Wireless Network System Used To Monitoring Emission of Carbon Dioxide Gas in Industrial Areas

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Abstract:
The main purpose of this project is to monitor the emission of carbon dioxide in industrial areas by using the wireless sensor networks technology. A remote online carbon dioxide (CO2) emission monitoring system is developed, based on the technologies of wireless sensor networks, in allusion to the gas emission monitoring requirement for industrial area. The remote online CO2 monitoring system consists of monitoring equipment, a data center server, and the clients. The monitoring equipment is composed of a central processing unit (CPU), global positioning system (GPS) receiver module, secure digital memory card (SD) storage module, liquid crystal display (LCD) module, and general packet radio service (GPRS) wireless transmission module. The CO2 used to collect data and the GPS receiver module is adopted to collect location and time information. The CPU automatically stores the collected data in the SD card data storage module and displays them on the LCD display module in real-time. Afterwards, the GPRS module continuously wirelessly transmits the collected information to the data center server. The online monitoring Web GIS clients are developed using a PHP programming language, which runs on the Apache web server. My SQL is utilized as the database because of its speed and reliability, and the stunning cross browser web maps are created, optimized, and deployed with the Open Layers J JavaScript web-mapping library.

Key words: Carbon Dioxide, Central Processing Unit, Global Positioning System, Liquid Crystal Display.

I. INTRODUCTION

Due to rapid industrial growth the society has so many benefits as well as harms. Harms are due to fire, explosion, accident and pollution. The effect of pollution is depending upon the volume, concentration, emission and spread area. One of the harmful emissions is CO2 and its effects are monitored by wireless sensor networks. It is required to provide a safe and clean environment to the society. 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 CO2 storage and leakage. 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. The remainder of this paper is as follows. Presents the backgrounds of leakage monitoring based on WSN and their related issues, describes the hardware infrastructure of CO2 leakage monitoring equipment and different sensor and modules selected, demonstrates the firmware How of CO2 remote online monitoring system. The implementation and application example is presented. Finally, the conclusions of the paper and new avenues for the future works are put forward in this part.

1. OBJECTIVE

The objective of this project is to monitor and control the pollution of the state or country with user interface and administrator interface using GSM for Pollution Department. With the growth of the market and Country, the system analysis needs to be made dynamic and web-enabled. Some demerits of the existing systems are the management (Pollution management Comity) and administrator is unable to track status of Pollution in terms of schedule, it requires manpower to do paper works. But our proposed system overcomes these all demerits of the existing system, which is GPS AND GSM based.

1.1 Scope of the project

CO2 (Carbon Dioxide) detecting system is not much effective. To make such an effective system we are implemented this project. In this, the CO2 will be monitored and SMS alert. The system is implemented in industries to avoid accidents caused by gas emission. The CO2 sensor is fixed inside the industry to detect the presence of gas. CO2 sensor is giving the analog voltage depending upon the CO2 on the air. This will be given to the amplifier and it will boost the 0 to 5v level. And it is given to the ADC for convert to the Digital value for display and comparison. We can set a gas percentage level by using the keypad in the eeprom memory of the microcontroller.

1.2 General structure of monitoring

Figure 1. General structure of monitoring
1.3 Existing system

CO₂ capture and storage is one of the effective ways to realize effective greenhouse gas storage, and on the other to improve oil and gas production. Many countries such as the United States, Japan, and Canada are in search of effective approaches for CO₂ storage in either geological formations or ocean. In China, the first demonstrative industrial project of CO₂ storage has come into operation in Shenhua mine area. However, once CO₂ leaks from the storage reservoir, all the efforts humans have made to fight global warming would be go down the drain. Therefore, what is in needed after the geological CO₂ storage is long-term terrain monitoring of the greenhouse gas leakage, which is absolutely crucial to help ensure that geologic sequestration of CO₂ is safe. For this reason, the development of remote online monitoring system is of great significance to geological CO₂ storage and leakage warning.

1.4 Proposed system

In the proposed system, remote online monitoring system is of great significance to geological CO₂ storage and leakage warning has been executed. By using different sensors like CO₂ sensor, temperature sensor, humidity sensor, light intensity sensor we can monitor the CO₂ storage reservoir. By using this proposed system, the responsible person will come to know before the distortion has occurred. So the environment and the loss of human effect and time and also the money is being saved by using this proposed system. The information regarding the CO₂ monitoring will be updated on the PC. Our system also uses the remote access by using the GPS protocol.

