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Zigbee Based Mine Safety and Automation System

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ABSTRACT

The implementation aspects of mine safety and automation system discussed in this paper. The system is build using the concept of Wireless sensor network which is build with the help of Zigbee. Zigbee devices are configured as end device, router device and coordinator device to perform sensing, routing and collecting the information respectively. We have used four sensors to sense four divers factors of environment inside mine. LM35 to sense temperature, AM1001 to sense humidity, Light dependent resistor (LDR) for detecting visibility and soil moisture sensor is build around LM393 Op-Amp IC. A software is designed which is responsible to collectively perform the automation and safety work while storing the data received by sensor node.

Keywords: Wireless Sensor Network (WSN), Sensor, Zigbee, ARM7, Graphical User Interface (GUI), Database

I. INTRODUCTION

Minerals are the key factors of any countries growth and plays a vital role in almost every industry. India is one of the naturally gifted country that have various metallic and non-metallic minerals and all of these are came from mines across the India. In the 2013 the mortality rate during mining work is about 0.23 per 1000. A report published by director general of mines which states that during the period of 2010-14 coal mine suffers 56 fatal accidents and 62 serious accidents which lead our focus to improve the health and safety in mines [1],[2],[3]. In order to reduce these accidents in mines there were many approaches have been presented by researchers. Some of them presented a solution with the integration of various sensor at sensing node and the data is sent by Zigbee to a central unit and this central unit actuate accordingly[6][7][11]. Some researchers developed a system that helps and protects the mine worker instead of mine itself that empowers the mine working person with a safety instrument that not only capable of protect mine worker it can also sense the physical conditions near the mine worker[8][9]. Another kind of approach towards mine safety cum monitoring system is based on mobile device that can move across the mine and sense the parameters[10].

The system we have developed uses the concept of Wireless Communication Network (WSN) in which end node is communicate with the gateway node to send the information/sensed data from a far location to a central hub to control and actuate as per. For the communication purpose WSN uses some kind of network topology by the virtue of which one device (End Node) is communicate with other device (Gateway node, Router node or End Node). Star, Tree and Mesh topologies are the most commonly adopted network topologies. The solution here presented is divided into two major parts first is Sensor node, second is Control Node. The control node is also break into two unit first is Control Unit and second is Actuation Unit.

II. SYSTEM ARCHITECTURE

The system architecture of mine safety and automation system is shown in figure 1. The system we have developed uses the tree network topology to communicate with central node. The sensor unit sense data and send the data to coordinator bide with the help of Zigbee router device. The data sent by sensor node is then stored into database and can also be visualized by user or management.

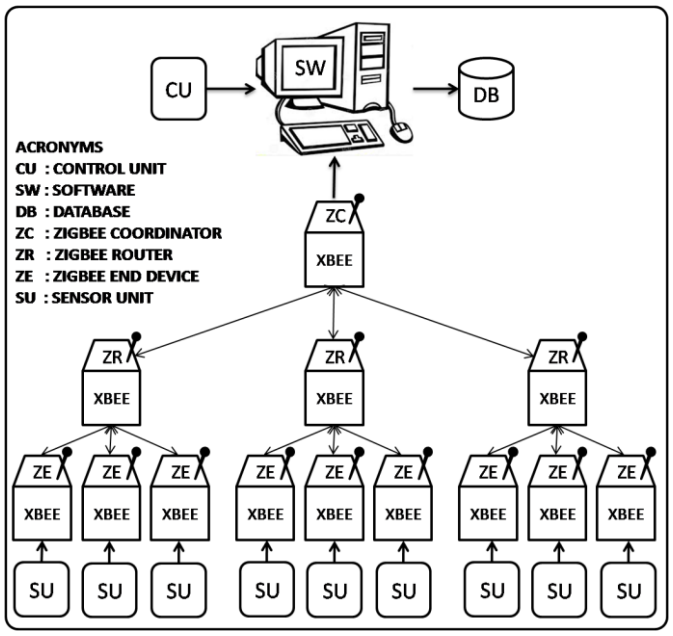

Figure 1. System Architecture

A. Sensor Node:

The sensor node is also known as End Node in WSN system. It consists of sensor that are responsible to sense the environmental conditions inside the mine. We have used Light Dependent Resistor to sense light, LM35 temperature sensor to sense temperature, AM1001 to sense Humidity and soil moisture sensor. The output of these sensor is applied to the analog input of Zigbee which is configured as end device. The Zigbee is responsible to convert this analog signal into digital and then send this data to coordinator node. Block diagram of sensor unit is shown in figure 2.

