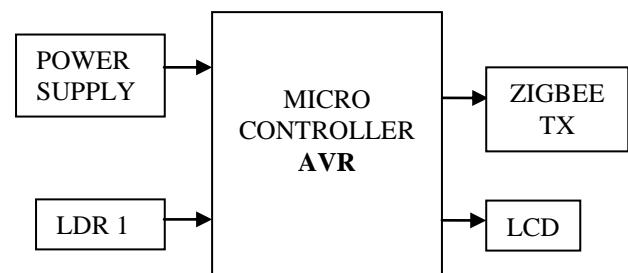


Figure 1: Block Diagram of Transmitter section

The block diagram of the proposed system consists of Transmitter and receiver sections. The Transmitter section consists of Atmega Development Board with Atmega8 microcontroller and the receiver section consisting of ARM7 based LPC2148 microcontroller. The block diagram of the Transmitter section is shown in the Fig. 1 and Receiver section is shown in Fig. 2.

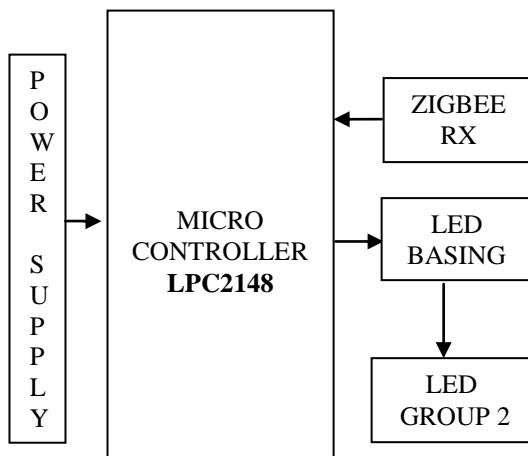


Figure2: Block Diagram of Reciever section

A. Data acquisition phase

In this prototype data acquisition is sensing the amount of illuminance. This process is done with the help of LDR sensor cnb542 [14].The Light Dependent Resistor is which will be acting as a sensor is also called dark resistor. The LDR offers resistance in response to the ambient light. The resistance decreases and the intensity of incident light increases, vice-versa. In the absence of light, LDR exhibits a resistance of the order of mega-ohms which decreases to few hundred ohms in the presence of light. It can act as a sensor, since a varying voltage drop can be obtained in accordance with the varying light. The sensor used in the project is shown in the Fig. 3.

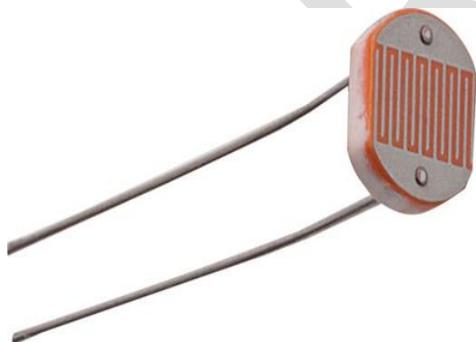


Figure 3 LDR sensor(cnb542) used for sensing light

B. Processing phase

The microcontroller acts as a processing unit and executes all the functions in the prototype. For executing the instructions microcontroller is programmed in ‘C’ language with the help of Kiel software. LPC2148 based on 16-bit/32-

bit ARM7TDMI-S CPU with real time emulation and embedded trace support, that combine the microcontroller with embedded high speed flash memory ranging from 32kB to 512kB is used in the system [8].

The microcontroller development board is activated with power supply of 5V by using power regulator. By activating the serial ports in the microcontroller, communication path is established by using UART1 and MAX232. The digital data will be receiving from zigbee to the microcontroller. By using the Pulse Width Modulation (PWM) pin the voltage of the light is controlled automatically by the microcontroller.

The Atmega8 microcontroller for executing the instructions microcontroller is programmed in ‘C’ language with the help of AVR Studios8 software. Atmega8 is an 8 bit microcontroller with 8K Bytes of in-system self-programmable flash, 1K Bytes of internal SRAM and 512 Bytes EEPROM [12].

The microcontroller development board is activated with power supply of 5V by using power regulator. By activating the serial ports in the microcontroller, communication path is established by using UART1 and MAX232. The analog to digital convertor pins is used to receive the data from the LDR sensor in the analog form and to convert the received data to digital form and transfer the data to microcontroller.

C. Communication Phase

In this prototype communication phase is used for sending and receiving data form the node to server and to push the light intensity to the cloud. The communication phase consists of a pair of ZIGBEE modules and ESP8266 module.

A pair of ZIGBEE modules are used for both transmitting and receiving of data. In Transmitter side ZIGBEE is interfaced with ATmega Development board and, on receiver side is interfaced with LPC2148 microcontroller board. The typical range of zigbee is 50 meters in an indoor environment. The cost and power technology are low[13].

