Design and Development of a Network Based and Web Based System for Greenhouse Gas (GHG) Emission Monitoring

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Summary
Global warming is the main scenario to be solved for the preservation of global environment from increase in greenhouse gas emissions. There are no attempts to establish or design a Global Emission Monitoring System in the light of Kyoto protocol. The objective of the Kyoto Protocol is to achieve "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." For this purpose continuous monitoring of GHG Emissions from member countries is required. To enable this a global level network based monitoring system will be ideal. With this idea the concept is designed and being implemented. The hardware requirements including the system for Greenhouse gas emission sensors, global pollution system and others were conceptualized and practicability is established, JAVA programming techniques are used as user interface of the system and ORACLE is used as back end of the system to store the obtained data from the sensors. Finally the applicability of this system has been tested using individual gas sensors under controlled conditions using standard gas samples and applicability of the monitoring system is satisfactory.

Key Words:
Hard ware and software tools, database system, web based system, Kyoto protocol, Greenhouse Gas (GHG)

1. Introduction

The global warming problem has been recognized as one of the most important policy issues to be solved for preservation of the global environment. To promote the adoption of countermeasures, the amounts and types of various greenhouse gas emissions must be precisely predicted, and the effects of available countermeasures must be accurately evaluated [1]. The IPCC projects that under a range of plausible emissions, the concentration of greenhouse gases in the atmosphere will be two to three times pre-industrial levels, or 540-970 parts per million causing a mean global temperature rise of about 4-9°F. It has been suggesting limiting global warming to 2°C, or an atmospheric concentration of 450ppm may be appropriate goals [2]. In view of reducing Greenhouse gases that cause climate change, a protocol called Kyoto Protocol was agreed on 11 December 1997 at the 3rd conference of the parties to the treaty when they met in Kyoto, and entered into force on 16 February 2005. The Kyoto Protocol is an agreement made under the United Nations Framework Convention on climate change (UNFCCC). Countries that ratify this protocol commit to reduce their emissions of carbon dioxide and five other greenhouse gases or engage in emissions trading if they maintain or increase emissions of these gases. The Kyoto Protocol introduced three "flexibility mechanisms" for achieving the reduction of goal: Emission Trading (ET) and Joint Implementation (JI) among developed countries, Clean Developed Mechanisms (CDM) for cooperation between developed and developing countries [3].

In view of above study to decrease the greenhouse gas levels and air pollution nationally or globally that cause climate change first we should know how much amounts of greenhouse gas levels are emitted nationally or globally. Though there is a protocol to decrease the greenhouse gas emissions to escape from climate change, there is no exact efficient and economical system which can calculate the correct and exact amount of greenhouse gases emitted by each country every year from all the available greenhouse gas sinks. There is no suitable mechanism operated by the nations to know the air pollution levels globally or nationally. In view of this concept we proposed a system which can detect the amount of emission of air pollution gases and stored in the database of the system.
So in this scenario, it is very clear that there should be a globally acceptable mechanism which can deliver the requirements, estimation and quantification of the greenhouse gases. This system should be transparent and technologically advanced. The system should also give an opportunity for constant up gradation and able to have interface with local and regional networks.

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In this work an attempt is made to design such system with the software and hardware modules which can continuously monitor and quantify the greenhouse gases globally. Initially this work is able to design a prototype where the software and hardware modules are designed and implemented. So that the same can be used as the prototype for global network

2. Conceptual System:

The proposed conceptual system is classified into two sub systems shown in the fig 1 and the actual implementation of the system shown in fig 2.

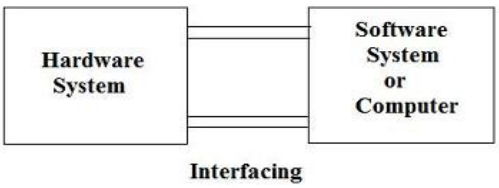

Fig. 1: Abstract view of the System

Fig.2: Original implementation of the System

Based on the notion that to have the database of greenhouse gas emissions from each and every country and to take suitable counter measures to decrease the greenhouse gas emissions for the sustenance of clean environment, we have proposed the following conceptual system. The proposed system is used to detect the amount of Carbon Dioxide level, present in the different areas of the experimental region.

