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Electronic Eye for Smart Industries

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ABSTRACT: The development of remote WSN monitoring equipment is the core task in the security matters. This embedded system is providing a great security system which was deployed at CO₂ geological storage monitoring regions, industries and underground mines. It can collect CO₂ concentration, temperature, humidity, light intensity and other air environmental information through sensors and received data stored in personal computer by using ASK wireless transmission. Each node will then transmit the data to the monitoring station and to the authority persons by using GSM wireless communication service. The system uses a compact circuitry built around LPC2148 (ARM7) microcontroller and Programs are developed in Embedded C. Flash magic is used for loading programs into Microcontroller.

KEYWORDS: ARM LPC2148, CO₂ sensor, Humidity sensor, Temperature sensor, LCD, Light intensity sensor, etc....

I. INTRODUCTION

Atmospheric concentrations of the key greenhouse gas (GHG) carbon dioxide (CO₂) well above pre-industrial levels constitute the main cause for the predicted rise at average surface temperature on Earth and the corresponding change of the global climate system [2]. However, once CO₂ leaks from the storage reservoir, all the efforts human beings have made to fight global warming would be go down the drain. Recent advances in information and communication technologies have resulted in the development of more efficient, low cost and multi-functional sensors [4].

These micro-sensors can be deployed in wireless sensor networks (WSN) to monitor and collect air environmental information such as CO₂ concentration, temperature, humidity, light intensity, air pressure, wind power, wind direction, etc. The information is then wirelessly transmitted to data center server where they are integrated and analyzed for evaluating of geological values. Deploying sensor networks allows inaccessible areas to be covered by minimizing the sensing costs compared with the use of separate sensors to completely cover the same area [1].

The remainder is as follows, section 2 gives the information regarding blocks presents in the hard ware system, and section 3 gives the information about data flow route, section 4 gives implementation and applications examples, section 5 gives the conclusion of the paper and new avenues for the future work to implement this paper towards latest technologies.

II. HARDWARE DESCRIPTION

The system is mainly based on sensors which are used for sensing the geological values from the nature. The equipment is composed of the sensors array, central processing unit, LCD display module, GSM wireless transmission module, ASK transmitter and Personal computer with ASK receiver for data storage as shown in bellow Figure 1 & 2.

The microprocessor is interfaced with sensor array(CO₂ sensor, temperature sensor, humidity sensor, Light intensity sensor), GSM module for data transferring from the sensor network to authority persons, 20x4 LCD for displaying the data, ASK RF transmitter for transferring the data to the PC for data storage. The sensed data will be transferred to microcontroller via ADC circuit, the digitalized data forwarded to the concerned modules like ASK module, GSM module, LCD display unit.

The receiver part having one personal computer interfaced with ASK receiver through RS 232 cable. The PC is used for storing the sensed values from the sensor transferred through the ASK transmitter.

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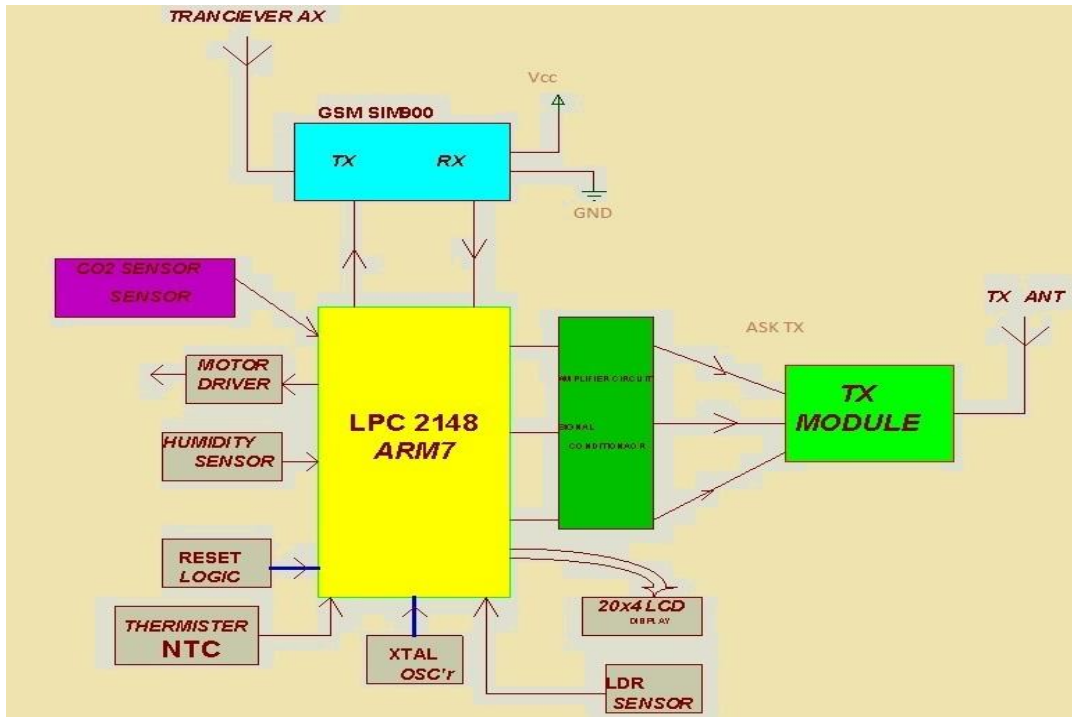