The ESP8266 module[15] is connected to relay through MAX232 connecting to pc. The relay is an electronic circuit which acts like switch to trip the UART. The data sent from the communication path is in serial, to the UART1. In this prototype for uploading the data to web server ESP8266 module is used.The data is sent to the cloud through ESP266 from UART1. The responds to the microcontroller with the AT (Attention) commands [9].

The overall built proposed system consisting of LCD display, LDR sensor(cnb542), LPC2148 microcontroller board, ATmega Development board ,A pair of zigbee modules is shown in the Fig. 4

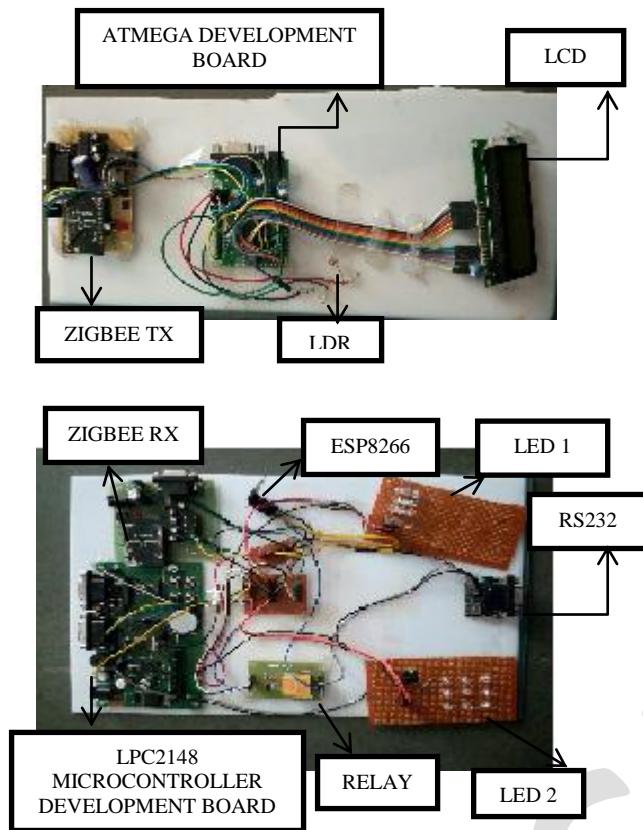


Figure 4 Hardware of transmitter and receiver circuit

D. Working of the proposed system

The working of the system starts with sensing of the amount of the intensity of brightness in a prescribed area with the help of LDR. The LDR is a sensor with resistance and voltage are inversely proportional to each other, when resistance decreases the voltage increases and vice versa. The typical value of resistance in dark is $2\text{M}\Omega$ and in light it is 200Ω . If an electrical quantity is made to vary directly in proportion to this value then what we have is analogue signal. The electrical quantity in most case is voltage. To bring this quantity into digital form we have to convert into digital form for which ADC converter is needed which is inbuilt for Atmega8 microcontroller.

An ADC converts an input voltage into a number. A 10-bit ADC has a range of 0-1023($2^{10}=1024$). The ADC also have a reference voltage(ARef). When input voltage is ground the output is 0 and when input voltage is equal to ARef then output is 1023. So the input range is 0-ARef and digital output is 0-1023. If there is no light then we get 0 and if there is light to certain brightness then we may get around 350, when it is to maximum extent then we will get 1022. The values will be varying between 0-1023 based on the intensity of light.

The digital value which is displayed on LCD is transmitted and received through zigbee pairs .The data received to zigbee at the receiving end is transferred to

LPC2148 microcontroller .The LPC2148 microcontroller Development board consists of ARM7TDMI processor where it is programmed in embedded C language to control the voltage with the help of Pulse Width Modulation (PWM).

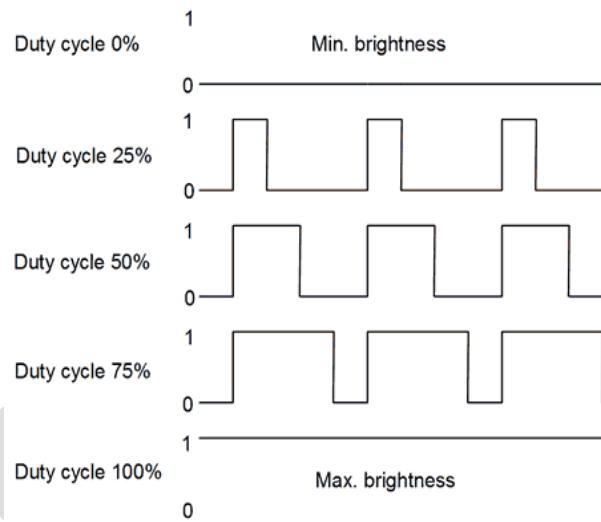


Figure 5 ON and OFF state of a duty cycle in square wave

The Width of the pulse can be modulated with the help of duty cycle. The duty cycle is expressed in percentage (%).The percentage duty cycle specifically describes the percentage of time a digital signal is on over an interval or period of time. The PWM is represented with square wave where the width represents the ON position depending on the duty cycle as shown in the fig 5.

