Green Environment Monitoring System (GEMS) for Industries Using Li-Fi Technology

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Abstract- Objective: ***This work assures to design a green environment monitoring system for industries using Li-Fi technology to provide secured communication, high data rate transfer and pollution free environment.***
Methods: ***The ATMEGA328P microcontroller is chosen for implementation. Light-emitting diodes are used as the source for data transmission and they are preferred as they have a longer life-time. Different sensors are deployed to monitor various parameters namely temperature, Gas and light intensity in an industrial environment and these sensors transmit the sensed information using Li-Fi technology in terms of flickering of LEDs. Linear quadratic estimation algorithm is implemented to improve the accuracy of sensor values.***
Findings: ***The proposed system is implemented in Arduino (ATmega328P) that consumes less power. The designed system provides communication at the rate of 1.5 Mb/s over a distance of 1 meter and they are free from electromagnetic interference. They are not affected by artificial or natural light sources.***
Improvement/Applications: ***The implementation of Linear Quadratic estimator improved the accuracy of sensor output values. This technology is eco-friendly and the working atmosphere is conserved thereby ensuring a green environment. The sensors used in industrial applications communicate with low cost and also in a secured manner.***

I. INTRODUCTION

The Light-Fidelity (Li-Fi) technology was invented and coined by Harald Haas. Li-Fi is viewed as the future of wireless communication. Li-Fi uses light waves for data transmission Light-Fidelity is gaining its popularity due to its wide deployment, eco-friendliness and available bandwidth in the spectrum. Li-fi provides better security than orthodox Wireless Fidelity (Wi-Fi) communication. This makes Li-Fi difficult for the hackers to infiltrate. Li-fi is a full duplex communication using light waves. Li-Fi has certain constraints such as it cannot penetrate walls and ceilings which limit it communication range. The light intensity of natural and artificial light sources affects the receiver and the communication might be blocked. The saturation must be prevented and robustness to noise must be improved for better communication. There are certain constraints of optical communication the light intensity should be in acceptable range.

II. LITERATURE REVIEW

Jennifer JL, Jayanthy S, Sujitha J, [1] "Li-Fi technology-based fleet vanguard and security", Indian Journal of Science and Technology. 2016 Mar; 9(11):1–5.

Abstract Objectives: This paper ensures to enhance the quality of Intelligent Transportation System by combining the technologies of GPS and Li-Fi to provide an effective vehicle communication and protection between the fleet of vehicles. Using Li-Fi the data stream is transmitted in form of bits through visible light. Methods: A low power microcontroller TI MSP430F5529 is interfaced with Li-Fi module through which data such as speed and direction of vehicle is transferred between the leading and following vehicle. In case of vehicle goes out of range, the location of the vehicle is informed using GPS and GSM technology to the leading vehicle and the base station. This Li-Fi communication happens between the vehicles at high speed while the urgent messages can be transferred through the GSM module which overcomes the RF band limitation. Findings: In our prototype the usage of LEDs yields high speed data transmission, improves energy savings and requires less maintenance and also the Li-Fi technology is safer as it eliminates the harmful radiation intrusion. High

directional communication ensures good message integration with ideal reachability and reduced latency.Applications:As the designed module combines the illumination, communication and tracking purposes together, the operating costs of the vehicles is highly reduced. Our prototype will provide a reliable and an eco-friendly solution which enables people to enjoy high end technology at an economical rate.

Chi Q, Yan H, Zhang C, Pang Z, Xu LD, [2] "A reconfigurable smart sensor interface for industrial WSN in IoT environment", IEEE Transaction on Industrial Informatics. 2014 May; 10(2):1417–25.

Abstract: A sensor interface device is essential for sensor data collection of industrial wireless sensor networks (WSN) in IoT environments. However, the current connect number, sampling rate, and signal types of sensors are generally restricted by the device. Meanwhile, in the Internet of Things (IoT) environment, each sensor connected to the device is required to write complicated and cumbersome data collection program code. In this paper, to solve these problems, a new method is proposed to design a reconfigurable smart sensor interface

for industrial WSN in IoT environment, in which complex programmable logic device (CPLD) is adopted as the core controller. Thus, it can read data in parallel and in real time with high speed on multiple different sensor data. The standard of IEEE1451.2 intelligent sensor interface specification is adopted for this design. It comprehensively stipulates the smart sensor hardware and software design framework and relevant interface protocol to realize the intelligent acquisition for common sensors. A new solution is provided for the traditional sensor data acquisitions.

