P.Ram Bhupal, M.Soujanya / International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com
Vol. 2, Issue 6, November- December 2012, pp.830-834

Real-time Monitoring and Preventive Measures of Leakage Accidents in Gas and Petrochemical Industries using Zigbee

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ABSTRACT

This method develops hardware and software for detection, location of gas leakages and prevention of accidents in gas, chemical and petroleum industries. This entire approach is developed based on Wireless Sensor Networks (WSN). Based on ARM7 processor, ZIGBEE modules this system can be easily developed and can meet the preventive measures for controlling accidents and to reduce economy, human loss greatly. In previous approaches of wired networks we couldn't detect leakages in real time, locate leakage point it occurred exactly and prevent leakage accidents immediately it occurs[1]. In this method we can overcome this easily and can reduce loss greatly.

Key words: Zigbee, Gas sensor, Temperature sensor, Pumping motor, Leakage, ARM7 Processor

1. INTRODUCTION

In high risky industries like gas, chemical, petroleum industries, it is hard to detect the leakages and accidents in real time and its more hard to control loss. Even now a day it is more concern of operators to overcome it. By taking series of measures we can meet safety of Industries easily. However, there are still some shortcomings in real-time monitoring and on data transmission and accurate location of a leakage point when an accident happens[1]. Mainly because: most of the current equipments are based on wired networks, it is backward in technology and hard to be deployed; In highly risky industries like gas, petroleum industries the accidents by leakage will occur within fraction of seconds, so we cannot control it immediately[2].

The technology of data acquisition in accidents is also backward and so it is hard to locate the leakage point and control it. These problems can be overcome with the help of WSN[7]. WSN has absolute superiority on data acquisition and transmission. A timely evaluation and response to leakages allows proper management of the risk system.

2. MODEL OF THE PROPOSED SYSTEM

In this proposed system we deploy temperature sensor for real time sensing of changes in temperature, and also as soon as the sensor detects leakage of gas it will stop the pumping system of gas, and shuts required sensitive paths. The gas leak detection, location and prevention system consists of three distinguished parts in hardware. They are: Control centre, Coordinator, Terminal nodes. There are number of terminal nodes depending upon the type of application or Industry.

Coming from the terminal nodes, there are two types: Full function device (FFD), reduced function device (RFD). RFD is an end device, which can only collect data from sensors and sends data to FFD[7]. On the other hand FFD works as router that associates with the other router and end devices and they all will communicate with coordinator. The coordinator will be connected to the monitoring section (PC) by using a RS-232 cable and communicate with it to update the sensors data in real time. The PC will display location and status of sensors data of all the monitoring sites.

Typically this proposed system can be deployed in two types of modes: Fixed point monitoring and dynamic deployment modes.

In Fixed point monitoring we will fix the terminal nodes in the industry particularly at the corners where there is more chance for leakages, and joints of pipes, screws and places where there is chance to pipes be eroded or broken. After deploying in this way the system can track the monitoring data of the industrial areas in real time. Trace leakage is mainly caused by
erosion, bad connection and external forces and so on; it is a hidden fire danger or causes of other serious accidents. But it is hard to find out.

In second mode i.e., dynamic deployment, is being used when an accident occurs. In certain situations rescue units also could not move in to the accident area, due to hidden danger of explosion. In this mode, these modules are thrown in to the accident zone using robot.

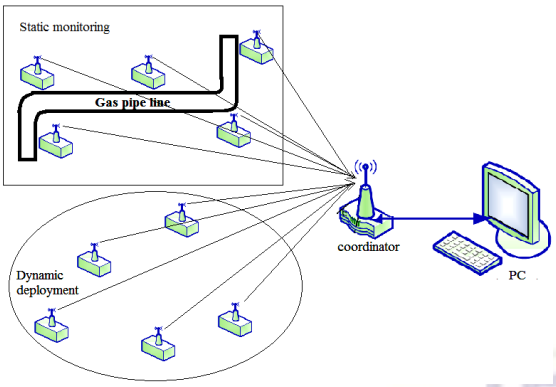

Fig 1. Structure of the system

So all the information or sensors data like hike in temperature or increased thickness of dangerous gas will be collected. The location of the gas leakage point will be known from analyzing real time. Because of dangerous gas, hidden dangerous of unexpected explosion the rescuers could not enter the accident zone[2]; it is very hard to save industry and workers. So with this proposed method we will successfully stop gas leakage in real time, and can meet safety measures as soon as possible.

