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Monitoring And Controlling The Gas Plant By Wireless Sensor Network Using Co-operative Communication

Jyoti M. Giri (M.E. Student),Prof. S.M. Kulkarni
PVPIT, Department of Electronics & Telecommunication,
University of Pune, Maharashtra, India.

***Abstract*— This paper deals with zigbee based wireless sensor network platform for monitoring and controlling the gas plant using Co-operative communication .it consist of co-ordinator & sensor node .Co-ordinator is Centralized unit, it collects information from node on demand & provides to the end user. The sensor node is made intelligent for controlling the plant. This node attached with zigbee for remote controlling.**

We design a WSN using Co-operative Communication based on zigbee data acquisition system using ARM 7 processor which is having many important advantages such as low cost, low power consumption &low data rate. Furthermore, the system is simple stronger mobility& practicability. The system dedicates to automatic data collection & control.

This paper describes the design of WSN based on zigbee technology using Master& Slave combination. It is mainly used for collecting & transferring the various monitoring information about temperature, LPG Gas, LDR light in gas plant. The system consists of zigbee based network, 3 sensors, PC master, two sub-masters & one slave combination. The co-operative communication technique is used to make sure that the slave is always in range of master .for this 2 sub-master units are used. here the main PC master terminal has VB software on it. The PC master terminal used to monitor the status of slave.

The sensor node is implemented using ARM 7microcontroller programmed using Embeded 'C'. The experimental results obtained demonstrates the usefulness of the proposed system in terms of low power consumption, low cost, targeted towards automation & remote control application.

Key Terms:-
ARM Processor, LDR, LPG sensor, Temperature sensor, Wireless Sensor Network, Zigbee etc.

I. INTRODUCTION

Wireless smart sensor platform is a novel technology in acquiring & processing information and has been an active research area in recent years .There are no. of applications outlined in many areas such as military, environmental ,health, home, commercial & industrial. It is considered as one of the most important technology that changes the future.

Wireless Smart Sensor-based controls developed to reduced costs, better power management, ease in maintenance, and effortless deployment in remote and hard-to-reach areas. They have been successfully used many industrial applications such as maintenance, monitoring, control, security, etc. In this research, our focus is on the issues of portability, reliability, flexibility and robustness while using wireless connectivity in industrial applications such as instrumentation and predictive maintenance, and to design a workable solution[3].

Wireless Smart Sensor Platform is a collection of large no. of miniature autonomous devices known as sensor nodes to form network. The individual nodes are capable of sensing their environments, processing the information locally, or sending it to one /more collection points through a wireless link. The attributes of WSN are:-

1) Minimum power consumption
2) Short range communication
3) Low RF transmit power
4) Operating frequency

The advantage of wireless connection in sensor networks are:-

1) They provide higher flexibility in sensor placement.
2) They avoid use of wires& hence save the cost.
3) They can minimize human interventions do not require particular infrastructures.

There are many wireless technologies on the market like

GSM, GPRS, & DECT which are characterized by a high range coverage area, high cost & high power consumption. Others are characterized by low coverage area, low cost & low power consumption such as Bluetooth, IEEE802.11 & wireless Fidelity (Wi-Fi).From economical point of view, wireless systems are promising for use in sensor network configuration & for different industrial applications.

WSN's offer oil & gas companies immediate & measurable benefits, including improved performance, greater flexibility & reduced costs for installation & ongoing maintenance.

Gas industry represents an example of very high complexity in real time production & condition monitoring, where wireless sensor network solutions can be particularly successful in providing an effective approach to data collection & transport for overall plant efficiency.

• Oil & gas companies have been early adapter of wireless sensor network technology & have played a key role in driving innovations & defining wireless standard's.