Quintana C, Guerra V, Rufo J, Rabadan J, Perez-Jimenez R, [3] "Reading lamp- based visible light communication system for in-flight entertainment", IEEE Transactions on Consumer Electronics. 2013 Feb; 59(1):31–7.

This paper explores the use of a reading lamp as an access point for a Visible Light Communications (VLC) downlink channel. We have established an infrared uplink channel based on a network adapter, supporting both a VLC receiver and an infrared emitter. The optical signal power distribution over the passenger area has been also studied using a Monte Carlo Ray Tracing algorithm.

Tiwari SV, Sewaiwar A, Chung YH, [4] "Color coded multiple access scheme for bidirectional multiuser visible light com¬munications in smart home technologies", Optics Commu¬nications. 2015 Oct; 353:1–5.

Optical wireless communications, multiple channel transmission is an attractive solution to enhancing capacity and system performance. A new modulation scheme called color coded multiple access (CCMA) for bidirectional multiuser visible light communications (VLC) is presented for smart home applications. The proposed scheme uses red, green and blue (RGB) light emitting diodes (LED) for downlink and phosphor based white LED (P- LED) for uplink to establish a bidirectional VLC and also employs orthogonal codes to support multiple users and devices.

III. METHODOLOGY

- Block Diagram

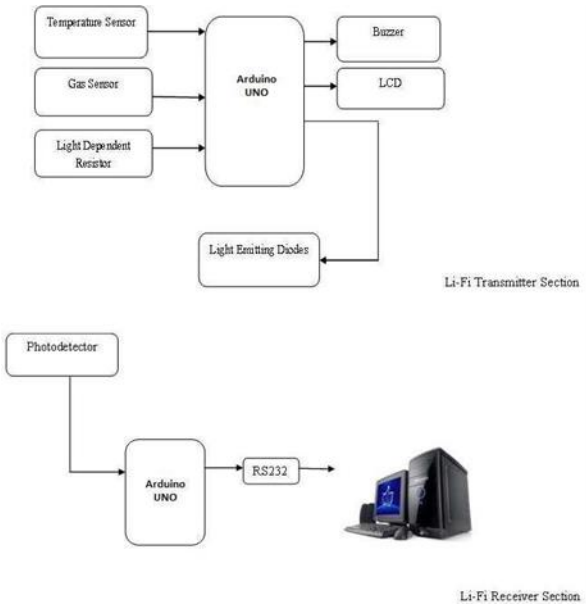

Fig.4: Block Diagram of Proposed System

1) DESIGN OF THE PROPOSED SYSTEM

Figure 1 provides the block diagram of the proposed system. The goal of the system put forward is to have an industrial environment monitoring system that is less polluted and eco-friendly. The Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The analog values of Temperature, Gas, and Light intensity in the environment are acquired by the sensors. The analog values from the sensors are converted to digital by on chip analog to digital converter available in the ATmega328P microcontroller. The LED lamp is used as the transmitter in Li-Fi communication.

The light from the LED lamp is received by a photo detector. The Light Emitting Diode as a transmitting source does not cause any electromagnetic interference. This makes it suitable for industrial environment monitoring. When the threshold values of the sensors exceed, a warning alarm is produced to alert the employees to evacuate. The Li-Fi solves the traditional issues in radio frequency communication such as Wi-Fi and Zigbee interference in industrial monitoring applications. It also solves the traditional issues such as zigbee to zigbee interference in industrial environment monitoring. It is more secure than RF communication which makes it difficult for the hackers to infiltrate. It eliminates health hazards caused to the humans and the environment by traditional radio frequency communication. Thus making the environment greener and safer for the survival of living organisms.