2. INTEGRATED MANAGEMENT SYSTEM

![Diagram of integrated management system]

2.1 Working principle

The 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; GPS receiver module is adopted to collect GPS position and time information; Afterwards, for the collected data, through GPRS wireless transmission module, continuous wireless transmission is conducted.

2.2 Hardware infrastructure

The CO₂ emission monitoring equipment based on WSN are mobile devices used by humans. The equipment is composed of the air environment sensors array, GPS receiver module, central processing unit, SD card data storage module, LCD display module and GPRS wireless transmission module.

2.2.1 Microcontroller

This operates at CPU frequencies of up to 100 MHz. The peripheral complement of the LPC1768 includes up to 512 KB of flash memory, up to 64KB of data memory, Ethernet MAC, USB Device/Host/OTG interface, 8-channel general purpose DMA controller, 4 UARTs, 2 CAN channels, 2 SSP controllers, SPI interface, 3 IZC-bus interfaces, 8-channel 12-bit ADC, 10-bit DAC, four general purpose timers, 6-output general purpose PWM, ultra-low power Real-Time Clock (RTC) with separate battery supply, and up to 70 general purpose I/O pins.

2.2.2 Sensor Specifications

**CO₂ Sensor**

With broad measurement range, high sensitivity, fast response time, good selectivity and strong anti-interference ability, S-100 miniature CO₂ sensor module is selected. This sensor adopts Non-dispersive infrared (NDIR) spectroscopic analysis technology, and is widely used in many fields such as air quality monitoring. Its performance and accuracy could well meet the needs of emission of CO₂ monitoring.

2.2.3 GPS Receiver Module

With the high sensitivity, good tracking performance, and high position and speed accuracy in the world, the 6593 is selected as the GPS receiver module which providing the best solution. The G593 GPS module can supports up to 210PRN channels, with 66 search channels and 22 simultaneous tracking channels. It supports signal procession of L1 band signals such as GPS C/A and Satellite Based Augmentation Systems (SBAS), including Wide Area Augmentation System (WAAS), global navigation satellite system (EGNOS), and Multi-functional Satellite Augmentation System (MSAS).

2.2.4 GPRS Remote Transmission

The transmission of Real-time collected data is via GPRS wireless transmission module-SIM900A. The module takes Surface Mount Technology (SMT) packaged dual GSM/GPRS as solution, the powerful processor ARM9216EJS as the core and the International Mobile Equipment Identity (IMEI) code as a unique identifier. It is characterized by the small chip, compact, high reliability and low power consumption. Central processing unit uses Universal Asynchronous Receiver Transmitter (UART) to reach the connection to GPRS wireless transmission module to further realize wireless transceivers of data collecting. First, based on Transmission Control Protocol/Internet Protocol (TCP/IP) stack, the central processing unit initialize UART, send the command AT and initialize GPRS wireless transmission module; Second, send
the dial command ATD * 97 # to GPRS wireless transmission module and line on after the dial-up succeeds. Then, the central processing unit starts using Point to Point Protocol (PPP) and TCP/IP stack to get the connection to Domain Name System (DNS) servers via GPRS wireless transmission module, domain name get parsed first and then servers get connected, thus establishing point to point communication with remote mobile networks. Finally, the collected data is packed through User Datagram Protocol (UDP) so as to realize wireless transmission.

III. TECHNICAL AND PRODUCT DETAILS

3.1 Carbon dioxide sensor

3.1.1 Schematic Circuit

![Carbon dioxide sensor schematic circuit](image1)

3.1.2 Schematic explanation

CO$_2$ sensor Module for use in Home or Factory to warn of fatal Carbon dioxide build-ups. The unit will work with a simple drive circuit and offers excellent stability with long life. The Carbon dioxide is sensed by the CO$_2$ sensor. The smoke sensor is the one type of transducer which produces the voltage signal depends on the Carbon dioxide level. Then the voltage signal is given to inverting input terminal of the comparator. The comparator is constructed by the operational amplifier LM 741. The reference voltage is given to non-inverting input terminal. The comparator compares with normal reference signal and produces the corresponding output error signal. Then the output voltage is given to microcontroller in order to determine the Carbon dioxide content is present or not in the atmosphere.

