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Designing and Development of PIC 18F4550 based Wireless Natural Light Intensity Control System for Polyhouse for Agricultural Applications

N. N. Kumbhar[1] and P. V. Mane-Deshmukh[2]*
[1]Assistant Professor, Department of Electronics, Mudhoji College, Phaltan, India
[2]Assistant Professor P. G. Department of Electronics, ShankarraoMohiteMahavidyalaya, Akluj, India
Corresponding author: prashantmanedesh@gmail.com

ABSTRACT

The Wireless Sensor Network (WSN) is a powerful technology for exchange information cooperatively for monitoring as well as controlling the various physical parameters of different sectors like industries, agricultural, medical etc. The WSN composed of tiny remote terminal units widely known as nodes, carried out various functions like sensing, processing, standardization and transmission of the same signal to the coordinator or actuator unit through typical protocol. Nowadays, the agriculturalists are interesting to adopt advance technologies for cultivation of the crops in county like India. The advances like drip irrigation, polyhouse, etc. To control the polyhouse environment, the sophisticated instrument is necessary. To cater the need of society we developed the Wireless Sensor Network based on embedded technology for monitoring of temperature and controlling of nature light intensity of the polyhouse. For this purpose, sensor and actuator nodes are developed about PIC18F4550 microcontroller and ZigBee device. The Wireless Sensor Network is established using developed sensor and actuator nodes for dedicated application. On investigation, it is found that the system works successfully with accuracy and reliability.

Keywords: PIC 18F4450, ZigBee, X-CTU, Light Intensity Control

I. INTRODUCTION

An India is big agricultural country has been following traditional crop cultivation systems means of the agriculture [1]. However, nowadays, the situation is changing and the agriculturists are attracting towards precision, automotive and cost effective agriculture wherein the crops are cultivated in controlled environment [2]. As the polyhouse agriculture is best example of the precision agriculture. However, the agriculturists are demanding highly reliable, sophisticated electronics for controlling environmental parameters [1]. The smart system development in this field is need of an hour. Based on embedded system, it is proposed to developed smart system for polyhouse. For this, smart sensors are deployed along with signal conditioning and processing system. To reduce the complexity of wiring and reduce cost, new technology is adopted which is familiar as Wireless Sensor Network (WSN) [3]. The WSN is advance technology that has a wide range of potential applications particularly in agricultural sector. A Wireless Sensor Network (WSN) consists of spatially distributed sensor actuator nodes to co-operatively monitor and control the physical or environmental conditions [4].

On literature survey, it is observed that, the WSN is used for various applications like temperature, humidity, light intensity, soil moisture monitoring [1] as well as control, but we propose to develop the embedded based WSN for naturel light intensity

control within the polyhouse environment. To achieve the desired goal of the objective the sensor nodes are designed about PIC 18F4550 microcontroller and discussed in this paper in detail.

II. HARDWARE

The hardware as well as software is co-designed. Both hardware and software part are presented through subsequent point in this paper. Deploying smart controller, PIC 18F4550 the system sensor actuator nodes are developed. The sensor node helps to sense the physical environment within the polyhouse and process, convert same in standard unit and transmit same data to the actuator node. On other hand actuator node receives the electromagnetic signal from space through antenna, decode the signal and process the same signal according to user commands. Sequentially the actuator node generates the command signal to operate relay for driving the motor, hence to cover or remove polythene paper on top of polyhouse. The block diagrams of the sensor and actuator nodes are shown in figure 1 and 2 respectively.

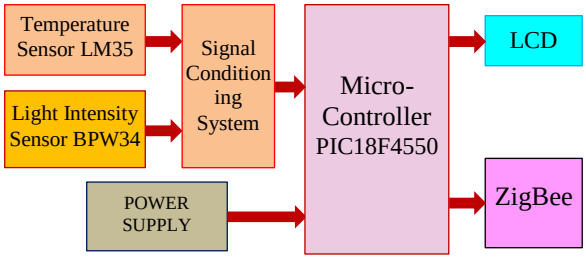

Figure 1: Block Diagram of Sensor Node

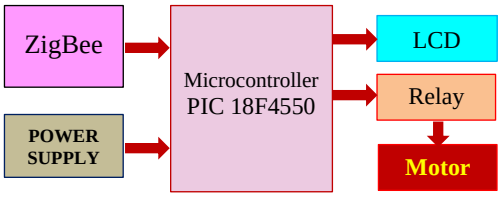

Figure 2: Block Diagram of Actuator Node

An objective of present work is to design wireless Node for light intensity. Nowadays, Polyhouse agriculture is a best example of precision agriculture, wherein the crops are cultivated in controlled environmental conditions. Moreover, various parameters may be monitored and controlled precisely. In polyhouse The sun`s radiations are penetrating through the polythene cover and used to stimulate the photosynthesis process. Therefore, intensity of light significantly affects the crop growth. To detect light energy the light intensity sensor BPW34 is deployed (Figure 3) [5]. It is a PIN photodiode with high speed and high radiant sensitivity. It is sensitive to visible and near infrared radiation as well. BPW 34 operates on 5V power supply, hence easy to interact with microcontrollers. The sensor is wired in reverse biased mode and resulting current, μA, is allowed to pass through a resistor of 1 killo Ohm. The resulting emf is used for further analog design.