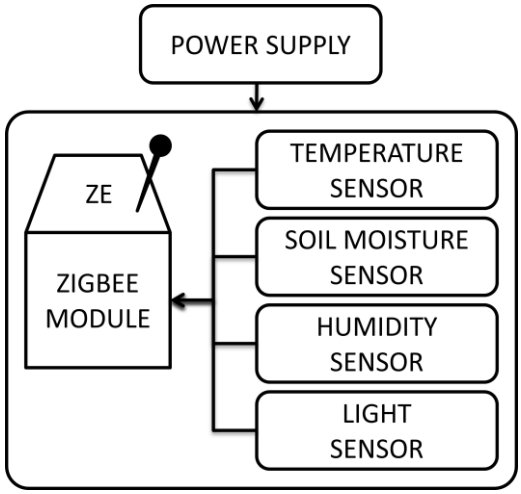

Figure 2. Sensor Unit Block Diagram

B. Control Node:

The control node is also consists of two unit first is control unit and second is actuation unit. The controller unit contains a Zigbee device which is configured as coordinator device. The controller unit receives the data from sensor node then process this data and show on graphical user interface designed for the monitoring purpose and it also stores the data in a database for future work. Second part of Control Node is actuation unit, this unit is responsible to actuate peripheral devices to control mine parameter unit. Actuation unit receives the command from controller unit and then it actuate the devices as per command received. We have connected servo motors to control the ventilator and water supply valve, exhaust and fresh air blower to circulate the airflow properly, LED light bulb for light intensity controlling purpose. Block diagram of Control node is shown in figure 3.

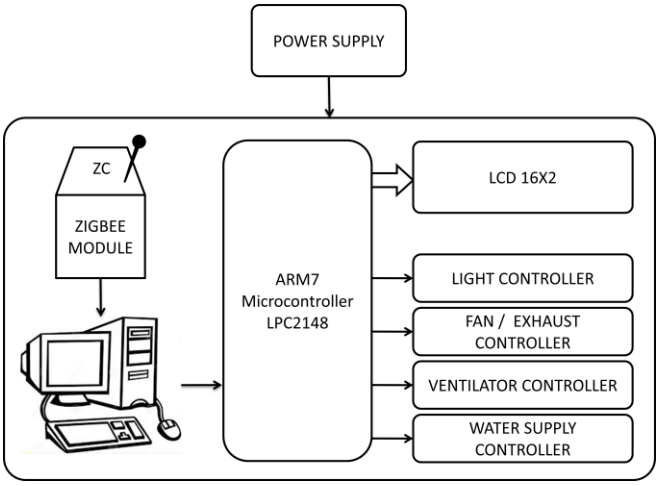

Figure 3. Block Diagram of Control Node

III. DESIGN AND MODELING

A. Circuit diagram and PCB layout:

The system hardware is divided into two parts first is sensor unit and second is actuation unit and circuit diagram of both the devices is shown in figure.

- **Sensor Unit:** The circuit diagram of sensor unit is shown in fig and PCB layout is shown in figure 4.

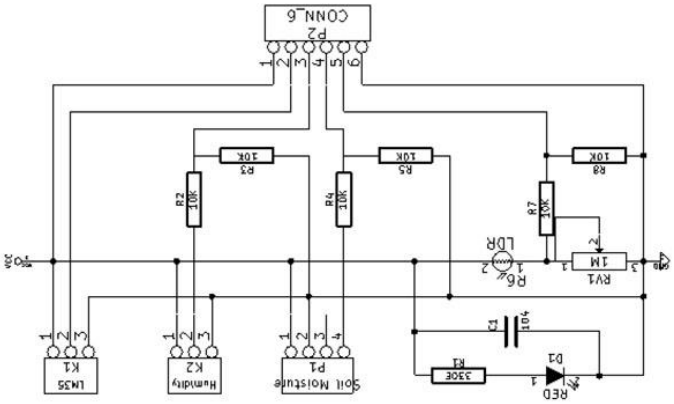

Figure 4 Circuit Diagram of Sensor Unit

Sensors LM35, AM1001, LDR and Soil moisture sensor are connected to analog input pins of Zigbee. Sensor

node Zigbee is configured as End Device. All the sensors gives analog output which is converted into digital data by Zigbee and then send to central node configured as coordinator device.