Fig: 1 Block diagram representation at transmitter side

These values are helpful for the future reference and calculating the concentrations of gases, if any problems happen certain limitations according to the problem.

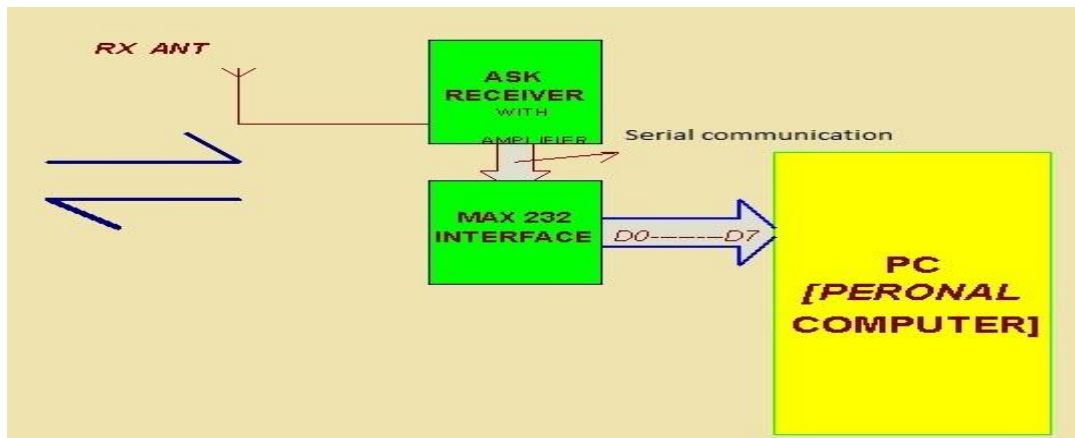


Fig: 2 Block diagram at personal computer

A. ARM CONTROLLER

The designers and embedded developers are using ARM processors to quickly develop the new microprocessor based products and applications. From the last few years developers are using these ARM 32 bit architectures in different applications from Home applications to industrial applications.

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Fig: 3 ARM7 LPC2148 Chip Board

ARM7 is the one of the famous microcontroller in embedded real time applications. ARM is a family of instruction set of architecture which is reduced instruction set architecture developed by British company ARM holdings.

LPC2148 is a widely used microcontroller from ARM7 family. It is preloaded with many inbuilt peripherals to provide efficient functioning and easy processing.

The features of this microcontroller as 8 to 40 kB of on-chip static RAM, 32 to 512 kB of on-chip flash program memory, 128 bit wide interface/accelerator enables high speed 60 MHz operation, on-chip boot-loader software, 10-bit A/D converters provide a total of 6/14 analog inputs, 10-bit D/A converter provides variable Analog output, Two 32-bit timers/external event counters, PWM unit (six outputs) and watchdog, 32 kHz clock input, Low power real-time clock, two UARTs, two Fast I2C-bus, On-chip integrated oscillator operates with an external crystal in range from 1 MHz to 30 MHz and with an external oscillator up to 50 MHz, CPU operating voltage range of 3.0 V to 3.6 V ($3.3\text{ V} \pm 10\%$) with 5 V tolerant I/O pads [3].

B. CO₂ SENSOR

CO₂ sensor is the instrument which is used for measuring the carbon dioxide gas. There are two types of CO₂ sensors one is NDIR sensor and second one is chemical CO₂ sensor. NDIR sensors are based on the principle spectroscopic sensors to detect CO₂ from gaseous environment by based on gas characteristic. These sensors have the sensitivities from 20-50PPM.

