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Monitoring Indoor Air Quality for Smart Sensor Network using CAN Interface

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Abstract— *Indoor air quality (IAQ) could be a key issue for making certain safety, health and luxury of the individuals. Since physical variables describing IAQ, like the concentration of volatile organic compounds (VOCs), concentrations of aerosolised air contaminants and that of alternative virulent gases want to be closely monitored, conception of management network has to be enforced. In this paper, a framework of device network for watching IAQ is explained wherever sensors area unit physically distributed and the serial communication network will is employed to exchange system data. will (Controller space Network) could be a high integrity serial bus protocol that's designed to control at high speeds starting from 20kbit/s to 1Mbit/s which offer Associate in Nursing economical, reliable and extremely economical link between device nodes and show node. The communication between the device nodes and therefore the show node through the will bus is evaluated mistreatment Hardware tests.*

Keywords— *Indoor Air Quality, Sensor Network, Controller Area Network*

1. INTRODUCTION

Indoor air quality (IAQ) could be a steady increasing health concern since individuals pay around ninetieth of their time inside. Indoor pollution sources that unleash gases or particles into the air area unit the first reason for indoor air quality issues at homes, jam-pawncked subways, in chemical industries and closed cabins like AC railway cabins. With a networked system with distributed device nodes and show nodes indoor air quality are often incessantly monitored. as a result of the new growth of wireless technology, wireless device network uses wireless protocol for the communication and traditional wireless protocol emphasize bit rate over skillfulness and dependability, that is unsuitable for management and watching applications. For this reason, even though wireless technology is employed at testing management level, real time management applications mistreatment wireless communication techniques area unit still only a few. A wired communication protocol could be a sensible choice during this case.

In the networked system an oversized range of short information must be transmitted and received between nodes and conjointly information ought to maintain high integrity. so as to fulfill these specifications Controller space Network (CAN) protocol are often used for the communication between nodes. will protocol support topology which is able to offer high network flexibility. Failure of 1 of the nodes doesn't have an effect on the operate of the rest of the nodes in the network.

2. DESIGN OF THE PROJECTED SYSTEM

The Schematic of projected system is shown in Fig one.The device node incessantly detects the presence of volatile organic compounds and alternative aerosolised air contaminants. The device information is scaled to it level that the built-in ADC of the microcontroller will settle for. The built-in will controller fulfils communication functions prescribed by the will protocol. The will transceiver connects the will controller to the will bus. The transceiver converts the transmit bit signal received from the will controller into a sign that's sent to the bus. It conjointly adapts signal levels from the bus to levels that the will controller supports. Through the will bus interface the device information is transmitted to a show node were the concentrations of the aerosolised air contaminants are often simply be monitored.

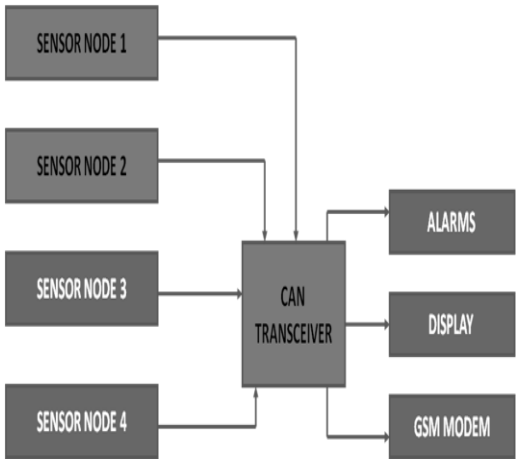

Figure 1. Architecture of the project

The will bus could be a 2 wire differential line bus that is terminated at the 2 ends with 120Ω resistors. the 2 lines of the will bus is CAN_H line and CAN_L line. will is Associate in Nursing asynchronous serial communication protocol that with efficiency supports distributed period of time management with a awfully high level of security. it's a 2 wire, 0.5 duplex high speed network system developed

within the middle Nineteen Eighties by Hieronymus Bosch GmbH, to supply a cheap communication bus for automotive applications. In will controllers the information link layer is enforced in hardware. The physical layer specifies the physical and electrical characteristics of the bus.

