Mobile Data Acquisition for Air Pollution Monitoring Using Embedded System

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ABSTRACT

The main aim of this proposed system is to monitor the air pollution levels at the different geographic locations. So that proper measures can be taken to prevent the environmental damage due to air pollution. The proposed pollution monitoring system consists of a Mobile Data-Acquisition (DAQ) unit and database unit. The Mobile data-Acquisition DAQ unit integrates a single-chip micro controller, air pollution sensors array (CO sensor),(SO2 sensor),(NO2 sensor), a Global System for Mobile Communications Modem (GSM-Modem), and a Global Positioning System Module (GPS-Module). The Mobile-DAQ unit gathers air pollutants levels and packs them in a frame with the GPS physical location and time. The frame is subsequently uploaded to the GSM-Modem and transmitted to the database via the public mobile network for the research analysis purpose.

KEYWORDS : Mobile data acquisition, sensor array, air pollution, GSM, GPRS.

INTRODUCTION

Control and prevention of air pollution is a major environmental challenge facing modern society. Meeting this challenge is especially important to the millions of people who live and work in urban areas, where the burning of fossil fuels releases many pollutants that form smog-filled air.

Although the problem of air pollution has been throughout recorded in history, including the ancient Greek and Roman societies, it was not until the latter half of the 20th century that many countries took action to address the problem. There are many options for the types of air quality information that can be collected, and the cost of air quality monitoring systems can vary by orders of magnitude.

An air pollution monitoring system consisting of gas sensors by which the gas levels of system can be known. Here use carbon monoxide (MQ-7), LPG sensor (MQ-6) to shows the pollution level, latitude, longitude and UTC. The unit can be placed on the top of any moving device such as a public transportation vehicle. While the vehicle is moving, the micro controller generates a frame consisting of a acquired air pollutant levels from the sensor array and the physical location that is reported from the attached GPS module. The pollutants frame is then uploaded to the general packet radio service modem (GPRS modem) and transmitted to the pollution server via the public mobile network.

SYSTEM REQUIREMENT

The system can be characterized according to its functional and nonfunctional requirement. Functional requirements describe the primary functionality of system while non functional requirements describe attributes like reliability and security, etc.

Functional Requirements are:-

System must support accurate and continuous real data collection.

1. System needs to store the data and provide access to a location map interface.

2. System needs to support mobility.

3. System must use minimum power.

4. System must be compact.

5. System must support two way communications between the client and server.

6. System should be easy to deploy.

Nonfunctional requirement for the system is reliable, portable, accurate, maintainable secure, accessible, and usable. In addition the system must support performance standards for an accurate response time and storage space for data.

Hard ware requirements

To satisfy the system functional and nonfunctional requirement two major building blocks are mobile data base and server station.

A. Single chip micro controller

The PIC micro controller is micro computer on chip it is everything built in it, its advantages are smaller components, low cost, less size. The micro controller is single chip device that has rich built resource for digital input, output ports.

High-Performance RISC CPU, Interrupt based operation, 40 MHz osc/clock input, Priority levels for interrupts, Three external interrupt pins, Up to 10 MIPs operation,
1 Serial Port, CMOS technology, Change interrupts.

