Gas Leakage Detection and Monitoring Based on Low Power Microcontroller and Xbee

C.Sasikumar [#1], D.Manivannan [*2]
Embedded systems, School of Computing,
SASTRA University, Thanjavur, Tamil Nadu, India-613402.
[1] sasi.kmrc@gmail.com
[2] dmv@cse.sastra.edu

Abstract **- Gas leakage detection and monitoring through wireless sensor network is considered to be more economical for industries gas leakage. Main purpose of this system model is to avoid damages and safety of gas industry. The entire control system is based on is based on low power MSP430 microcontroller and Xbee techniques. The sensor node helps in collecting data regarding gas leakage and the particular area of sensor node address is located. The collected information is sent to the monitoring client or user to update the data. Data packets are continuously transmitted from sensor nodes and communication devices. This system helps to minimizing human intervention and reduces power consumption, thus providing greater performance. This paper focus on overall modeling and design on both software and hardware part to accomplish it.**

Keywords **— MSP430 microcontroller, Wireless Monitoring, Xbee, Sensors, Embedded systems.**

I.INTRODUCTION

Nowadays Industrial growth is very rapid and continuous in terms of innovations and technology. Simultaneously safety issues should also be concentrated especially in risky working areas. Lack of safety measures results in adverse effects and small negligence may result in secure destruction equipments and workers. Hence real time monitoring of the equipments for any leakages of gaseous material should be mandatory to avoid the unnecessary accidents and provide healthy environment. Industries are not advanced and lagging in technology to identify the exact and accurate of gas leakage point. WSN is used because of more absolute superiority and low power consumption [1].

II.STRUCTURE

This proposed system consists of terminal nodes, router, coordination system and two power controller. Reduced function device (RFD) and fully functioned device (FFD) is placed at pipeline joints. RFD only is to function only acquire data and forward to cluster node like as end device. FFD acts as router, gathering its own sensor information and also from the header other header nodes and forward the message to client [7][8].

Software used for the controller is based on TI's Z location Engine. Coordinator gets all the information from FFD and RFD, and transmits it to the system and forward the information. The FFD device acts as a router that links all groups and provides multihoping. The location is displayed and the status is monitored [2] [9]. Fig.1 represent the sensor node structure consists of two sections - dynamic deployment and fixed point monitoring.

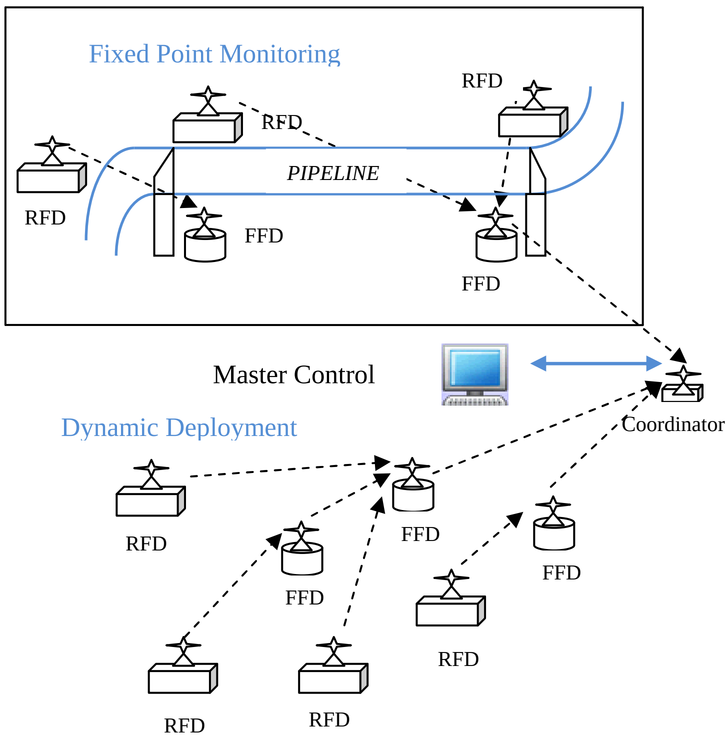

Fig. 1 System Architecture

In gas industry some terminal nodes and risky areas such as joints reaction and pipelines that are easily broken, so the system can track data in these areas continuously. The leakage mainly occurs through the pipeline passage by the fixed monitoring. In fixed monitoring sensor nodes are placed in pipeline joints and pipeline passage ant its terminal points so it is easy to find the leakage area and hence accidents can be avoided [3][4].