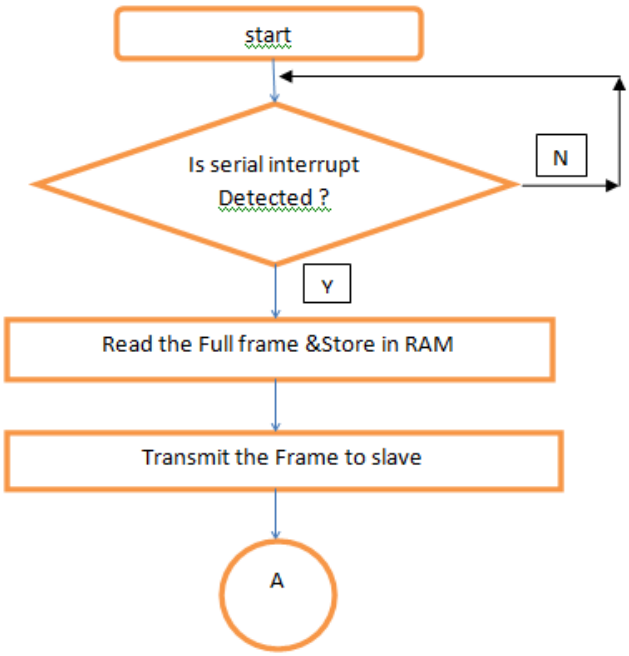
• All of the major process automation companies such as ABB, Cooper, Emersion, Honeywell, Siemens &Yokogawa have wireless sensing systems for the oil & gas industry.

In a Gas plant, several measurement points are required to trace down the local parameters in the different parts of the gas plant to make automation system work properly.

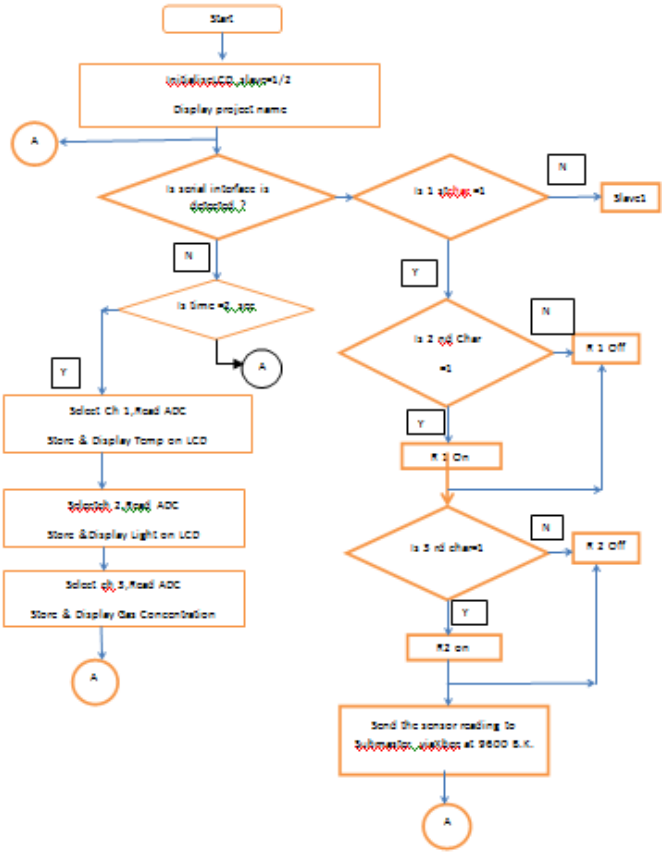
Cabling would make the measurement system expensive & vulnerable. Moreover, the cabled measurement points are difficult to relocate once they are installed. Thus wireless monitoring and control using smart sensor platform consisting of small size is an attractive & cost efficient option[6].