3.1.3 Features

- High Sensitivity
- Detection Range: 10 1,000 ppm CO$_2$
- Fast Response Time: <10s
- Heater Voltage: 5.0V

3.1.4 PCB Layout

![PCB layout](image2)

3.2 GLOBAL SYSTEM MONITORING (GSM)

This is a plug and play GSM Modem with a simple to interface serial interface. Use it to send SMS, make and receive calls, and do other GSM operations by controlling it through simple AT commands from micro controllers and computers. It uses the highly popular SIM300 module for all its operations. It comes with a standard R8232 interface which can be used to easily interface the modem to micro controllers and computers. The modem consists of all the required external circuitry required to start experimenting with the SIM300 module like the power regulation, external antenna, SIM, Holder, etc.

3.2.1 PCB Layout

![PCB layout](image3)
3.3 ARM PROCESSOR

<table>
<thead>
<tr>
<th>Designer</th>
<th>ARM Holdings</th>
</tr>
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<tbody>
<tr>
<td>Bits</td>
<td>32-bit</td>
</tr>
<tr>
<td>Introduced</td>
<td>1983</td>
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<tr>
<td>Version</td>
<td>ARMv7</td>
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<tr>
<td>Design</td>
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<tr>
<td>Extensions</td>
<td>NEON, Thumb, Jazelle, VFP</td>
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The ARM is a 32-bit reduced instruction set computer (RISC) instruction set architecture (ISA) developed by ARM Holdings. It was known as the Advanced RISC Machine, and before that as the Acorn RISC Machine. The ARM architecture is the most widely used 32-bit ISA in terms of numbers produced. They were originally conceived as a processor for desktop personal computers by Acorn Computers, a market now dominated by the x86 family used by IBM PC compatible computers. The relative simplicity of ARM processors made them suitable for low power applications. This has made them dominant in the mobile and embedded electronics market as relatively low cost and small microprocessors and microcontrollers. As of 2007, about 98 percent of the more than one billion mobile phones sold each year use at least one ARM processor. As of 2009, ARM processors account for approximately 90% of all embedded 32-bit RISC processors. ARM processors are used extensively in consumer electronics, including PDAs, mobile phones, digital media and music players, hand-held game consoles, calculators and computer peripherals such as hard drives and routers. The ARM architecture is licensable. Companies that are current or former ARM licensees include Alcatel-Lucent, Apple Inc., Atmel, Broadcom, Cirrus Logic, Digital Equipment Corporation, Freescale, Intel (through DEC), LG, Marvell Technology Group, Microsoft, NEC, Nuvoton, NVIDIA, NXP (previously Philips), Oki, Qualcomm, Samsung, Sharp, STMicroelectronics, Symbioses Logic, Texas Instruments, VLSI Technology, Yamaha and ZiiLAB S. ARM processors are developed by ARM and by ARM licensees. Prominent examples of ARM Holdings ARM processor families include the ARM7, ARM9, ARM11 and Cortex. Examples of ARM processors developed by major licensees include DECStrongARM, Freescale.MX, Marvell (formerly Intel) XScale, Nintendo, NVIDIA Tegra, ST-Ericsson Nomadik, Qualcomm Snapdragon, and the Texas Instruments OMAP product line.

Wilson set about developing the instruction set, writing a simulation of the processor in BBC Basic that ran on a BBC Micro with a 6502 second processor. It convinced the Acorn engineers that they were on the right track. Before they could go any timber, however, they would need more resources. It was time for Wilson to approach Acorn’s CEO, Hermann Hauser, and explain what was afoot. Once the go ahead had been given, a small team was put together to implement Wilson’s model in hardware.