Dynamic deployment, nodes are placed dynamically in the risky area to get the information related to temperature and gas leakage and exact location can be identified.

III.SYSTEM DESIGN

The hardware consists of three modules are control and frequency module (CF), power management module (PM), sensor detecting module (SD) [5][6][10]. The data transmission between the radio frequency modules is through IEEE 802.15.4 standard. IEEE 802.11 is a set of standards for executing wireless local area network (WLAN) computer communication in the 2.4, 3.6 and 5 GHz frequency bands. They are formed and sustain by the IEEE LAN/MAN Standards Committee (IEEE 802)

The MSP430 is from Texas Instruments that supports all these requirements. The MSP430 is low powered embedded controller and a mixed-signal processor family. The electric current 1 µA drawn in idle state. The top CPU processing speed is 25 MHz and the microcontroller uses six different low-power modes, which can disable unneeded clocks and CPU. The device comes in a variety of configurations featuring the usual peripherals: internal oscillator, timer including PWM, watchdog, SPI, 10/12/14/16-bit ADCs, USART, I²C, and brownout reset circuitry. And also MSP430 microcontroller is flexible as it can adjust an application sensor to a specific function area. In this case, the application area is a pipeline system. Features fast wake-up from standby mode in less than 6 µs. THE tool simulator chain used for msp430 is IAR C/C++ compiler.

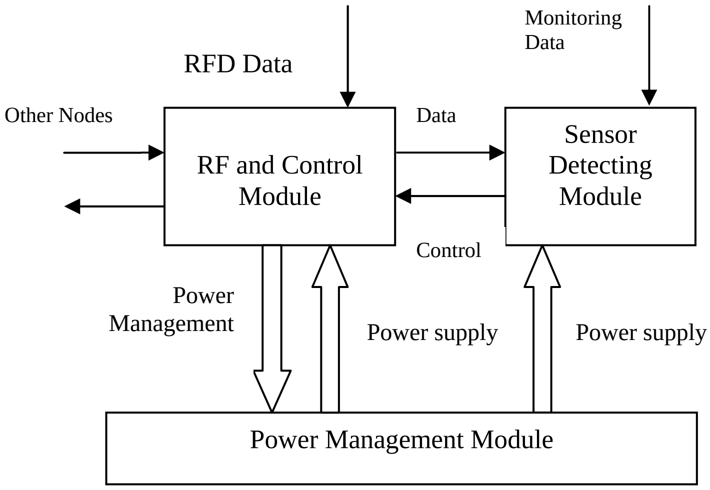

Fig. 2 FFD Function Design

Fig.2. Represent the system design Xbee stack with free protocol stack Xbee 2006, combined with TI MSP430 are combined for better performance. Transmitting power is 1mW, current loss is less than 0.6mA and receiving sensitivity is 94dBm [11][12][13].

IV.RESULT & DISCUSSION

A.Simulation

Controller coding is compiled in IAR compiler and simulated in Proteus software which can be easily developed in hardware system. IAR for MSP430 Development Environment (IDE) is for the development of embedded applications employing TI low power microcontrollers. It includes a feature-rich editor, source-level debugger, project manager, software simulator, and supports popular hardware tools.

Proteus 7.0 is a Virtual System Modeling (VSM) that combines circuit simulation, animated components and models to co-simulate the complete microcontroller based designs. This is the perfect tool to test the designs before constructing a physical prototype in real time. It allows users to interact with the design using on-screen indicators and/or LED and LCD displays and, if attached to the PC, switches and buttons. Proteus 7.0 is the program to use when you want to simulate the interaction between software running on a microcontroller and any analog or digital electronic device connected to it. Fig. 3 represent the simulation model of Gas leakage detection sensor interfaced with MSP430 microcontroller and data is processed and transmit to client through Xbee.