II. SOFTWARE :- Flowchart:-

A. Co-operative Communication:-



B. Request &Response



III. DESCRIPTION OF PROPOSED SYSTEM

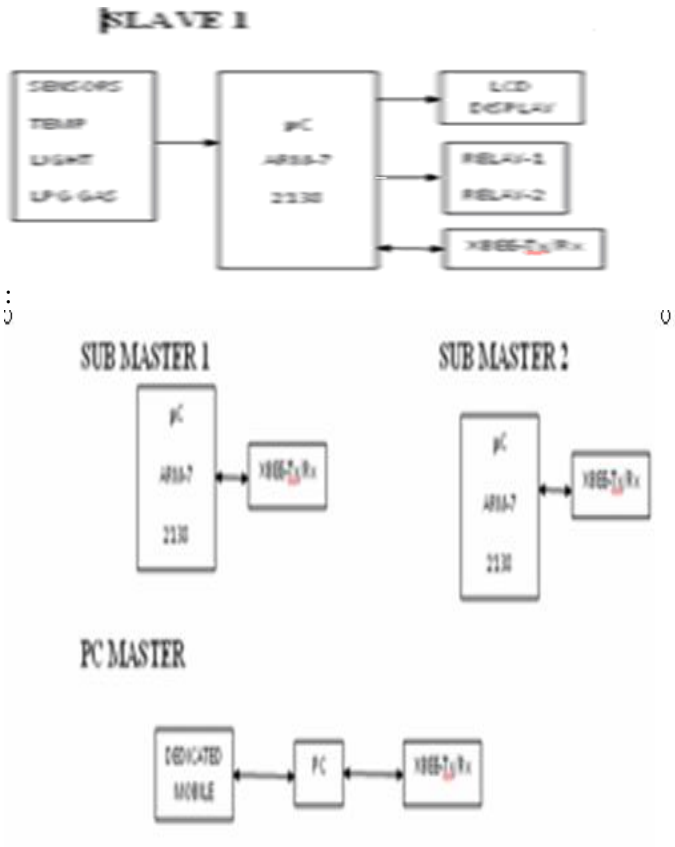


Figure 1: Block Diagram

A. Zigbee:-

Zigbee is a new wireless technology based on wireless standard 802.15.4. It is an extention of the WPAN, having a significant features:-

Short Range: - Which is between 10-100 m, good enough to meet the need of mobility equipment.

Low Power:-When data exchange is not needed the node will enter a very low power consumption sleep mode

Low Transmission Rate .

Compared to Blutooth & Wi-Fi , Zigbee technology has following advantage

1) Good Security:-Zigbee provides data validation capabilities, using AES 128 encryption algorithm

2) Low Cost:-Data transmission rate is low,the protocol is simple ,it costs much less & free of royalties.

3) Low power Consumption :- Perticularly in standby mode to save energy.

4) Short Delay:-Usually between 15 &30 msec.

5) Low Transmission Rate:-Only 10 to 250 k bytes/sec, for low data rate n/w's.

6) Flexible working BW :- Using frequency bands for 2.4 GHz,868 MHz, 915 MHz, all are license free band.

7) Large n/w Capacity: - Each zigbee n/w can support up to 255 devices.

B. ARM Processor:-

The central part of the proposed sensor node is ARM controller module its main functions are control of the sensing element, synchronization of the data transfer between sensor & memory. The processor module uses a LPC 2138 ARM Controller .Due to their tiny size & low power consumption, this microcontroller is ideal for applications where miniaturization is a key requirement ,such as access control & point of sale. Wide range of serial communications interfaces& On-chip SRAM option of 8 KB,16 KB,& 32 KB, they are very well suited for communication gateway& protocol converters, soft modems, voice recognition & low end imaging, providing both large buffer size & high processing power. Various 32 bit timers single /dual 10 bit 8 channel ADC(s) ,10 bit DAC, PWM channels & 47 GPIO lines with upto nine edge/level sensitive external interrupt pins make these microcontroller particularly suitable for industrial control & medical systems[7].

C. Liquid Crystal Display:-

LCD used in a project to visualize the output of the application. We have used 16x2 LCD which indicates 16 columns and 2 rows. So, we can write 16 characters in each line. So, total 32 characters we can display on 16x2 LCD.

LCD can also used in a project to check the output of different modules interfaced with the microcontroller. Thus LCD plays a vital role in a project to see the output and to debug the system module wise in case of system failure in order to rectify the problem.

D. RS 232:-

RS 232 is a serial communication cable used in the system. Here, the RS 232 provides the serial communication between the microcontroller and the outside world such as Display, PC or Mobile etc. So it is a media used to communicate between Microcontroller and the PC.

E. Sensor:-

1. Temperature Sensor:-

Temperature sensor is used to sense the temperature. We have used a Temperature sensor called LM35. Irrespective of the application to which it is used, it gives the reading of the temperature. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. Temperature sensor is an analog sensor and gives the output into form of analog signal. This signal is feed to ADC which will convert it into digital form.