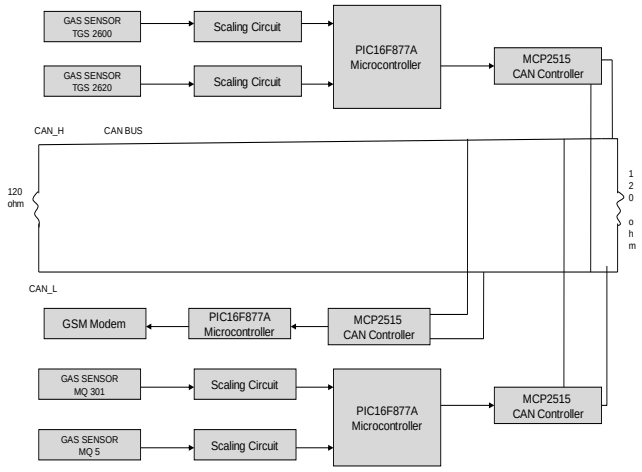

Figure 2. Overall Block Diagram

3. THE PROPOSED SYSTEM

A. Controller Area Network based smart sensor network for indoor air quality monitoring

The device nodes incessantly takes the readings that shows the presence of volatile organic compounds and alternative aerosolised air contaminants for a selected time and sends the information out on the bus. because the most device output voltage is bigger than the reference voltage of the built-in ADC of the microcontroller a scaling circuit is employed. The scaling circuit could be a easy inverting electronic equipment whose gain is adjusted therefore on scale the device output, followed by another electronic equipment in inverting mode with unity gain.

The built-in will controller fulfils communication functions prescribed by the will protocol. The will transceiver connects the will controller to the will bus. The bus transceiver converts the quality logic signals from the will controller to the physical levels used on the physical will bus. It conjointly adapts signal levels from the bus to levels that the will controller supports.

B. CAN 2.0 protocol specifications

CAN could be a serial bus protocol particularly fitted to networking intelligent devices moreover as sensors and actuators at intervals a system or system.CAN (Controller space Network) was originally developed for automotive applications within the early 1980's . it's Associate in Nursing asynchronous serial communication protocol that with efficiency supports distributed period of time management with a awfully high level of security. CAN 2.0 could be a broadcast digital bus designed to control at speeds from 20kb/s to 1Mb/s. CAN 2.0 is a lovely resolution for embedded management systems as a result of its low value, lightweight protocol management, the settled resolution of the competition, and therefore the inbuilt options for error detection and retransmission.

CAN could be a serial bus system with multi-master capabilities, that is, all will nodes area unit able to transmit information and a number of other will nodes will request the bus at the same time. It covers very cheap 2 layers of the ISO/OSI reference model which incorporates the information link and physical layer. the information link layer acknowledges and understands the format of messages [5]. will protocol outline messages as frames. Embedded within the information frames area unit arbitration fields, management fields, information fields, cyclic redundancy check add (CRC) fields, a a pair of bit acknowledge field, Associate in Nursingd an finish of frame. The arbitration field prioritizes messages on the bus. For a regular information frame, the arbitration field consists of eleven bit symbol and for extended information frame twenty nine bit symbol.

The physical layer specifies the physical and electrical characteristics of the bus. Most will systems implement the physical layer of the protocol by mistreatment some reasonably transceiver that connects the will ICSH and might nine L pins to the will bus with a differential signal of 0-3 V. ISO one8982 is that the most used physical layer commonplace for will networks during which rate is outlined up to one Mbit/s with a in theory attainable bus length of forty m at 1 Mbit/s. The high-speed commonplace specifies a two-wire differential bus with a most of thirty nodes. The bus level is decided by a possible distinction between the am i able to H and might L wires. The will transit line will have one in all 2 logical states: recessive and dominant. Typically, the voltage level like recessive (logical 1) is a pair of.5 V and therefore the levels like dominant (logical 0) area unit three.5 V for will Hand one.5 V for will L. The voltage level on the will bus is recessive once the-bus is idle.