- **Actuation Unit :**
  The actuation unit is build around Easy ARM7 and is shown in figure 5. This is the heart of our system and is powered by 9 V 1A DC. R2, C3 and SW2 collaboratively work as reset circuitry for microcontroller. The command through central pc is given by Serial port of microcontroller.

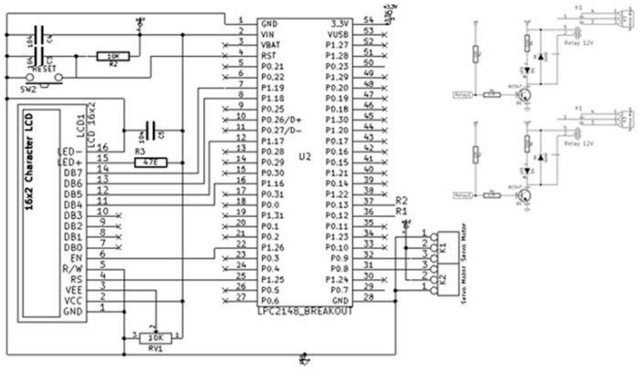

Figure 5. Circuit Diagram of Actuation Unit

LCD16x2 is used for display the status of controller and is configured on 4-bit mode, RV1 is used to control the contrast level of display. The switching circuit is build around NPN transistor (BC547) Q1 and Q2. As the current starts flowing through the coils the relay connects to the NO pin of Relay and as current stops relay trips and off the switch. LED connected in parallel with relay indicates the status of relay.

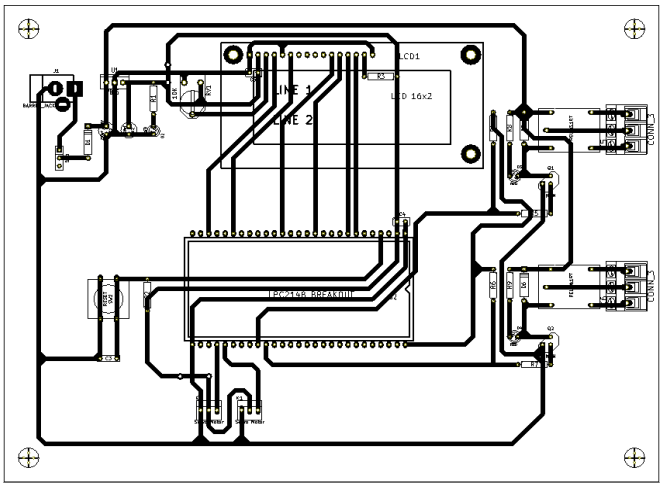

Figure 6. PCB Layout of Actuation unit

Sensors LM35, AM1001, LDR and Soil moisture sensor are connected to analog input pins of Zigbee. Sensor node Zigbee is configured as End Device. All the sensors gives analog output which is converted into digital data by Zigbee and then send to central node configured as coordinator device. PCB layout is shown in figure 6.

B. Software

The start-up page of GUI is shown in figure 7. C#.Net is used to develop the GUI and Oracle database is used for store data received from sensor node.

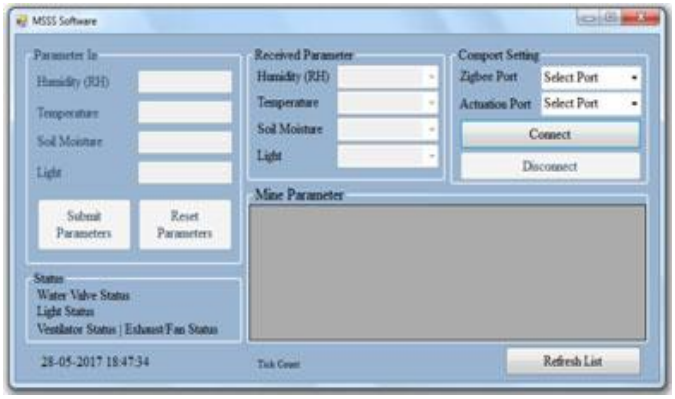

Figure 7. Start-up Page of Software

IV. SIMULATION

First of all user have to select communication port with Zigbee and Actuation and then have to click on Connect button after successful connectivity user need to set the critical environmental parameters and then have to click on submit parameters ones the user click the submit parameter button system starts communication between sensor node and coordinator node. The status block shows the status of currently working devices. Received parameter shows the currently received data of the sensor node. Mine parameter is used to display the previously stored parameter information.