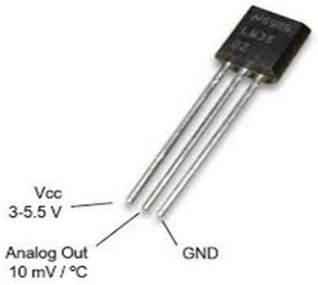

Figure 4: Temperature (LM35) sensor

Figure 3: Light Intensity Sensor BPW34

In addition, with the Light Intensity, it is essential to monitor the temperature of area under investigation of polyhouse. To monitor the temperature, the temperature sensor, LM35 is wired [6]. On extensive study, it is found that LM35 is more suitable than other temperature sensors like thermocouple, AD590 [7], etc. The LM 35 temperature sensor is small, as shown in figure 4. It is precision integrated-circuit temperature sensors, whose output voltage linearly proportional to the Celsius (Centigrade) temperature,

hence easy to calibrate to standard instrument. The main feature is it is low cost sensor.

Moreover, to interact sensor signal to analog channel of microcontroller, the signal conditioning system plays significant role. The signal conditioning system includes amplification, signal conversation, noise filtering, etc. For more than one input signals the separate signal conditioning is essential. However, the needs of separate circuits designing are reduces by the integrated circuit (IC) TLC 272 [8]. The operational amplifier TLC272 operates on low voltage, typically 5 V and over the extended industrial temperature range from -40°C to +125 °C. The TLC272 provides 3-MHz bandwidth from only 550 µA. Out-put of the both sensors are connected to respective non-inverting cannel of operational amplifier TLC272, and output of operational amplifier is directly coupled to the analog cannel of the microcontroller.

To process the sensed data of the sensors, microcontroller is essential according to the architecture of the WSN [6]. The smartness of the sensor nodes depends on the capability and advanced features of the Microcontroller. On extensive study it is found that, the controllers of PIC family have advanced features and they are widely deployed for industrial applications. The PIC 18F4550 from PIC family is wired for present investigation, which has various salient features reported by many researchers [9-10]. The PIC 18F4550 consumes low power for Ideal mode and connectivity applications that benefit from the availability of three serial ports as Universal Synchronous Bus (USB), Inter Integrated Circuit (I²C™) and Serial Peripheral Interface (SPI). Large amounts of RAM memory for buffering and Enhanced Flash program memory make it ideal for embedded control and monitoring applications. The PIC 18F4550 have 32K flash program memory, 256 bytes Data Memory along with 2048 Static Random Access Memory (SRAM). Moreover, each port pin sink and source 25mA current easily interacts with peripherals. It supports enhanced Power-On Reset and In Circuit Serial Programming and Debug. The PIC 18F4550 supports promising peripherals like Analog to digital convertor (ADC), Enhanced Universal Synchronous Asynchronous Receiver Transmitter (EUSART), Timers etc. The PIC 18F4550 supports13-channel Analog to Digital Converter module (A/D) with Programmable Acquisition Time having 10-bit resolution for each channel, helps to acquisition of sensor signal. Out of various peripherals, the ADC, EUSART and Memory, etc, are dynamically configured through the firmware for sensor signal acquisition and conversion in to digital form, processing, standardization and exchange the information to ZigBee for wireless communication.

The main aim of the present work is to design the Wireless Sensor Network (WSN) for light intensity control. To establish wireless sensor network, the sensor node needs RF module. The ZigBee is a wireless communication module, Digi built on the IEEE 802.15.4 standard, which works with 2.4 GHz [11-13]. The ZigBee wireless standard is works smarter than other wireless technologies like Bluetooth, WiFi, etc. It provides facilities of self-healing mesh networks. Zigbee module designed for extremely low cost then other RF models and it is easy to deploy. It consumes very low power due to sleep mode and operates on low power supply typically 2.8V to 3.3V, chargeable batteries. The ZigBee (Figure 5) exchange information with 250 Kbps and range about 90 m at outdoor and 30 m at indoor.