2. Gas Sensor:-

Gas sensor we are using is MQ-6. Sensitive material of MQ-6 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exist, the sensor's conductivity is more higher along with the gas concentration rising.

MQ-6 gas sensor has high sensitivity to Propane, Butane and LPG, also response to Natural gas. The sensor could be used to detect different combustible gas, especially Methane, it is with low cost and suitable for different application.

Gas sensor is an analog sensor and gives the output into form of analog signal. This signal is feed to ADC which will convert it into digital form.

IV. FEATURES

A. Cooperative Communication:

Here we are using the cooperative communication technique to make sure that the slave is always in range of the master [2]. For this we use two sub masters units. These units are basically repeater unit which will enhance the data signal when the slave is not in range of the master. Here the request is first given to the sub master. The frame transmitted by PC master will contain the sub master id as well as the slave id from whom the data is to be retrieved.

The sub master upon receiving the frame will then check for the slave id and will retransmit the frame as it is. If one of the sub masters fails then the other sub master can also send the data .

B. System specifications:

1) 10-bit resolution in built ADC.
2) 32 bit ARM Micro-controller.
3) RS 232 for serial data transfer.
4) LCD Display 16*2.
5) XBEE MODULE:
   30 METERS, 2.4 GHz OPERATING FREQUENCY.
   5V, 200 ma Current Consumption.
6) Display on PC using VISUAL BASIC

V. EXPERIMENTAL SETUP & RESULT

In Experimental setup we have shown slave & sub master connections as shown in Fig.2 &3. Sensor Reading & Sub-Master Reading is as shown in Fig 4 & Fig 5 As we are showing results on VB window onboard PC, where we can set the set points online ,we also see tabular view & graph of parameters(temperature, gas concentration, light intensity) Versus Time, and also indication of Red/Green signal depending on whether readings are greater than that of set point, which is shown by Fig 6,Fig 7 &Fig8.