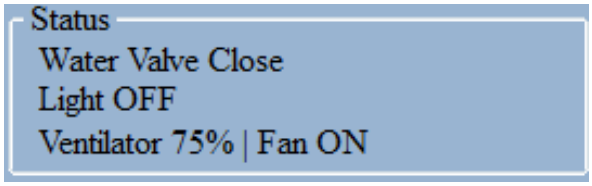

Figure 8. Status Block

Result Mine parameter block and Status block can be viewed as result of our system and is shown in figure 8, and figure 9.

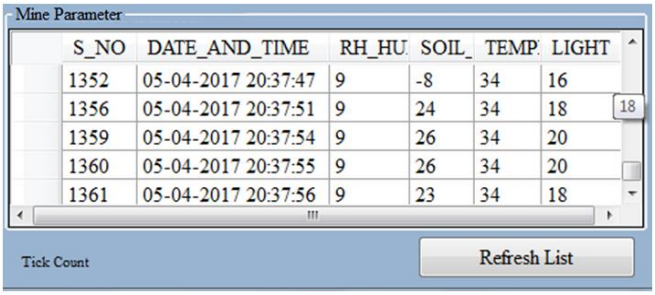

Figure 9. Mine Parameter Block

V. CONCLUSION

Low cost mine safety and automation system has been successfully developed based on Zigbee Wireless Sensor Network (WSN). This system is capable of sense temperature, humidity, soil moisture, and light intensity it is also capable of control these parameters up to a certain conditions. It can control water supply, ventilator opening, fresh air blower and it can also control the exhaust. The system is successfully tested on a prototype model of mine which found satisfactory.

VI.REFERENCES

[1] Annual Report 2016-17, Ministry of Mines, Government of India

[2] All India Installed Capacity (In Mw) Of Power Stations, As on 31-03-2017, Ministry of Power, Government of India

[3] Annual Report 2013, Directorate General of Mines Safety, Ministry of Labour & Employment, Government of India

[4] NetworksDeepmala Verma, Gajendra Singh, Kailash Patidar "Review of Vampire Attack, In Wireless Sensor Networks", Dept of CSE, Shri Satya Sai Institute of Science & Technology, Sehore.

[5] Sharnee Kaul, Helen Samuel, Jose Anand," Defending Against Vampire Attacks In Wireless Sensor Networks", International Journal Of Communication Engineering Applications-Ijcea Http://Technicaljournals.Org ISSN: 2230-8520; E-ISSN: 2230- 8539 2010-2014 - Technicaljournals®.

[6] G.Ahalya, P.Suresh Babu, P.Prabhakar Rao, "Development Of Coal Mine Safety System Using Wireless Sensor Networks", IJESAT Jun-Jul 2013, Volume-3, Issue-3, 74-78

[7] T.Asesh Kumar , K.Sambasiva Rao, "Integrated Mine Safety Monitoring and Alerting System Using Zigbee & Can Bus", IOSR Journal of Electrical and Electronics Engineering, Volume 8, Issue 3 (Nov. - Dec. 2013), PP 82-87

[8] G. Divya, B. A. Sarath Manohar Babu, "Rescue System for Coal Mine Workers using Different Sensors Based on GSM and RF-PRO", International Journal of Advanced Research in Computer Engineering & Technology, Volume 3 Issue 7, July 2014, PP 2540- 2544

[9] N. Krithika* and R. Seethalakshmi, "Safety Scheme for Mining Industry using Zigbee Module", Indian Journal of Science and Technology, Vol 7(8), August 2014, PP 1222–1227

[10] Sachin M. Ledange, Swarup S. Mathurkar, "Robot Based Wireless Monitoring and Safety System for Underground Coal Mines using Zigbee Protocol: A Review", International Journal of Science, Engineering and Technology Research (IJSETR), Volume 5, Issue 1, January 2016, PP 203-206

[11] Valdo Henriques and Reza Malekian, "Mine Safety System UsingWireless Sensor Network", IEEE Access, VOLUME 4, 2016, PP 3511-3521