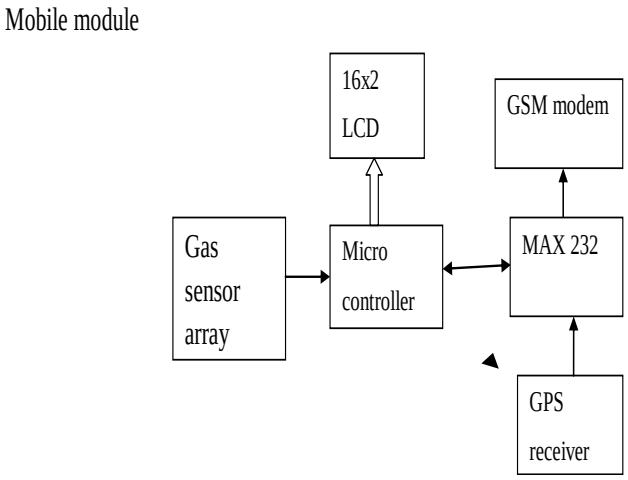
B. Sensor Array

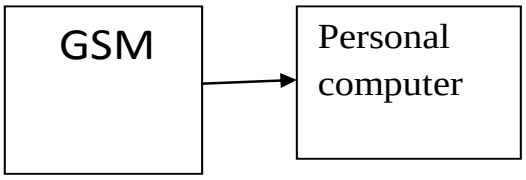
The sensor array consists of two pollutants that are liquid petroleum gas sensor (LPG), carbon monoxide (CO) sensor and temperature sensor.

The CO sensor is high sensitivity to carbon monoxide, stable and long life. They are used in gas detecting equipment for carbon monoxide in family and industry or car. Its detecting range is from 20ppm-2000ppm. The enveloped MQ-7 has 6 pins, 4 of them are used to fetch signals, and other 2 are used for providing heating current. Mm

The MQ-6 LPG sensor is high sensitivity to LPG iso butane propane, small sensitivity to alcohol smoke, fast response, stable and long life, simple drive circuit. It suitable for detecting of LPG ISO butane, Propane LNG avoids the noise of alcohol and cooking fumes and cigarette smoke.

Resistance value of MQ-6 is difference to various kinds and various concentration gases.





Data base module

C. GPS Module

The GPS Module provides the physical coordinate location of the mobile DAQ time and date in national marine electronics association (NMEA) format the NMEA format includes the complete position, velocity and time computed by a GPS receiver where the position is given in latitude and longitude the data pocket from the GPS module includes the RMS header followed UTC time data validity check sum latitude, longitude velocity heading date, magnetic variation and direction mode the only information required for the proposed system is date time latitude, longitude. The GPS Modem is inter faced with the micro controlled using the RS/232 communication standard.

D. GPRS Modem

The general pocket radio receiver is a pocket oriented mobile data service used in 2G and 3G cellular communication system global system for mobile communication (GSM). The proposed system uses a GPS Modem as a communication device to transmit time date physical location and levels of air pollutant. It transmits a message showing the vehicle latitude and longitude coordinates and pollution levels in the area where vehicle is located.

Speed of Response

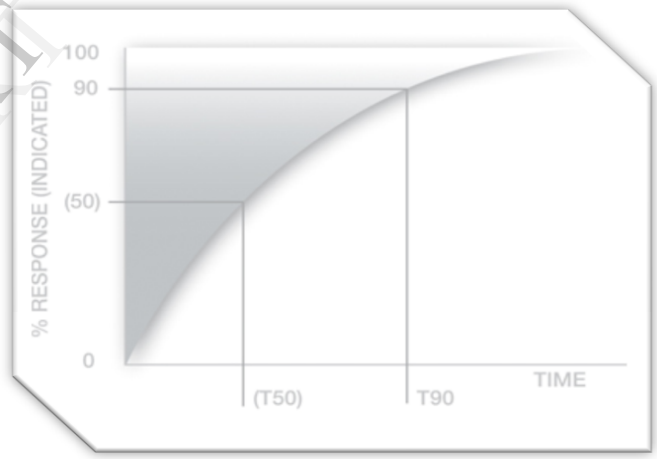


Figure: Speed response

Gas sensors:

Gas sensors interact with a gas to initiate the measurement of its concentration. The gas sensor then provides output to a gas instrument to display the measurements. Common gases measured by gas sensors include ammonia, aerosols, arsine, bromine, carbon dioxide, carbon monoxide, chlorine, chlorine dioxide, diborane, dust, fluorine,

germane, halocarbons or refrigerants, hydrocarbons, hydrogen, hydrogen chloride, hydrogen cyanide, hydrogen fluoride, hydrogen selenide, hydrogen sulfide, mercury vapor, nitrogen dioxide, nitrogen oxides, nitric oxide, organic solvents, oxygen, ozone, phosphine, silane, sulfur dioxide, and water vapor.

Measurement Specifications

Important measurement specifications to consider when looking for gas sensors include the response time, the distance, and the flow rate.