The voltage can be controlled in both manual and auto mode .In auto mode voltage is controlled by checking the intensity of light and required amount of brightness, where in manual mode we have to give the required voltage by controlling it manually from the server. We can use either of them as required.

The ESP8266 is a wifi module which is used to push the data on to the cloud that can be observed on any mobility device. The graph represents the amount of brightness generated .

E. Execution Algorithm

- Step 1. Start .
- Step 2. Initialize ADC.
- Step 3. Initialize UART.
- Step 4 Initialize ADC to interface Zigbee.
- Step 5. Read the input values from LDR.
- Step 6. Calculate digital values of LDR.
- Step 7. Display LDR values on LCD.
- Step 8. Transmit and Recieve LDR data through Zigbee to the ARM processor.
- Step 9. Then ARM reads the data from the Zigbee sent from

LDR node, which provides brightness values on LCD. Step10.Now the arm processor will Vary the brightness of LED light inside by comparing both internal and external lights.
Step11.Again repeat the same from step six.

III. RESULTS & DISCUSSION

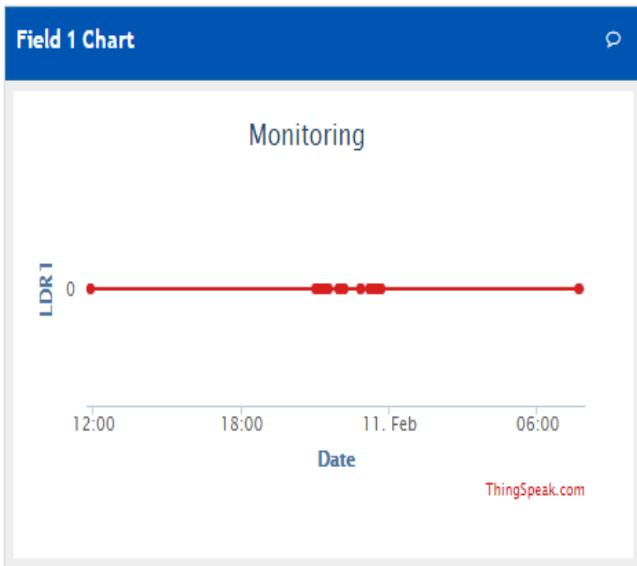


Figure 6 LDR 1 value uploaded to server

we examine the energy-saving with the consumed electrical power using the two different schemes. In general, office lighting is turned on at 100% when it is not dimmed. That power consumption in this environment is high. With the WSN-ILS, compared to the situation when ILS is not installed, we found that it is possible to reduce the power consumption to roughly two thirds. And we found that the limited lighting control scheme is able to efficiently achieve the individual target illuminances.

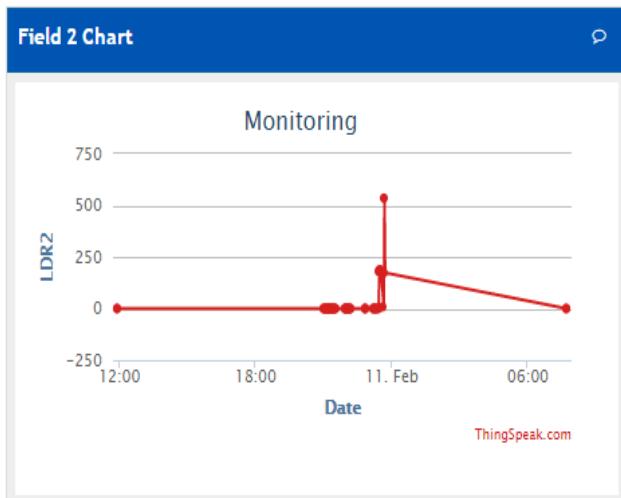


Figure 7 LDR 2 value uploaded to server

IV. CONCLUSION

In our study here that deals with office spaces, we have proposed and developed an energy-efficient lighting control system which can provide a distinct lighting environment for each worker. Firstly, we considered the required configuration of equipment and the evaluation scheme for a lighting system which can provide each worker with a distinct illuminance, and next, we presented a control algorithm and processing flow using an optimization method.

After that, in assembling the WSN-ILS, we investigated different schemes which could be considered as schemes for lighting control and their respective characteristics, and using both of these schemes in an actual environment, we carried out a verification test for the WSN-ILS and both control schemes. The results of the verification test showed that we could successfully cut the power consumption for the lights by approximately two thirds using the proposed system.

And for the lighting control scheme, we found that a limited lighting control system, which limited the lights that were controlled to just those with a large effect, can reasonably thought to be superior to the all lights control scheme, which controls all of the lights, with respect to both the time required for convergence of the illuminance, and also the energy-saving efficiency. However, with the WSN-ILS, we found that approximately 5 minutes was needed for the illuminance to converge to the target value, which indicates that further speeding up of this convergence would be required if we propose to use it in a real setting.

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