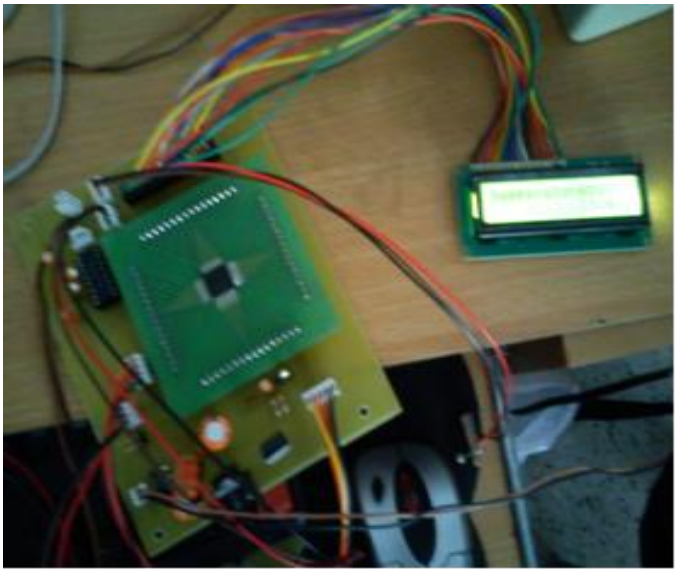


Figure 2: Slave Unit

Figure 3: Sub Master Unit

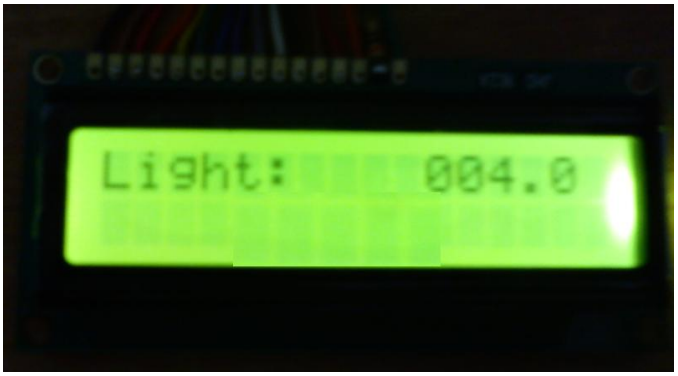


Figure 4: Sensor Reading

Figure 5: Sub-Master LCD

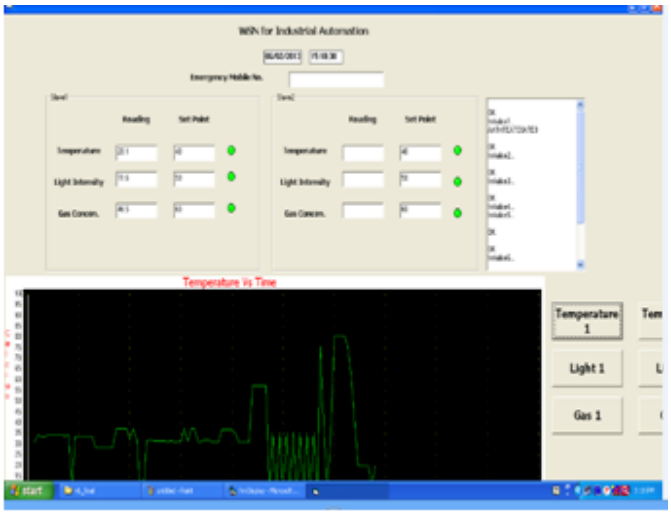


Figure 6:Temp V/S Time

Figure 7: Light Intensity V/S Time

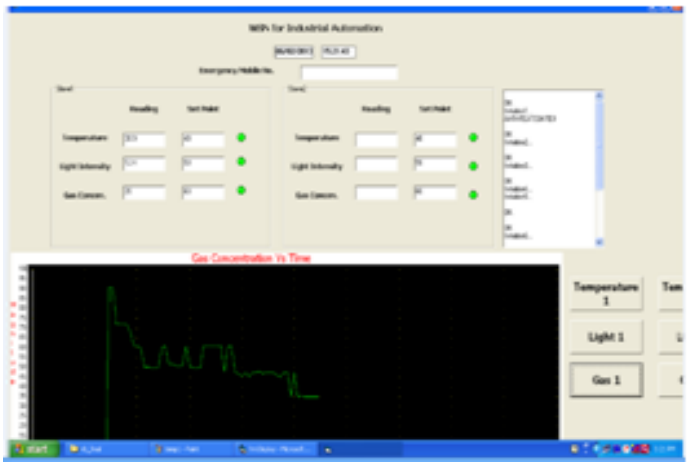


Figure 8: Gas Concentration V/S Time

Key Features of System:
1) Efficient way for wireless data logging of hazardous applications
2) Less time delays
3) Quick response time
4) Fully automate system
5) Robust system
6) Low power requirement

Applications:
1) Data logging in hazardous application such as nuclear plants, gas plants, chemical plants etc.
2) Wireless communication over long distances such as oil rigs.
3) Forest fire Detection.
4) Industrial Monitoring etc.

VI. CONCLUSION & FUTURE WORK

In summary, zigbee wireless smart sensor platform is a new close range, simple low power, low data rate & low cost technology. It is based on IEEE 802.15.4 std.

In our system we uses various features like Co-operative Communication whose goal is to increase communication rate & reliability .also we are using dedicated mobile to give the SMS.

Here we can also add the no. of slaves, the idea is that if the slave goes out of range of PC master then the communication fails. All slaves placed in such a way that they will be always in range of the PC master. (ie we can use feature of collision avoidance protocol).

Future research &development may continue to be focused on further improvements of the reliability & responsiveness & technology advancement on energy saving, power management, fault tolerance & smart routing.

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Author Profile

Jyoti M. Giri Completed her Graduation in Electronics from AISSMS WCOE, Pune, MH, India in 2006. She is having 4 years of industrial experience &1.5years of teaching experience in ITC College Chandannagar. She is doing M.E.(E & TC) from P.V.P.I.T. Bavdhan , Pune. Her research area include Wireless sensor Network based on Zigbee.