The will protocol handles bus accesses in line with the conception known as Carrier Sense Multiple Access with Arbitration on message priority. If 2 or a lot of bus nodes begin their transmission at identical time once having found the bus to be idle, collision of messages area unit avoided by bitwise arbitration. Every node sends the bits of

its message symbol and monitors the bus level. once a dominant bit is being sent, the ensuing bus state in line with wired-AND principle is additionally dominant. Otherwise, if a recessive bit is being sent, the ensuing bus state depends on what alternative nodes area unit causing within the same time. The recessive bus state means there's no collision, the dominant state means a minimum of one node is causing dominant bit. once the node receives a dominant bit throughout causing a recessive one, it loses the arbitration and withdraws from the transmission. It means messages with lower ID values higher priority. Nodes that lose arbitration mechanically try and repeat their transmission once the bus come to the idle state.

4. HARDWARE IMPLEMENTATION

A. Sensing Module

Within the projected system there area unit 2 device nodes with four completely different gas sensors. The TGS 2620 could be a volatile compound device and TGS 2600 is air material device as shown in Fig three. each of the sensors area unit from Figaro cluster. TGS 2620 has high sensitivity to the vapours of organic solvents moreover as alternative volatile vapours. It conjointly has sensitivity to a spread of flamable gases like carbon monoxide gas, creating it a decent general purpose device. TGS 2600 has high sensitivity to aerosolised air contaminants like gas and carbon monoxide gas. within the presence of a detectable gas, the sensor's conduction will increase counting on the gas concentration within the air. a straightforward electric circuit will convert the amendment in conduction to Associate in Nursing signaling that corresponds to the gas concentration.

Each device node consists of Gas device, Scaling circuit, PIC Microcontroller 16F877A, & will Transceiver MCP 2551 as shown in Fig four.

Figure 3. TGS 2600 & TGS 2620 sensor

In this paper, four types of sensors are used and corresponding circuits are designed and implemented as shown in Fig 5.

B. Signal Conditioning Module

The output of the device is within the vary of 0-5V. however the utmost analog input the built-in ADC will support is 3V. therefore a scaling circuit mistreatment the operational electronic equipment LM741 is employed because the signal acquisition circuit. The gain of the opamp and therefore the input determines the output of the circuit.

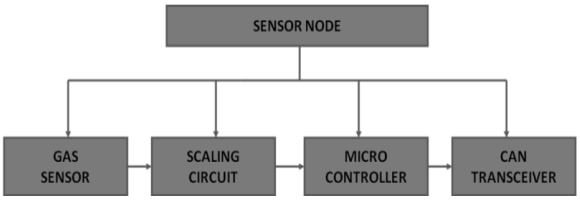

Figure 4. Sensor node

C. Microcontroller Module

PIC 16F877A is Associate in Nursing 8-bit microcontroller. The projected system uses the terribly skinny quad flat package IC. Associate in Nursing adapter is employed because the IC can't be programmed directly. The conditioned device output is given to 1 of the analog input channel of the ADC, that converts it into corresponding digital output. The digital output is given to the will message channel of the built-in will controller. The device information is processed by the will controller supported the will protocol version a pair of 2.0A.

D. CAN Transceiver Module

The MCP2551 could be a high speed will transceiver. it's particularly designed for top speed will Controller differential mode information transmission between will Controllers and therefore the physical differential bus lines. It supports a most transmission speed of 1Mb/s..

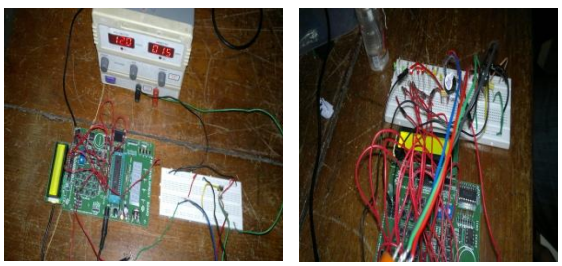

Figure 5. Designed sensor nodes

E. Display Module

Display unit consists of will transceiver {which will|which will|which is able to} convert the can bus signal into corresponding information and is connected to

microcontroller during which built-in will controller is there. The will controller can decipher the information. LED show is employed to show the received information in hex values. {lcd|liquid crystal show|LCD|digital display|alphanumeric display} display can also be used, which is able to show the corresponding ASCII values of the received information. The show node may contain a pc that incessantly monitors the information returning from the device nodes.

