A Zigbee-Based Approach for Enhancing Industrial Disaster Management and Emergency Response

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ABSTRACT

In an industry during certain hazards is will be very difficult to monitor the parameter through wires and analog devices such as transducers. To overcome this problem we use wireless device to monitor the parameters so that we can take certain steps even in worst case. Few years back the use of wireless device was very less, but due the rapid development is technology now-a-days we use maximum of our data transfer through wireless like Wi-Fi, Bluetooth, WI-Max, etc. The fundamental aim of this project is to develop an embedded system to design a wireless monitoring system which enables to monitor the weather parameter in an industry or anywhere by using Zigbee technology and display the parameter on the PC's screen. The system contains two parts. One is transmitter node and another one is receiver part and both can be any number. The transmitter part consists of whether sensors, microcontroller and Zigbee and the receiver part consist of a PC interfaced with Zigbee through PC serial port. In this project we deal with monitoring the parameters through wireless Zigbee modules. Here we monitor Gas direction and Fire with the help of respective sensors. The data from the sensors are collected by the micro controller and transmitted to the receiver section through wireless medium. All the parameters are viewed by the pc using program in the receiver side.

KEYWORDS: Wi-Fi, Bluetooth , Zigbee, PC, sensors.

I. INTRODUCTION

Emergency management is a continuous process by which all individuals, groups, and communities manage hazards in an effort to avoid or reorganize the impact of disasters resulting from the hazards. The main attributes of a disaster include unpredictability, unfamiliarity, speed, urgency, uncertainty, threat etc. Accidents in Chemical industry can occur due to human errors,leaks, failure of vessels/equipments or pipelines, lack of safety measure etc. In addition, natural hazards pose an additional risk for industrial accidents. In any disaster, there is an element of surprise. Emergency preparedness is aimed at training people in overcoming this surprise element so that there is a well defined action plan for minimizing the impact of hazard/disaster. It also focuses on minimizing the effects of the incident on person, property and environment. In industry, one of the main measures of preparedness is the enactment of handling the emergency situations as mock drills. These mock drills are planned and rehearsed for all possible emergency situations within the industry. A detailed action plan on the activities at site and outside, including rescue operation, hazard containment, safe assembly points, coordination with statutory authorities with specific roles for Emergency coordinator & Rescue operations coordinator etc will be charted out in advance. A safe place should be predetermined as assembly point where personnel evacuated from the affected areas are to be assembled. Depending on the severity of the situation '*onsite*' or '*off site emergency*' is declared. Main elements of Emergency plan include Leadership and Administration, Role and Responsibilities of Key Personnel, Emergency action, Protective and rescue equipments, Communication, Medicalcare, Training, Periodical revision of plan etc. This focuses on the Role of Emergency preparedness in Industrial & Chemical Disaster Management in Kerala. The whole scenario is observed from the view point of a production engineer in a Chemical industry in the Cochin industrial belt. As the concept of 'Zero Risk' simply does not exist in the practical world.Project consist of industrial accident management system having the detection system and controlling and generating the message for the police ambulance and fire bridge system etc.

II. LITERATURE REVIEW

The National Institute of Disaster Management New Delhi and the Indian Statistical Institute Kolkata have decided to work together for development of a robust statistical system on hazards, vulnerabilities and risks of disasters in the country. Under this arrangement ISI would assist NIDM in studying the existing statistical system for the collection and analysis of data on natural and manmade hazards and disasters and suggest methods for improving the system. ISI shall further offer their expertise for the development of suitable methodology for assessing the macro-economic impacts of disasters and cost-benefit analysis of investments on disaster risk reduction. A MoU to this effect was signed by Shri P.G.Dhar Chakrabarti Executive Director of NIDM with Professor Bimal Roy Director of the ISI on 8 March 2011 in New Delhi.