3.3.1 Acorn RISC Machine: ARM2

The official Acorn RISC Machine project started in October 1983. VLSI Technology, Inc was chosen as silicon partner, since it already supplied Acorn with ROMs and some custom chips. The design was led by Wilson and Furber, with a key design goal of achieving low-latency input/output (interrupt) handling like the MOS Technology 6502 used in Acorn’s existing computer designs. The 6502’s memory access architecture had allowed developers to produce fast machines without the use of costly direct memory access hardware. VLSI produced the first ARM silicon on 26 April 1985 it worked first time and came to be known as ARM1 by April 1985.” The first "real" production systems named ARM2 were available the following year. Its first practical application was as a second processor to the BBC Micro, where it was used to develop the simulation software to finish work on the support chips (VIDC, IOC, MEMC) and to speed up the operation of the CAD simulation software to finish work on the support chips (VIDC, IOC, MEMC). The code to be very dense, making ARM BBC Basic an extremely good test for any ARM emulator. The original aim of a principally ARM-based computer was achieved in 1987 with the release of the Acorn Archimedes. Such was the secrecy surrounding the ARM CPU project that when Olivetti were negotiating to take a controlling share of Acorn in 1985, they were not told about the development team until after the negotiations had been finalised. In 1992 Acorn once more won the Queen's Award for Technology for the ARM. The ARM2 featured a 32-bit data bus, a 26-bit address space and sixteen 32-bit registers. Program code had to lie within the first 64 Mbyte of the memory, as the program counter was limited to 26 bits because the top 4 and bottom 2 bits of the 32-bit register served as status flags. The ARM2 was possibly the simplest useful 32-bit microprocessor in the world, with only 30,000 transistors (compare the transistor count with Motorola's six-year old 68000 models with around 70,000 transistors). Much of this simplicity comes from not having microcode (which represents about one-quarter to one-third of the 68000) and, like most CPUs of the day, not including any cache. This simplicity led to its low power usage, while performing better than the Intel 80286. A successor, ARM3, was produced with a 4KB cache, which further improved performance.

3.4 GLOBAL POSITIONING SYSTEM

3.4.1 ABOUT GPS

Originally conceived as a navigation aid for the military, the Global Positioning System, or GPS, has since grown from...
relatively humble beginnings as different supporting technologies have been developed, some of which are within reach of consumer budgets. All that GPS does is provide a set of coordinates which represent the location of the GPS unit with respect to its latitude, longitude and elevation on planet Earth. It also provides time, which is as accurate as that given by an atomic clock. The actual application of the GPS technology is what leads to such things as navigation systems, GPS tracking devices, GPS surveying and GPS mapping. GPS in itself does not provide any functionality beyond being able to receive satellite signals and calculate position information. But it does that very well.

3.4.2 GPS working

The actual principle of GPS is very easy to appreciate, since it is exactly the same as traditional “triangulation” (although this is not quite correct, as GPS does not use angles). If one imagines an orienteer needing to locate them on a map, they first need to be able to find at least three points that they recognize in the real world, which allows them to pinpoint their location on the map. They can then measure, using a compass, the azimuth that would be needed to take them from the point on the map to their current position. A line is then drawn from each of the three points, and where the three lines meet is where they are on the map. Translating this into the GPS world, we can replace the known points with satellites, and the azimuth with time taken for a signal to travel from each of the known points to the GPS receiver. This enables the system to work out roughly where it is located if we are using the circles representing the distance from the satellite, calculated on the basis of the travel time of the signal, intersect. Of course, this requires that the GPS locator has the same coordinated time as the satellites, which have atomic clocks on board. To do this, it cross checks the intersection of the three circles with a fourth circle, which it acquires from another satellite. If the four circles no longer intersect at the same point, then the GPS system knows that there is an error in its clock, and can adjust it by finding one common Value (one second, half a second and so on) that can be applied to the three initial signals which would cause the circles to intersect in the same place. Behind the scenes, there are also many complex calculations taking place which enable the system to compensate for atmospheric distortion of the signals, and so forth, but the principle remains the same.

3.4.3 GPS tracking

In fact, it is this use which represents the simplest form of GPS tracking. The user is able, using a portable GPS device, to keep a track of where they have been, in order to be able to either retrace their steps, or follow the same path again in the future. When combined with other technologies such as GPS phones, this also gives the possibility for other users of GPS to follow in the footsteps of the initial user; which can be a useful application of GPS tracking for field activities. Where GPS tracking comes into its own, however, is when it is combined with other broadcast technologies such as radio. GPS watches, for example, can be fitted with a GPS receiver which is capable of calculating its position, whilst also broadcasting that using a miniature radio transmitter. The signal is relayed to a central command centre equipped with GPS software systems which can track the position of the wearer, and either store it as a path, or relay that information to a third party. That third party could be an anxious parent, or the police. In fact there a variety of GPS phones and wristbands which are sold in conjunction with a service which enables third parties to find out where their charges are at any time of the day or night.