Figure 5: The ZigBee

To control the natural light intensity within polyhouse environment, the polythene paper layers are covered on the top of polyhouse by motor as shown in figure 6. To drive the motor, relay drive circuits are used. Using this, different layered polythene paper covered on top for controlling of the light intensity. The motors are directed at both directions clockwise and anticlockwise

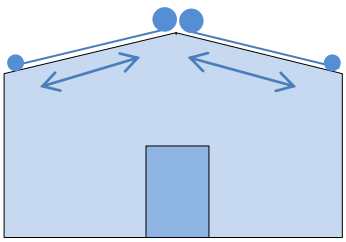

Figure 6. The Polyhouse

according to need through the control signal of microcontroller after processing the sensor signal.

IV. SOFTWARE

The wireless sensor network is realization of smart embedded system [7]. According to the structure of an embedded system, the hardware as well as software for present system is developed. As discussed earlier, the sensor and actuator nodes are wired about microcontroller PIC 18F4550. For coding of the PIC, the PIC C Wizard (PCW) Integrated Development Environment (IDE) of Custom Computer Service (CCS) is used [14]. Realizing the concept of real time operating system, the firmware is written and compiled. The generated hex file is flashed in to the program memory of PIC 18F4550 through PICPgm programmer [15]. The firmwares are developed for both sensor node and actuator node. The sensor node firmware consist of RTOS tasks for configuration for AN0 and AN1 analog cannel for signal acquisition, conversion in to digital form, EUSART transreceiver mode with 9600 baud, etc., configurations and signal calibration. Moreover, the RTOS task for control signal generation written for typical nodes firmware to perform control action of light intensity control.

After successfully development of the hardware and firmware, the WSN is ready for implementation for practical validation. For this five nodes are designed out of that typical node is shown in figure 7.

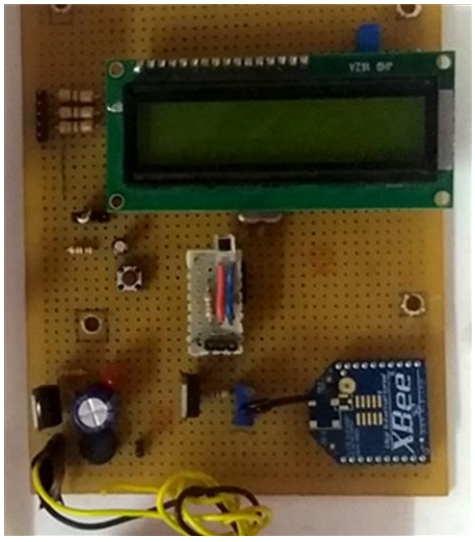

Figure 7: Sensor Node under Investigation

III. RESULT AND DISCUSSION

The developed sensor nodes are calibrated for temperature in degree Celsius and Light intensity in Lux by using standard meters [6, 1]. After successful calibration of the sensor nodes, the wireless sensor network is implemented at the polyhouse. The five sensor nodes are systematically located by fragmenting the area under investigation in hypothetical cells. These nodes are powered from rechargeable battery. The sensor nodes sense the parameters, temperature and light intensity surrounding to the localized area and processes data according to the developed firmware of respective nodes and transmit the same data towered the control station. On other hand, actuator node, collects the data from distributed sensor nodes and generates the control action for controlling the light intensity. On observation of the system response, it is found that, the system easily controls three different values of natural light intensities within the polyhouse.

IV. CONCLUSION

Realizing the concept of Wireless Sensor Network, ZigBee technology and advanced microcontroller; the system is designed for temperature monitoring and light intensity control. Realizing re-configurability, both hardware and software are co-developed. The sensor nodes are calibrated for temperature in to °C and light intensity in Lux. Based on ZigBee technology, the WSN is established in star topology. It can be concluded, that the PIC 18F4550 based WSN is designed successfully for measurement of temperature and controlling of natural light intensity. On inspection of result, it can be said that, present system work satisfactorily and precisely.

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Dr. Prashant V. Mane-Deshmukh completed his Ph.D. from Solapur University, Solapur (India). His area of research is embedded technology, Wireless Sensor Network and Instrumentation designing for high tech process industries, Precision Agricultural and Environmental Parameters monitoring applications. He awarded with best paper presentation award at Research Festival, five times, organized by Solapur University, Solapur. Two awards as best paper presentation award at National level conferences. He published 15 papers in International Journals. He presented 35 research papers in National level conferences.

Mr. Navanath N. Kumbhar is completed his M.Sc. from Solapur University, Solapur (India). His area of research is embedded technology and Instrumentation designing for agricultural applications. He published 1 papers in International Journals. He actively participated in many National level conferences.