3. MODEL OF THE SYSTEM

A. Hardware Design:

In hardware part, the total system consists of nodes location section, coordinator and Monitoring PC.

I. Nodes location section:

Every node consists of wireless Radio Frequency (RF) modules, sensor modules, temperature sensor, and power management module. And all these are connected to ARM7 processor and deployed at nodes section (industry).

ZIGBEE: In this system we are using Zigbee module namely CC2430 chip for reducing the cost of the entire system, and to shorten development cycle and lower the difficulty [3]. Low power consumption, receiving sensitivity, also key features of Zigbee. And its data rate is 240Kb/s when the RF is 2.4 GHz. Zigbee is guided by IEEE 802.15.4 PAN standard. It is designed for the wide range controlling applications [6]. One of the main advantages of this ZIGBEE communication is that it provides a noise free communication, the amount of noise added in this type of communication is very less compared to the other wireless communications

ARM7 Processor (LPC 2148): ARM processors use RISC architecture, and it is based on 16- bit/32 bit CPU.

Inline barrel shifter and 16 bit thumb mode makes this processor suitable for industrial applications which need faster processing. ARM processors use AMBA (Advanced Microcontroller Bus Architecture) Bus. Earlier AMBA introduced ARM system Bus (ASB) and ARM peripheral Bus (APB), but later ARM high performance bus (AHB). Since it provides high data through put. Its flash memory ranges from 32 kB to 512 kB. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 40 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 32-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 45 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make this microcontroller suitable for industrial control and medical systems.

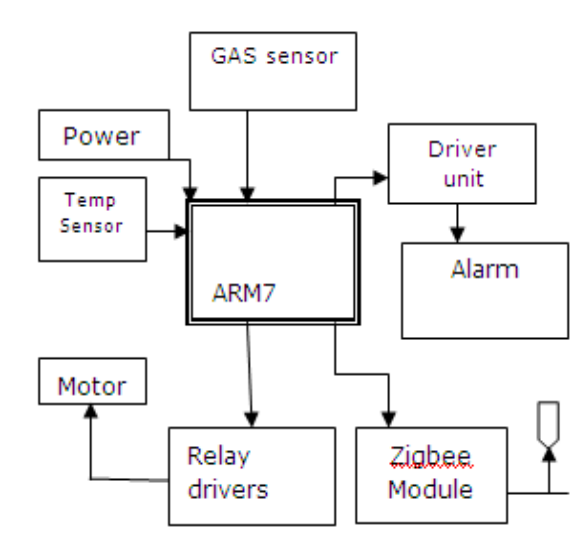

Fig2. Block diagram of nodes section

MQ6 Gas sensor: Coming to gas sensor we use MQ-6 sensor. According to the changes of thickness of gas in the atmosphere the electrical properties of the sensor changes. Resistance value of MQ-6 is difference to various kinds and various concentration gases. When accurately measuring, the proper alarm point for the gas detector is determined after considering the temperature and humidity influence. It is high sensitivity to LPG, iso-butane, propane and small sensitivity to alcohol, smoke. It is stable and can run long life with its simple drive circuit. This is well ideal to use in gas leakage detecting equipments in family and industry, and suitable for detecting of LPG, iso-butane, propane, LNG, avoid the noise of alcohol and cooking fumes and cigarette smoke.

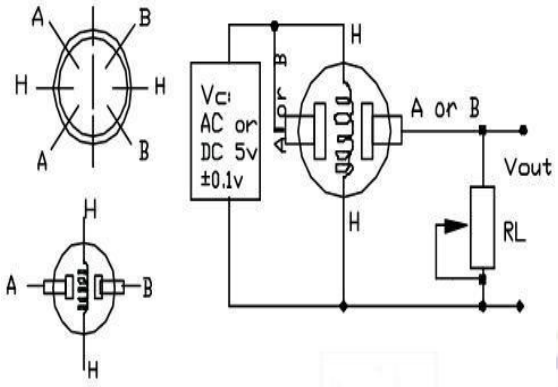

Fig3. Schematic of MQ6 gas sensor

LM35 Temperature sensor:

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in ºC). The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified. The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4 ºC at room temperature and +/- 0.8 ºC over a range of 0 ºC to +100 ºC. Another important characteristic of the LM35DZ is that it draws only 60 micro amps from its supply and possesses a low self-heating capability. The sensor self-heating causes less than 0.1 ºC temperature rise in still air.