A Gas sensor in the hardware system is used to detect the gas level in the atmosphere and the obtained signal is sent to the Computer through proper interfacing. The interfacing between the systems is made by connecting the obtained signal from the hardware system to the serial port of the Computer through cable. The software system consists of Oracle 10G which receives the signal from the gas sensor and stores the obtained signal in the database of the system. And by using Java programming techniques, a user friendly interface is made to review the obtained signals in the particular intervals.

2.1 The hardware system and Specifications:

The hard ware system (Fig. 3) consists of three main components, they are green house gas sensors, Analog to Digital converter 0808 and Microcontroller 89C51.

Circuit Diagram:

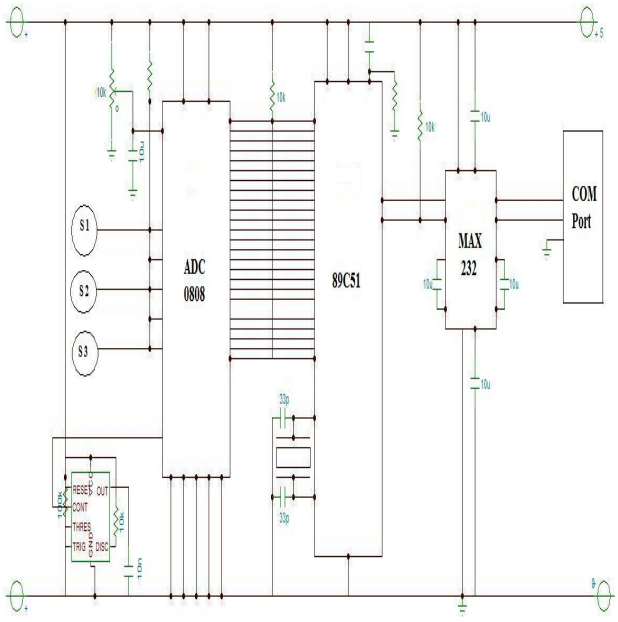

Fig 3 Circuit Diagram of Hardware System

Gas Sensors (S1, S2, S3):

A gas sensor is a device which detects the presence of various gases within an area, usually as part of a system to warn about gases which might be harmful to humans or

animals. Initially Carbon Dioxide (CO_2) sensor (S1) which is used for detection of CO_2 is the major greenhouse gas present in the atmosphere [4]. The atmosphere consists of more than 75% of Carbon Dioxide which is highly emitted into the air as human exhale, burn fossil fuels for energy, and deforestation of the planet.

Microcontroller 89C51:

A Microcontroller (MCU) is a computer-on-a-chip used to control electronic devices. It is an integrated circuit, which includes a microprocessor and limited amounts of RAM, ROM and I/O. We used ATMEL Microcontroller 89C51 which is a low-power, high-performance CMOS 8-bit microcomputer with 4Kbytes of Flash Programmable and Erasable Read Only Memory (PEROM) for our experimental purpose [5].

Analog to Digital Converter 0808:

Connecting digital circuit to sensor devices is simple if the sensor devices are inherently digital themselves. Switches, relays, and encoders are easily interfaced with gate circuits due to the on/off nature of their signals. However, when analog devices are involved, interfacing becomes much more complex. What is needed is a way to translate analog signals electronically into digital (binary) quantities, and vice-versa. An analog-to-digital converter (ADC) performs the former task while a digital-to-analog converter, (DAC), performs the latter. We used ADC0808 data acquisition component which is a monolithic CMOS device with an 8-bit analog-to-digital converter, 8-channel multiplexer and microprocessor compatible control logic [6]. The device contains an 8-channel single-ended analog signal multiplexer. A particular input channel is selected by using the address decoder.