F. GSM modem

A GSM electronic equipment could be a specialised variety of electronic equipment, that accepts a SIM card, and operates over a subscription to a mobile operator, similar to a mobile. From the mobile operator perspective, a GSM electronic equipment appearance similar to a mobile. A GSM electronic equipment are often an obsessive electronic equipment device with a serial, USB or Bluetooth association, or it's going to be a mobile that gives GSM electronic equipment capabilities.

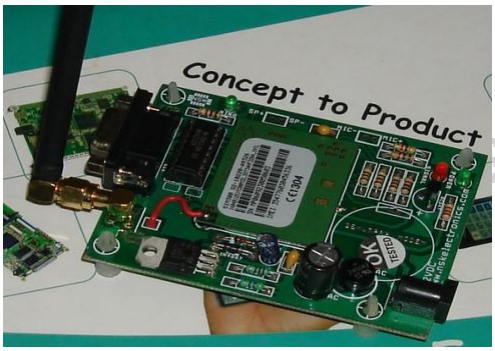

Figure 6. GSM Modem

A GSM electronic equipment might even be a regular GSM mobile with the acceptable cable and code driver to attach to a interface or USB port on pc. Any phone that supports the "extended AT command set" for sending/ receiving SMS messages, as outlined within the ETSI GSM 07.05 Specification are often supported by the currently SMS/MMS entry. within the projected system SIMCOM SIM300 GSM module is employed as shown in Fig five. GSM electronic equipment is connected to PIC microcontroller with RS232.

5. EXPERIMENT

All the sensors send the analog values to the ADC of PIC microcontroller during which serial communication network will is employed to exchange the data from one controller to a different controller. The ADC price are often displayed , and therefore the monitored price are often send to mobile through GSM electronic equipment. The implementation figure is shown at at Fig 7.

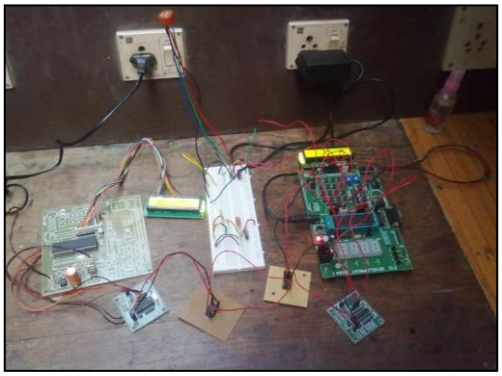

Figure 7. Snap shot of proposed system

6. RESULTS AND OBSERVATION

The recorded values of the parameters at different time instants are tabulated in Table 1.

TABLE 1. RECORDED PARAMETERS

GAS MODEL	TARGET GAS	PPM RANGE
MQ - 2	FLAMMABLE GAS & SMOKE	300 – 10000 ppm
MQ - 3	ALCOHOL IN BREATH	100 – 15000 ppm
MQ - 4	METHANE	200 – 10000 ppm
MQ - 5	LPG,NATURAL GAS,FUMES,CIGARETTE SMOKE,TOWN GAS	50 – 5000 ppm
MQ - 6	ISO – BUTANE,PROPANE,LNG & CIGARETTE SMOKE	100 – 10000 ppm
MQ - 7	CARBON MONOXIDE	20 – 2000 ppm
MQ - 135	AMMONIA,SULFIDE,SMOKE	200 – 20000 ppm
MQ 303 A	ALCOHOL	100 – 10000 ppm

7. CONCLUSIONS AND FUTURE RESEARCH

Three nodes has been designed, 2 of that area unit designed in transmission mode and therefore the third one in reception mode. The transmitter nodes area unit designed as device nodes and therefore the receiver node because the show node. Communication between the transmitter and receiver nodes has been enforced through the will physical layer commonplace ISO 11898-2, that

defines will bus as 2 wire differential bus. the tiny size of the will transceiver IC and therefore the microcontroller with integrated will resolution reduces the dimensions and price of the node significantly. With the employment of high speed will transceiver the information is transmitted and received in quicker rates with high level of integrity. The time interval associated is additionally tiny.

The future scope of the work is:

1. Implementation of a lot of device nodes and a sway node within the network.
2. To implement the bit screen for indoor air quality.
3. To implement in thirty two bit processor

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