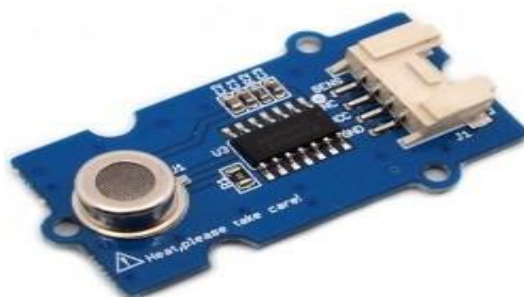


Fig: 4 CO₂ sensor Board

With broad measurement range, high sensitivity, fast response time, good selectivity and strong anti-interference ability. The parameters of this sensor Operating Temperature 0 °C-50 °C, Storage Temperature -30 °C-70 °C, Operating Humidity 0%-95% RH (Non-condensing) Sensing Method NDIR (Non-dispersive infrared), Measurement Range 0-5000 ppm (expandable up to 10000 ppm), Accuracy $\pm 30\text{ ppm} \pm 5\%$ of measured value Step Response Time (90%) 60 s, Sampling Interval 3 s [8].

C. TEMPERATURE SENSOR

DS18B20 digital thermometer, which can convert the temperature to digital within 1 second and provide 9-bit digital value of temperature readings is chosen with the measurement range of -55° - $+125^{\circ}$ and value-added volume of 0.5° .

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Fig: 5 Temperature Sensor

Single-mode 1-Wire bus is adopted by this thermometer to connect to the central processing unit and no external components or backup power supply is needed.

D. HUMIDITY SENSOR

HS1101 humidity sensor is used for acquiring humidity levels from the air. The voltage input of 5 V DC and measurement range is of 1~99% RH. Capacitor frequency conversion is applied so as to reach the connection to the central processing unit.



Fig: 6 Humidity sensor

E. LIGHT INTENSITY SENSOR

The LDR (Light dependent resistor) or photo cell or photo resistor used for light intensity sensing which is based on resistivity.

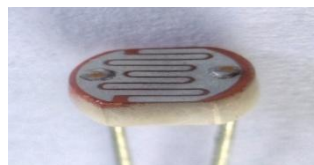


Fig: 7 LDR Sensor

The sensor is made up with a high resistance semiconductor. The resistance is high when the sensor is in dark place and the resistance is low when the sensor is in the light.

F. GSM MODULE

The GSM module is used for transferring the data from microcontroller to authorized persons. A GSM module assembles a GSM modem with standard communication interfaces like RS-232 (Serial Port), USB etc., so that it can be easily interfaced with a computer or a microprocessor / microcontroller based system [6].



Fig: 8 GSM Module

The power supply circuit is also built in the module that can be activated by using a suitable adaptor.

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G. LCD DISPLAY

The LCD display is used for display the data which is sensed by the sensors through micro controller. Here I am using 20*4 LCD display for providing the data efficiently.



Fig: 9 20*4 LCD Display

Which is a character type based LCD display, Duty cycle is 1-16, power supply +3V or +5V. This LCD having a 18 pins of structure, Pin from 7-14 used for data lines, pin 2 is used for power supply, pin 1 for ground, pin 4& 5 used for register select and read/write pin, pin 6 is used for enable the LCD display.

H. ASK MODULE



Fig: 10 ASK RF transmitter and receiver

This module is used for transferring the data wirelessly. In this project this module is used for data transferring between microprocessor and personal computer. This modules are convert the amplitudes into digital form so these modules are called as ASK modules. These are transmitted data at 433MHz or 315MHz frequencies [7]. So these modules named as ASK RF modules.

III. CIRCUIT DIAGRAM

The above diagram represents the circuit diagram for interfacing the components. In which the design is given for components interfacing, power supply, pin configurations, pin connections.

The fig 11 easily represents the way of project designing. Pin 19 is interfacing with the ASK RF module, pin 13 for CO2 sensor, pin 33 is for GSM module, pin 11 for LDR, pin 15 for Humidity sensor, pin 14 for temperature sensor, pin 61&62 for crystal OSC, pin 57 for reset, pins 4,8,12,16 for LCD data connections, pin 44 for read select, pin 48 for enable.

The ASK RF receiver module was interfaced with personal computer through RS232 cable for serial communication.