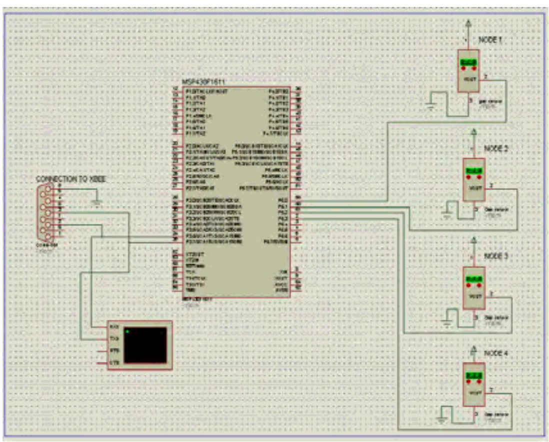

Fig 3. ISIS Simulation Result

B.Hardware

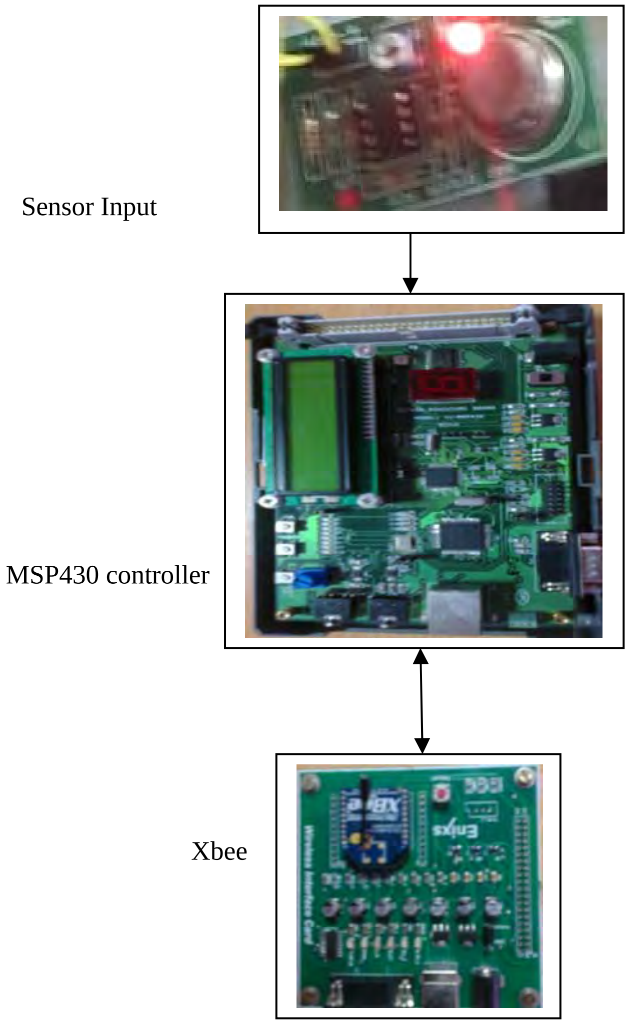

Fig. 4 Gas detection Sensor placement at particular node

Fig. 4 shows the Gas Leakage sensor to be used to identify that any Leakage. Node 1, Node 2, Node 3, Node 4 are placed at different location in industry pipeline joints and risky areas.

When the autonomous industry starts to work from one section it continuously run whole the year. If any leakage found in the pipeline path, sensor will detect. Fig. 5 represents the overall system – End device, Router, coordinator. X-ctu is configured and wireless communication data is monitored in terminal window. Figure 5 Shows the message delivered to particular user that the leakage detected. . In this result autonomous industry prototype model is developed and working status is monitored and verified.

The working status is broadly classified into two cases as depicted in fig 5, which shows normal mode and leakage mode.

On the X-ctu window of X-bee node 1 to 4 are in normal mode when there is no gases leakage in first step of data, where as node 2 is in gas leakage mode among the four nodes in second set of data.