The first off site emergency plan conducted by the National Disaster Management Authority (NDMA) in the industrial sector was based on an imaginary chemical disaster at Cochin combining three major chemical industries viz Travancore Cochin Chemicals (TCC), Hindustan Insecticides Limited (HIL) and Fertilizers and Chemical Travancore Limited (FACT). The event was planned between 11 a.m. and 12.40 p.m. on Tuesday 07-01-2008. Reports of 'chlorine leakage' at TCC came in first, followed by 'thynol chloride leakage' at HIL and finally, 'ammonia leakage' from FACT. Following this, District Collector rushed to the scene and a control room was quickly set up under his direct supervision at the FACT training centre. The 'situation' in all the three units could be brought under control within 20 minutes of the occurrence of the 'disaster' due to the 'timely intervention' of the District Disaster Management

Authority. During the year 2009, NDMA focus was on testing the district administration's preparedness in case of an urban flood in the district of Alappuzha. Prior inspection is done annually in major chemical industries by a team under the Directorate of Factories and Boilers and Chemical inspectorate. Special focus will be given on Safety in operation, Maintenance, House Keeping, usage of Personal protective Equipment . A compliance report is to be filed by the industry to the Directorate of Factories and Boilers on the implementation of the recommendations of the inspection committee. Safety audits are also conducted by in house experts in the specific industry to identify unsafe practices and potential hazard points. The major points to be focused in Industrial disaster management include restricting hazardous storages to lowest minimum inventories corresponding to containment system, effective instrumentation, strengthening of inherent safety design and frequent auditing of documents and features as per HAZOP studies, transparent interactions with employees and community about the toxic chemicals, training and re-training of employees, off-site responders and community, regular enactment of emergency plans, harmonizing up of medical facilities etc. Aimed at bringing down the risk and resultant consequences of chemical emergencies in the district, a Chemical Emergency Response Centre (CHEMREC) has been set up by the Factories and Boilers Department in association with the Industries Department, at Kochi during 2010. Equipped with latest communication network and active support of major industrial units, CHEMREC has facilities for field monitoring of chemical spills/releases into atmosphere, predicting its impact and apprising public on precautionary measures. Highest levels of preparedness including scientific expertise at local, state and national level needed to be developed for management of chemical disasters and the special care to be taken in synchronizing District Disaster Management Plans & Industries Emergency Response Plans for better results. With a clear and definite disaster management policy, approach, strategies, plans and practices in place, it is possible to make Kerala state, in the long run, to be free of major disasters.

III. ARCHITECTURE OF THE SYSTEM

The developed system can be divided into two sections. First is a hardware circuit that will beattached with the body of the mine workers. This may be preferably fitted with the safety helmet of the workers also.The circuit has a sensor module consisting of some MEMS based sensors those measures real-time Underground parameters like temperature, humidity and gas concentration. Gas concentration is meant for the harmful gases like methane and carbon-monoxide. A microcontroller is used with the sensors to receive the sensor outputs and to take the necessary decision. Once temperature is more than the safety level preprogrammed at microcontroller, it decodes beep alarms through the headset speaker connected with controller as shown in Fig. 1. Again, once the measured humidity value is more than the safety level preprogrammed at microcontroller, it decodes different type of beep alarms. Similarly when gas concentration crosses the safety level, microcontroller decodes siren alarms. In all such cases, this will send an alarm through an urgent message and alarm sound to the ground control terminal through RF Module. The microcontroller data is transmitted through two separate boards i.e. RF Module transmission module to the data collector or receiver module. The microcontroller used here is PIC TMEGA16 with 16MHz operating frequency. It has five I/O ports,eight A/D input channels and 368 bytes data memory. As shown in Fig. 2, the data receiving terminal of RF Module RX and data transmitting terminal XB_TX are cross connected to the microcontroller corresponding transmitter and receiver terminals TxD and RxD respectively. No extra component like MAX 232 and MAX233 is required between these connections. This is the advantage of ATMEGA16 .If the structure of UART (Universal Asynchronous Receiver Transmitter) system is completed, sending and receiving signal is possible using RF Module, after installing necessary software. The RESET pin of RF Module is used to provide an optional reset facility of user through a reset button. A transistor is used for this purpose. The RF Module used in the interfacing boards, are engineered to meet IEEE 802.15.4 standards. It is low-cost, low-power, reliable 20 pin device that operates within the ISM 2.4 GHz frequency band. It has 30 to 100 metre data transmission capability with rate of 250,000 bps. RF Module modules operate in five modes. When not receiving or transmitting data, the RF module is in Idle Mode. The RF module shifts into the other modes of operation under various conditions.