1. The response time is the amount of time required from the initial contact with the gas to the sensors processing of the signal.
2. Distance is the maximum distance from the leak or gas source that the sensor can detect gases.
3. The flow rate is the necessary flow rate of air or gas across the gas sensor to produce a signal.

Sensor Output

Gas sensors can output a measurement of the gases detected in a number of ways. These include percent LEL, percent volume, trace, leakage, consumption, density, and signature or spectra.

1. The lower explosive limit (LEL) or lower flammable limit (LFL) of a combustible gas is defined as the smallest amount of the gas that will support a self-propagating flame when mixed with air (or oxygen) and ignited. In gas-detection systems, the amount of gas present is specified in terms of % LEL: 0% LEL being a combustible gas-free atmosphere and 100% LEL being an atmosphere in which the gas is at its lower flammable limit. The relationship between % LEL and % by volume differs from gas to gas.
2. Also called volume percent or percent by volume, percent volume is typically only used for mixtures of liquids. Percent by volume is simply the volume of the solute divided by the sum of the volumes of the other components multiplied by 100%.
3. Trace gas sensors given in units of concentration: ppm.
4. Leakage is given as a flow rate like ml/min.
5. Consumption may also be called respiration. Given in units of ml/L/hr.
6. Density measurements are given in units of density: mg/m^3.
7. A signature or spectra measurement is a spectral signature of the gases present; the output is often a chromatogram.

Common outputs from gas sensors include analog voltage, pulse signals, analog currents and switch or relays. Operating parameters to consider for gas sensors include operating temperature and operating humidity.

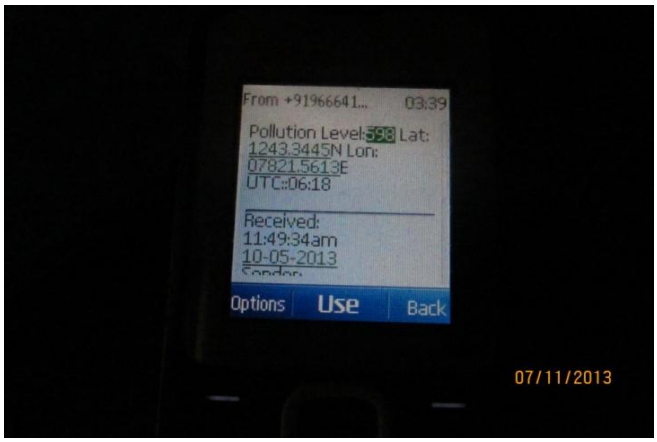
Standards

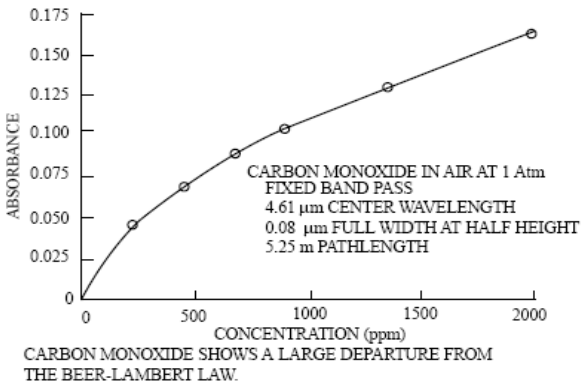
The International Society of Automation (ISA) specifies standard ISA 12.13.01 which describes test methods that apply to portable, transportable, and fixed devices for the detection and measurement of flammable gas or vapor c

Conclusion

A wireless distributed mobile air pollution monitoring system was designed. The system utilizes city buses to collect pollutant gases such as CO, NO2 and SO2. The data shows

the pollutant levels and their conformance to local air quality standards.





Measurement of carbon monoxide.

Selectivity is improved by adding a narrow-band-pass filter, which selects the wavelengths of interest and remove undesirable wavelengths from the beam.

The NDIR technique is most sensitive and selective for small molecules whose spectral fine structure is resolved under ambient conditions.

It is suitable for continuous monitoring of CO.

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