IV. FIRMWARE FLOW

Firmware process includes two main parts, real-time collecting and wireless transmission. First, the sensors array of CO2, temperature, humidity and light intensity are used to collect data; Afterwards, for the collected data, through GSM wireless transmission module, continuous wireless transmission is conducted as shown in bellow Figure 12

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Specific procedures are as below:

- Initialize the ARM microcontroller and all interfacing components.
- After initializing the WSN the sensors are started the sensing and processing it and forwarded to the microprocessor through DAC.
- The microprocessor processes the data and forwarded to the concerned elements. If any error was happened processor activate the GSM module for intimating to the authorities.

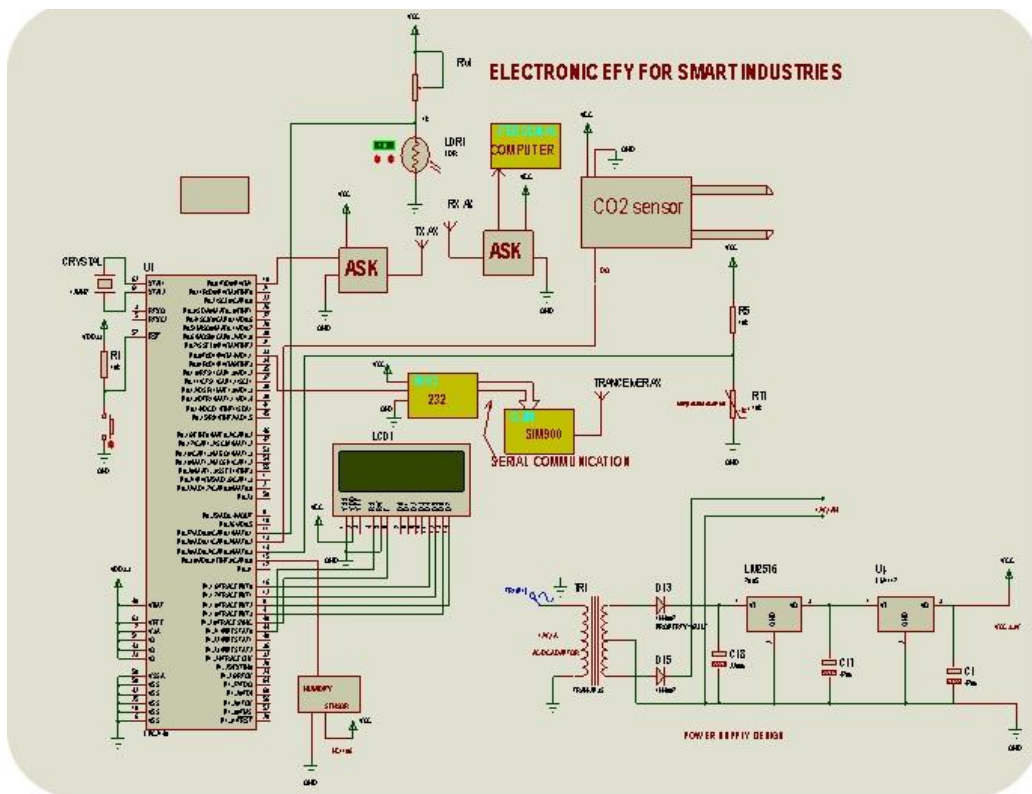


Fig: 11 Circuit diagram

The same data displayed at LCD display at work station.

- The GSM module sends the message to the correspondent persons along with the data.
- The collected data transferred to the personal computer through wireless transmission using ASK RF module.

At the PC end the data received by the ASK RF receiver module and to the personal computer interfaced with RS232 cable.

V. IMPLEMENTATION

The embedded system for monitoring the CO2 storage and leakage is successfully developed, which can realize the automatic display and wireless transmission of data of CO2 concentration, temperature, humidity and light intensity. The develop environment of this system is Keil with embedded c program language been used as shown in above figure 13.

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VI. RESULTS

The above embedded system enables the CO₂ leakage at industries where the Co₂ was stored as well as it findout the temperature, humidity and light intensity at that working place. The system acts like a human eye to monitor all the environmental conditions in working place. This system provide the minuite to minuite observation on the work field, if any sudden changes happened in the environment it alerts all the workers and authority persons to reduce the accidents and take further actions.