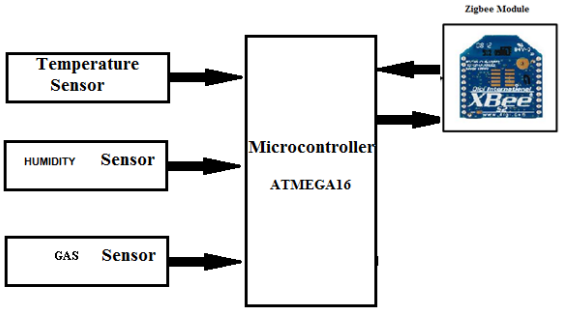

Figure 1 Block Diagram

- ZIG BEE Module is a communication module used for communication with the base station.
- Micro-controller is responsible for collecting environmental information (such as temperature, gas, smoke) and do some data conversion.
- Responsible for controlling and managing the entire nodes.
- The power module provides the necessary power for the nodes separately to run the various parts.
- Data from Microcontroller is fed to ZIG BEE Module to transmit data wirelessly.
- Transmitted data is received by ground station, for monitoring storage and processing.
- According to environmental condition of coal mine emergency alarm signal is generated and send to the coal mine station.

IV. RESULTS AND DISCUSSIONS

Receiver Circuit

Transmitter Circuit

ZigBee is a standard defines a set of communication protocols for low-data-rate short-range wireless networking. ZigBee-based wireless devices operate 2.4 GHz frequency bands. The maximum data rate is 250 K bits per second. ZigBee is mainly for battery-powered applications where low data rate, low cost, and long battery life are main requirements

1) To transmit a single variable to a receiver unit which outputs a 4-20mA or 0-10V signal corresponding to the input

2) To transmit multiple input values to a receiver unit which provides either multiple 4-20mA or 0-10V outputs or a single Ethernet or RS232 connection. The transmitter and receiver units are identical units factory configured for either function.

V. CONCLUSION

To overcome day to day problem faced by mine management, installation is a vital need for in industry. With the help of central processing unit at pit top, it will be possible to keep track of miners and moving in underground. It will also be possible to keep track of time. Implementation of system will also help disaster management send message to the important services

VI. REFERENCES

[1] "The Research on ZigBee-Based Mine Safety Monitoring System"by Ge Bin, LI Huizong. 978-1-4244-8039-5/11[2011]

[2] IEEE paper on "A Coal Mine Environmental Monitor System with Localization Function Based on ZigBee-Compliant Platform" by
Dongxuan Yang, Yan Chen, Kedong Wang. 978-1-4244-6252-0/11/ ©2011 IEEE

[3] "Design of the mine gas sensor based on zigbee" by Su baishun, Pang Zhengduo, MengGuoying [August 10].ISBN 978-952-
5726-10-7

[4] IEEE paper on "Zigbee based intelligent helmet for coal miners" by CHENG Qiang, sun ji_ping, zhangzhe, zhang February [2009]
CSIE2009.653

[5] "Rescue and protection system for underground mine workers based on zigbee" by Tanmoymaity, parthasarathi das,

[6] mithumukherjee, vol.2 no.2 [June_December,2012] int.jr.of advanced computer eng.& architecture

[7] "Wireless Networking ThroughZigbee Technology" by P.Rohitha, P. Ranjeet Kumar Prof.N.Adinarayana,
Prof.T.VenkatNarayanaRao ISSN: 2277 128X vol.2 [7 July 2012].

[8] "Design And Development Of A SensorModel For Coalmines" bySrinivasa A.H1, G.Varaprasad

[9] Application of gas monitoring sensors in underground coal mines and haradous area" by A. Kumar, T.M.G. Kingson, R.P. Verma,
A. Kumar, R. Mandal, S. Dutta, S.K. Chaulya and G.M. Prasad CSIR-Central Institute of Mining and Fuel Research, Dhanbad,
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