3.4.4 GPS applications

- Used in Navigation
- Useful to Vehicle tracking
- Mapping purpose
- For Traffic control
- Topographical survey
- Coordinated Tracking

3.5 KEYPAD

A numeric keypad, or numpad for short, is the small, palm-sized, seventeen key section of a computer keyboard, usually on the very far right. The numeric keypad features digits 0 to 9, addition (+), subtraction (-), multiplication (*) and division (/) symbols, a decimal point (.) and Num Lock and Enter keys. Laptop keyboards often do not have a numpad, but may provide numpad input by holding a modifier key (typically labelled “Fn”) and operating keys on the standard keyboard. Particularly large laptops (typically those with a 17 inch screen or larger) may have space for a real numpad, and many companies sell separate numpads which connect to the host laptop by a USB connection.

Numeric keypads usually operate in two modes: when Num Lock is off, keys 8, 6, 2, 4 act like an arrow keys and 7, 9, 3, 1 act like Home, PgUp, PgDn and End; when Num Lock is on, digits keys produce corresponding digits. These, however, differ from the numeric keys at the top of the keyboard in that, when combined with the Alt key on a PC, they are used to enter characters which may not be otherwise available: for example, Alt-0169 produces the copyright symbol. These are referred to as Alt codes. On Apple Computer Macintosh computers, which lack a Num Lock key, the numeric keypad always produces only numbers. The num lock key is replaced by the clear key

Figure 9. About GPS

3.6 LIQUID CRYSTAL DISPLAY (LCD)

3.6.1 LCD Working structure

Liquid Crystal Display (LCD’s) has materials, which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal. An LCD consists of two glass panels, with the liquid crystal material sandwiched in between them. The inner surface of the glass plates is coated with transparent electrodes which define the character, symbols or patterns to be displayed. Polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules maintain a defined orientation angle. One each polarizes are pasted outside the glass panels. These polarizes would rotate the light rays passing through them to a definite angle, in a particular direction. When the LCD is in the off state, light rays are rotated by the two polarizes and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarizes, which would result in activating / highlighting the desired characters. The LCD’s are lightweight with only a few millimetres thickness. Since the LCD’s consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD does not generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD’s have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD’s more customers friendly. The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications. Crystalonics dot-matrix ( alphanumeric) liquid crystal displays are available in TN, STN types, with or without backlight. The use of C-MOS LCD controller and driver ICs result in low power consumption. These modules can be interfaced with a 4-bit or 8-bit microprocessor/Micro controller.

3.7 AMPLIFIER

An electronic amplifier, amplifier, or (informally) amp is an electronic device that increases them of signal. It does this by taking energy from a power supply and controlling the output to match the input signal shape but with a larger amplitude. In this sense, an amplifier modulates the output of the power supply. There are four basic types of electronic amplifier: the voltage amplifier, the current amplifier, the Trans conductance amplifier, and the amplifier. A further distinction is whether the output is a linear or exponential representation of the input. As well, amplifiers can be categorized by their physical placement in the signal chain.

3.8 SECURE DIGITAL MEMORY CARD

Secure Digital (SD) memory card is used to store the data. It is capable to save our important data and keep that data in a safe manner. The stored data are in that card for a long time. So this will helps to us to maintain our secret datas. It will be portable so we can carry this card anywhere anytime without any disturbances to us and also to the society. It is more secured one, because we can also provide security passwords to the SD card.
IV. CIRCUIT DIAGRAM

![Circuit diagram]

Figure.13. Circuit diagram

V. RESULT AND CONCLUSION

The above said objective met successfully with a working prototype. Based on the CO₂ sensor which is suitable for the CO₂ emission monitoring was developed in order to realize remote real-time acquisition of multivariate information in the monitoring of CO₂ in industrial areas. This experiment adopts self-made portable CO₂ monitoring equipment, which obtains localization and time service information through GPS, and it can cache dynamic changes of real-time monitoring data into SD cards. GPRS is employed to wirelessly transmit them to the server, which ensures the continuity of data acquisition and monitoring. Apart from the sound effects, the monitoring system is simple in structure, easy to operate, convenient to carry, remote monitoring, real-time display and continuous wireless transmission. It provide remote real-time monitoring means for further study of quantitative analysis and dynamic simulation of the process of CO₂ emission under complex air environment.

VI. REFERENCES