IV. EXPERIMENT AND RESULTS

The Li-Fi transmitter setup with the LPC2148 core, Temperature sensor, Light Dependent Resistor (LDR), Gas sensors and Led transmitter are depicted in the Figure 3. The values of sensors and LDR are displayed on the LCD. The Li-Fi receiver setup with photodetector and a laptop is shown in the Figure 4.The experimental results showed that a distance of 10 meters can be achieved at a data rate of 1.5 Megabits per second and the data transmission is not affected by natural and artificial light sources. The Lab view integrated development environment is used to depict graphical output of sensor values The output values of sensors are depicted in the Lab view IDE in Figure 4.5.

Fig.4.1: Li-Fi transmitter.

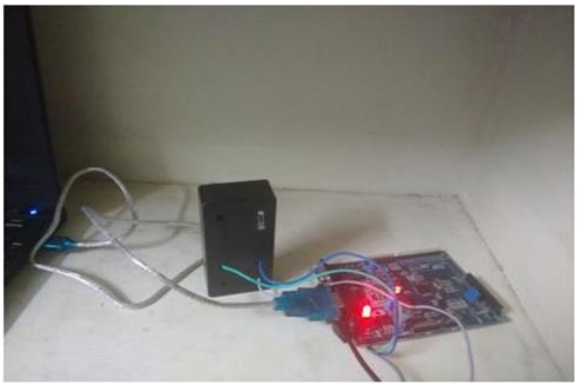

Fig.4.2: Li-Fi receiver

Fig.4.3: Labview output.

V. CONCLUSION AND FUTURE WORK

The proposed system is implemented in ARM 7 Core (LPC2148) that consumes less power. The designed system provides communication at the rate of 1.5 Mb/s over a distance of 5 meters and they are free from electromagnetic interference. They are not affected by artificial or natural light sources. The implementation

of Linear Quadratic estimator improved the accuracy of sensor output values. The application is suitable for radio frequency sensitive industries such as nuclear power plants. Li-Fi is secured and free from pollution. The Li- Fi provides higher data rate for communication. The bandwidth of data transmission can be varied at ease than orthodox wireless networks. Cameras can be integrated with the monitoring sensors and information can be transferred through the internet in future to provide warning and alert signals about a cause of accidents in industries during an emergency.

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REFERENCES

[1] Jennifer JL, Jayanthy S, Sujitha J. Li-Fi technology-based fleet vanguard and security. Indian Journal of Science and Technology. 2016 Mar; 9(11):1–5.

[2] Chi Q, Yan H, Zhang C, Pang Z, Xu LD. A reconfigurable smart sensor interface for industrial WSN in IoT environ- ment. IEEE Transaction on Industrial Informatics. 2014 May; 10(2):1417–25.

[3] Wang Z, Tsonev D, Videv S, Haas H. On the design of a so- lar-panel receiver for optical wireless communications with simultaneous energy harvesting. IEEE Journal on selected areas on communication. 2015 Aug; 33(8):1612–23.

[4] Quintana C, Guerra V, Rufo J, Rabadan J, Perez-Jimenez R. Reading lamp-based visible light communication system for in-flight entertainment. IEEE Transactions on Consum- er Electronics. 2013 Feb; 59(1):31–7.

[5] Dynamic load balancing with handover in hybrid Li-Fi and Wi-Fi networks. 2014 IEEE 25th Annual International Symposium on Personal, Indoor, and Mobile Radio Com- munication (PIMRC), 2014 Sep 2–5; 2015 Jun.

[6] Oikonomoua P, Botsialasa A, Olzierskya C A, KazasbI, Stratakosd I, Katsikasd S, Dimasd D, Mermiklid K, So- tiropoulose G, Goustouridisc D, Raptisc I, Sanopoulouaa

[7] M. A wireless sensing system for monitoring the workplace environment of an industrial installation. Sensors and Ac- tuators B Chemical. 2016 Mar; 224:266–74.

[8] Tiwari SV, Sewaiwar A, Chung YH. Color coded multiple access scheme for bidirectional multiuser visible light com- munications in smart home technologies. Optics Commu- nications. 2015 Oct; 353:1–5.