RS-232 STANDARDS:

We used RS-232 which is a standard device developed by Electronics Industry Association (EIA). This is one of the oldest and most used in communication interfaces. The PC will have two RS-232 ports designated as com1& com2. Most of the micro controllers have on-chip serial interface. The specifications describe the physical, mechanical, electrical and procedural characteristics for serial communication. RS-232 is the standard for serial communication i.e. the bits are transmitted serially. The communication between two devices is in full duplex, i.e. the data transfer can take place in both directions.

MAX 232 IC:

A micro controller system we must use voltage converter such as MAX232 to convert the TTL logic to the RS232 voltage levels, and vice-versa. MAX232 IC chips are commonly referred to as line to drivers (voltage converters).

2.2 Software System and Specifications:

The software system mainly consists of Java, a language used as front end of the system and oracle, used as the back end of the system. In this, we included Database system and Web based system

Front End of the system:

We used JAVA as a front End of the system which acts as a user interface of the total system and code has been implemented to know the amounts of greenhouse gases that are emitted at each interval by the user. We used JAVA as a front end of the system as it has many advantageous features like Java can be used to create two types of programs applications and applets. An application is a program that runs on the computer, under the operating system of that computer. An applet is an application designed to be transmitted over the Internet and executed by a Java-compatible Web browser.

The key that allows Java to solve both the security and the portability problems just described is that the output of a Java compiler is not executable code. Rather it is bytecode. Bytecode is a highly optimized set of instructions designed to be executed by the Java run-time system, which is called the Java Virtual Machine (JVM). That is, in its standard form, the JVM is an interpreter for byte code.

JDBC:

We used JDBC as it is a java API for executing SQL statements. It consists of a set of classes and interfaces written in java programming language. Using JDBC, it is easy to send SQL statements to virtually any relational database. One can write a single program using the JDBC API, and the program will be able to send SQL statements to the appropriate database. And with an application written in the java programming language, one also doesn't have to worry about writing different applications to run on different platforms. The combination of java and JDBC let a programmer write it once and run it any where. Java being robust, secure, easy to use, easy to understand, and automatically downloadable on a network, is an excellent language basis for database applications. JDBC extends what can be done in java.

Back End of the system:

We used ORACLE as the back end of the system to store the obtained greenhouse gas values from the hardware system. A modern RDBMS which perform a wide array of tasks in general acts as a transparent interface between the physical storage and logical representation of the data in practice and provides a set of more or less flexible and sophisticated tools for handling information. This tool is used to Define Database, Query the database, Add, edit and delete the data, Modify the structure of the database, Secure data from Public access, Communicate within networks, Export and import data.

3. Database system:

Database System" is a combination of database and DBMS. More accurately, the relational model is based on predicate logic and set theory. A set of statements of fact, and the underlying system can determine new sets of facts from those. For efficiency, these facts should be organize into groups that share the same structure (names and associated type domains), and in practice the ability to draw conclusions is limited by the system's command language (SQL poorly implements predicate logic and set theory; and the database doesn't do much of thinking). The real power comes from the complete control over determining new facts. All relationships between facts are explicit in the database, and the command language can use and manipulate them [7]. The mathematics behind the model makes this manipulation feasible

The main problem, identified was that no central point existed for the maintenance and storage of geographic information. As often happens, each department had its own set of data in various versions and copies and little exchange of data and information between the departments took place. An immediate investment was made in a dedicated server and the centralization of historical and current maps as well as aerial photos and all Ordnance Survey base mapping data began. Ealing realized that an Intranet-based GIS application would not only present a cost-effective solution but also allow, for the first time, true sharing of data [8]. The centralized data storage helps centralized management and access to data for officials working in remote and independent departments**.**

4. Experimental Results:

The experimental setup has been a success and the gas detected by the sensor is successfully updated to the database. The conceptual system can be developed to a full-scale network based system with the following features. The applicability of this system has been tested using individual gas sensors under controlled conditions using standard gas samples. The concept of networking and implementation of this network at global level is discussed at length and evaluated for its performance. The performance of this global emission monitoring system and its user friendliness is depicted by developing a web based prototype with all the crucial features of the system. So that the user can realize its potential applicability. The hardware and software systems used in such a way that these systems can be updated very easily.