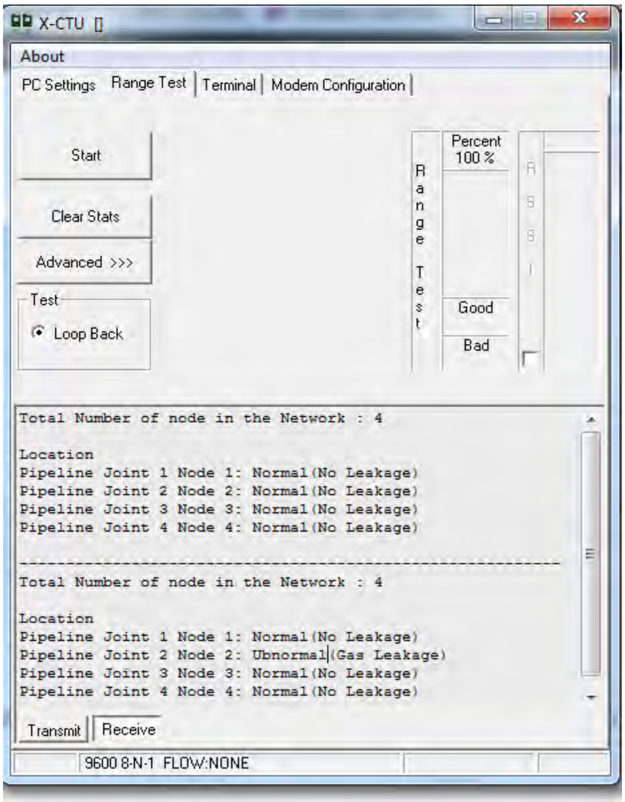

Fig. 5 Wireless Communication Xbee Data.

V.CONCLUSION

Gas leakage is one of the major problems in Industrial sectors. This paper helps in identifying the exact location of gas leakage in working atmosphere and the intimation is given through a text via Xbee. It is monitored live on a screen. Thus it ensures easy maintenance and enhances safety as well as provides low power consumption and cost effective system. Protective environment of any industrial sector involving motors and pipeline will stay safe if this mode of Maintenance scheme's followed.

VI. ACKNOWLEDGEMENT

The research has been supported by the Research and modernization funded project of SASTRA University-R and M/0008/SOC-001/2009-10.

VII. REFERENCES

[1] Ho-Jung Ryu, Seung-Yong Lee, Young Cheol Park, and Moon-Hee Park, "Solid Circulation Rate and Gas Leakage Measurements in an Interconnected Bubbling Fluidized Beds", World Academy of Science, Engineering and Technology, vol. 4, pp. 169-174, 2007.

[2] Gyou-tae Park, Young-gyu Kim, Jeong-rock Kwon, Yongwoo Lee and Hiesik Kim, "Development of the Gas Safety Management System using an Intelligent Gasmeter with Wireless ZigBee Network", World Academy of Science, Engineering and Technology vol.40, pp. 186-188, 2010.

[3] J. F. Davidson, R. Clift, and D Harrison, Fluidization, 2nd Ed., Academic Press, London, 1985, pp. 294-329.

[4] L. F. Diego, F. G. Labiano, P. Gayan, J. Cleaya, J. Palacios, and J. Adanez, "Operation of a 10kWth chemical-looping combustor during 200h with a CuO-Al2O3 oxygen carrier," Fuel, vol. 86, pp. 1036-1045, 2007.

[5] H. J. Ryu and G. T. Jin, "Conceptual design of 50kW thermal chemical-looping combustor and analysis of variables," Energy Engg. J., vol. 12, no. 4, pp. 289-301, 2003.

[6] H. J. Ryu and G. T. Jin, "Performance estimation and process selection for chemical-looping hydrogen generation system," Trans. Of the Korean Hydrogen Energy Society, vol. 16, no. 3, pp. 230-239, 2005.

[7] H. J. Ryu and J. H. Choi, "Effects of temperature and particle density on particle entrainment in a gas fluidized bed," HWAHAK KONGHAK, vol. 35, no. 2, pp. 173-180, 1997.

[8] E. Johansson, A. Lyngfelt, T. Mattisson, and F. Johnsson, "Gas leakage measurements in a cold model of an interconnected fluidized bed for chemical-looping combustion," Powder Technology, vol. 134, pp. 210-217, 2003.

[9] B. Kronberger, E. Johansson, G. Loffler, T. Mattisson, A. Lyngfelt, and H. Hofbauer, "A two-compartment fluidized bed reactor for CO2 capture by chemical-looping combustion," Chem. Eng. Technol., vol. 27, no. 12, pp. 1318-1326, 2004.

[10] D. Kunii and O. Levenspiel, Fluidization engineering, 2nd Ed., Butterworth-Heinemann, MA, 1991, pp. 71-75.

[11] Han Park, "An Enhanced Key Management Scheme Based on Key Infection in Wireless Sensor Network", World Academy of Scicence, Engineering and Technology 60, pp.249-254, 2009.

[12] G. T. Park, G. J Lyu and Y. G Kim "Implementation of gas safe management system using micom gas-meter with wireless zigbee communication," Korea Information and Communication Society. Vol. 1, pp. 122–123, June 2008.

[13] ZigBee Alliance, ZigBee-2009 Specification : ZigBee Document, 2009.