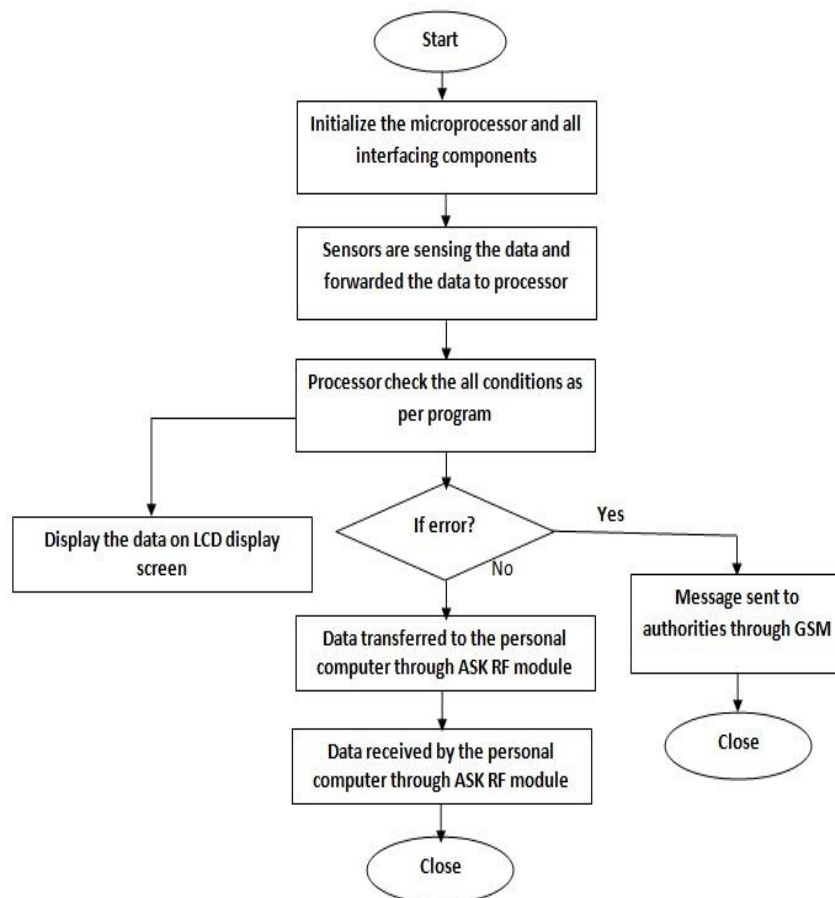


Fig: 12 Firmware flow

As I Observe that the NDIR CO₂ sensor is very powerful sensor, which detects the CO₂ concentration very efficiently. The remaining temperature sensor, humidity sensor, light intensity sensors are used for finding the general environmental conditions in workig environment.

VII. CONCLUSION

By using this embedded system we have to control the accidents is based on CO₂ leakage. This system is very efficient for sensing temparature, CO₂ concentration, Humidity, light intensity and some envvormental cases. By using GSM technology along with this embedded system we primarily providing the information about accidents.

This system is mainly used in industries, coal mines, undergroundmines, CO₂ storage areas, Military areas where the weapons are used under testing. By using this system we reduce the global warming and improve the human being life time.

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This monitoring system was very simply to use, low cost, easy way to operate everyone, convenient to carry to any place. The future scope of this project is if this project was developed under complex environments it is more helpful for the people and also Earth.

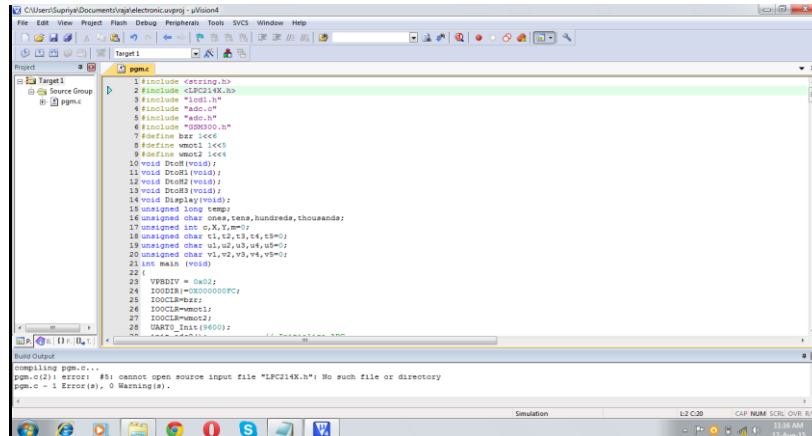


Fig: 13 Keil software snap shot

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BIOGRAPHY



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