5. Web based system:

The invention relates to periodic information management in medium to large organizations of countries, and, more particularly to a web-based interactive system for efficiently and effectively managing communications between organization members.

The web-based system Fig 4 is a tool provided for unifying the generation of graphs and reports and other communications between countries of an organization. The tool provides weekly, monthly and yearly reports of GHG emissions, submissions by respective countries and issues, and automatic report creation, with email notification to respective members. A flexible scheme allows for the deployment with permissions of the organizations, it drastically changed the entire scenario [9].

A system for receiving issues from and providing status to members of a project, comprising a computer-readable project definition file including definition data defining the organization of the project; and a computer-executable status and information program that maintains project data in a storage database responsive to the organization defined by the project definition file and that provides a user interface to access the project data stored in the storage database, wherein the project data in the storage database is stored and retrieved according to the organization defined by the project definition file, and wherein the user interface receives issues from and provides status to the project members according to the organization defined by the project definition file.

Fig 4: Web based system for Global Emission Monitoring System

6. Process of Implementation:

- Initially only one gas sensor S1 (Carbon Dioxide) is used to detect the level of gas in the experimental region.
- The positive voltage from the sensor is connected to the ADC as an input.
- The ADC is in turn connected to the Microcontroller. The Analog-to-Digital Converter collects the variable resistance and basing on the signal voltage, converts the same into a digital signal and are given as inputs to the micro-controller. The entire apparatus is mounted on a PCB as shown in the Fig 2.
- A pre-loaded arbitrary character is given out as an output, once the digital signal from the ADC is received and processed using the 89C51 microcontroller.
- Timing is one important aspect when it comes to dealing with multiple IC's, hence we use 555 Timer and onboard crystal oscillator for the timing sequences.
- An external power source of +5V is supplied to the circuit using a battery.
- The PCB is interfaced with the system through a COM Port as shown in Fig3.
- The obtained sensor data is reached to the computer through the serial port and is trapped by the JAVA code using java Communication package, used for the purpose of serial port communications.
- Back-end of the system (designed using ORACLE) is used to receive the sensor data and store in the database of the system through particular time intervals.
- The front-end of the system (designed using JAVA) contains a frame which shows the option buttons to view the obtained sensor data at the received time intervals.

7. Conclusions

The problem deals with the emission of greenhouse gases and their monitoring at global level using standard software and hardware modules. The model is mainly dealt with conceptualization, designing, implementation and prototype development. A system according to the invention includes a web-based status and issue tracking system for use by an organization. The system is made up of a variety of functions based upon parameterized definitions. For simplicity, the system is known for status and issue tracking system. It is established that to implement Kyoto protocol and also the emission trading a uniform and globally sustainable mechanism need to be evolved

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References:

[1] Mikiko Kainuma, Yuzuru Matsuoka, Tsuneyuki Morita, and Go Hibino, "Development of an End-Use Model for Analyzing Policy Options to Reduce Greenhouse Gas Emissions' (1999), Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on Volume 29, Issue 3, Page(s):317 – 324

[2] http://www.global-greenhouse-warming.com/IPCC-greenhouse-gas-emission-trends

[3] L. Priori, Consultant, Edison Spa, L. Salvaderi, "Limiting the Greenhouses Gases: a possible Italian strategy in the European Framework" (2003), Power Engineering Society General Meeting, 2003, IEEE, Volume 4, Issue, Page(s) 13-17.

[4] http://www.futurlec.com/CO2_Sensor.shtml

[5] http://www.atmel.com/dyn/resources/prod_documents/doc0265.pdf

[6] http://www.national.com/mpf/DC/AD 0808.html

[7] XQuery in Relational Database Systems Michael Rys mrys@microsoft.com

[8] **"**Geographical data sharing – advantages of web based technology to local Government", Sebastian Stachowicz Graphical Data Capture Ltd, Central & Eastern Europe Channel Manager, London, United Kingdom.

[9] Web-based status/issue tracking system based on parameterized definition Document Type and Number, United States Patent 6370575.

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