At the nodes section, after initialization if the gas is detected at the surrounding area, the sensor automatically detects [5]. Then it alerts the monitoring section. The sensor consisting of Tin Dioxide chemical material which has the property that when a gas is detected its resistance comes down greatly, then a large current flows through this. Then the processor activates buzzer, and it stops the pumping motor automatically.

Relay: A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches.

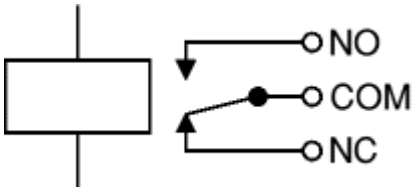

Fig4. Circuit symbol of relay

Relays allow one circuit to switch a second circuit which can be completely separate from the first. With relay the gas pumping motor will be controlled. If the gas leakage is detected,as soon as the coordinator observes it,the motor will be stopped pumping using relay unit.

II. Monitoring Section: The coordinator acts as a gateway to communicate with the control centre, which is different from the terminal nodes. So we need another communication link in hardware design to connect coordinator with PC. Ideally we can use RS-232 cable and USB for communicating with PC.

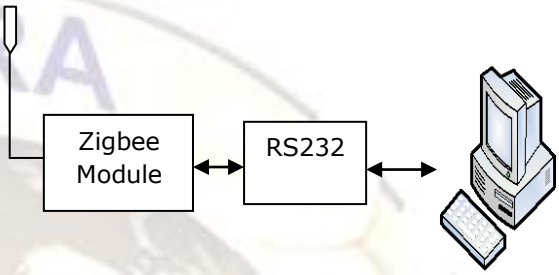

Fig5. Monitoring section

The coordinator has Zigbee module, for receiving data from the sensors at the terminal nodes[7]. This data will be sent to PC through RS-232 serial communication port. Serial data communication uses two methods, asynchronous and synchronous. The synchronous method transfers a block of data (characters) at a time while the asynchronous transfers a single byte at a time. The power required to operate the controller, Zigbee, Buzzer, Gas sensor, and Temperature is 3.3V.

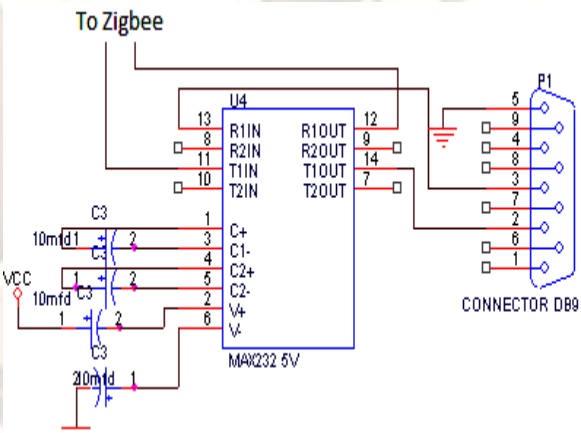

Fig6. RS-232 schematic

B. Software Design:

Apart from hardware design, software design makes the way of communication among nodes. It is designed so as the terminal nodes will regularly monitors the areas surrounding them and will communicate with coordinator in real-time to update its massages. Zigbee nodes are three types in this system: Coordinator, Full function device nodes, Reduced function device nodes. The main

difference between these nodes is communication software design. After initializing the coordinator automatically builds network with the terminal nodes[1]. At the terminal nodes section, the RFD nodes which are nearer to a FFD node forms a mesh type network and all other RFD nodes forms such network with nearer FFD nodes accordingly.

Now as the terminal nodes always sensing the differences in the atmosphere, the data of these sensors will be sent to coordinator node via FFD nodes. These information of nodes will be updated at the monitoring section in real time.

The algorithm for building up communication among the nodes is as follows:

Step1: Initialize the hardware components

Step2: Build a network with coordinator and all the terminal nodes

Step3: Build a mesh type network among all the RFD modules nearer to a FFD.

Step4: The terminal node monitors the atmosphere in real time for gas leakage.

Step5: send sensors information to monitoring section via coordinator to update information.

Step6: the sensors data will be sent to coordinator for every specified time cycle to update sensors values.

Step7: if the gas leakage is detected, send information to coordinator and go to step 8, if not go to step4

Step8: If the leakage is detected, the processor will activates alarm, and stops the pumping motor by sending stop signal accordingly.

The flow chart for the proposed method is shown below:

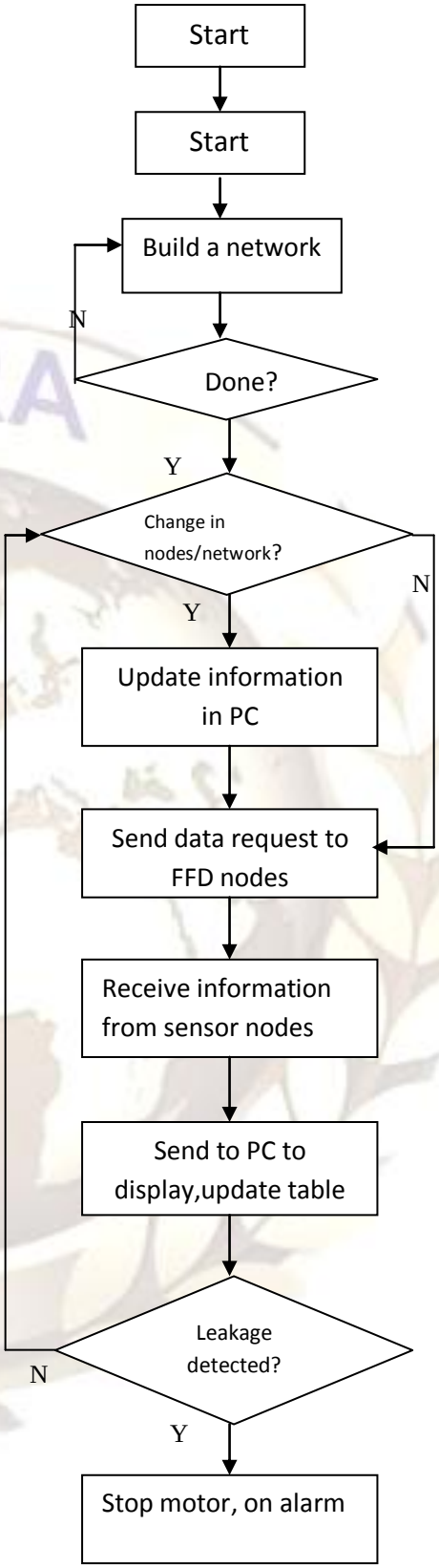

Fig7. Flow chart of coordinator section

4. CONCLUSION

With this software approach we can develop a real-time detecting and controlling of gas leakage system highly sensitive industries using Zigbee,ARM7 processor. It comprises Zigbee modules, gas, temperature sensors, so it can be easily deployed. In two modes this system can be operated they are: fixed more, and dynamic deployment mode such as when any accident occurs[2]. So with this proposed method we can overcome the shortcomings of the current systems. With this the rescue management improves and can save economy and lives very quickly.

REFERENCES

[1] Development on Gas Leak Detection and Location System Based on Wireless Sensor Networks-Ding Chengjun, Liu Ximao, Duan Ping School of Mechanical Engineering, Hebei University of Technology,Tianjin,300130,China

[2] Multi-level planning for protective action making under toxic-gas leakage-Wei Wang; 2011 International conference on Digital object identifiers

[3] A Wireless Sensor Network-Based Infrastructure for Real-Time and Online Pipeline Inspection- mahmoud Meribout, IEEE SENSORS JOURNAL, VOL. 11, NO.11, NOVEMBER 2011

[4] Computer Simulation on Industry Pipeline Gas Leakage and Dispersion. Fourth International conference on digital object identifier-2011; Dehong Zhou

[5] www.ti.com

[6] Jin-Shyan Lee, Chun-Chieh Chuang, and Chung- Chou Shen. "Applications of Short-Range Wireless Technologies to Industrial Automation: A ZigBee Approach", 2009 Fifth Advanced International Conference on Telecommunications, 2009 IEEE

[7] Liu Yanfei Wang Cheng Qiao Xiaojun Zhang,"An Improved Design of Zigbee Wireless Sensor Network"978-1-4244-4520-2/09/$25.00 2009 IEEE.

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I express my gratitude to **M.SOWJANYA** Associate Professor- Department of (ECE) and for her constant co-operation, support and for providing necessary facilities throughout the M.tech program. She has 4 Years of Experience, at B.Tech and M.tech Level and working as a Associate Professor in Sri Indu College of Engg. & Technology