Air Quality Monitoring System Based OnISO/IEC/IEEE 21451Standards

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***Abstract*—These standards-based air quality monitoring sys- tems (AQMS) are provided. The GSM wireless communication module was utilised in the creation of AQMS. The new devicecan measure air pollution gases including CO2, CO, NO2, and SO2 in real time. The air quality monitoring station and PC successfully communicated with the sink node through machine-to-machine communication. The system was tested using a variety ofgas sensor methods, including electrochemical and infrared sensors. The hardware and software for an AQMS were developed. Sensors on the AQMS gather data from the air around it and wirelesslytransferittoabasestation.Developerscreatedaneasy- to-use GUI (graphical user interface), which allows end users to engage with the system more effectively. The GUI displays gas concentration data. In order to ensure that the intended precision is maintained, the instrument is calibrated at certain intervals. This research aims to clarify some of the design disagreements thathavebeenraisedinpreviousinvestigations.**

Keywords:- GUI, Green House gases, WSN and Sensor

I. INTRODUCTION

A rise in greenhouse gas concentrations in Earth's troposphere is caused by this. Fuel from burning and clearing tropical forests also produces greenhouse gases. Lung cancer, asthma, heart disease, and other pulmonary diseases are on the rise due to the high levels of greenhouse gases in the atmosphere, which pose a serious danger to human life. Monitoring stations for air quality and climate (temperature and humidity) have been established by most industrialised nations in populous regions or outside the city. Primitive techniques like collecting air samples and testing them in labs have been used by most of these stations to monitor air quality. Although these methods aredependable,theyaretime-consumingandcostly. As a means of mitigating the effects of global warming, we need a comprehensive method to air quality monitoring in real time. As a result of this, it seems that air pollution monitors have a major impact on the quality of life. O3, CO, NO2, and SO2 are among theairpollution characteristics that may be monitored with a moni- toring processor. Using a sensor array, signal processing, and a sensor-actuator border, the computer monitors gas levels. The semiconductor sensor array was used. The air-conditioning system's gas discrimination for air quality dimension was proposed in. They described how data is thrown from one side of the web to the other [1]-[5]. A wireless antenna network and an infrared gas sensor were used by Jelicic et al. to monitor air quality indicators. Other ways that may be used to save energy were also discussed by the researchers. A mobile phone-based volatile organic compound monitoring system was developed by Chen et al. An integrated wireless device formonitoringvolatileorganiccompoundswasalsosuggested. Chung et al. demonstrated a way for remotely monitoring the environment of a room using a wireless sensor system.In addition, they can connect a PDA to a computer. WSN-based environment monitoring system developed by Kan and co- workers is described in the paper (EMS). The GPS module is employed in the system's development. The GPS system with WSN provides position information in distant places, focusing on power consumption, mobile messaging, and the immobility ofdatatransfer..Fortheconstructedenvironment,Kumaretal. created a low-cost comfort detecting system. They suggested using air conditioning and mechanical ventilation to monitor and regulate air quality and thermalconsole parameters in real time. Ekuakille et al. employed a semiconductor sensor array in conjunction with a cognitive wireless sensor complex to monitor volatile organic chemicals. We investigate the node and communication level of the power reduction strategy. GPRS-based air pollution sensors have been claimed to be in use. It's important to note that commercialising this idea will take a significant amount of time and effort. Existing systems in most of these categories have a number of flaws, and as a result, efforts to improve them are ongoing. There are a number of issues that need to be dealt with, including a high podium cost and a gas sensor module that interferes with each other. Additionally,thereisaneedforimprovedaccuracy,portability, and ease of operation, as well as data storage capacity in both the server and the sensor node [6]-[10]. Multidisciplinary design is important when designing for low cost, portability, automated datatransfer,datastorageatthememberofstaffservingat

table, machine-to machine statement. ISO/IEC/IEEE 21451- compliant ambient airmonitor monitoring system is provided in this work. Easy to use, inexpensive, and quick to respond are just a few of its advanced features. In addition, the system may be used for a wide range of other applications, such as environmental impact assessments, short-term pollution hotspots,andpollutionmonitoringatsportingfacilities [11]-[18].

II. RELATEDWORKS

Thereareanumberofdifferentwaystomonitortheenviron- ment, and this review article explains what is necessary for the various hardware and/or algorithmic logic variants. Energy- efficient and low-cost environmental monitoring systems are the primary focus of this review's examination of current state- of-the-art environmental monitoring methods. As a general rule of thumb for the development of electromagneticsystems, the following are some of the most important considerations: energy efficiency, overall system cost and antenna module re- sponse time; adequate signal to noise ratio; RFI/EMI rejection during varying atmospheric conditions and in heterogeneous environments; a user-friendly interface with the computer; and computational complexity. References to research publications on environmental monitoring systems show that this is also an issue. All or most of these requirements must be met in order for a system to be considered a success. WUSNs have dynamic subterranean channel characteristics and an eclec- tic network design, making connection analysis considerably more difficult than in terrestrial wireless antenna networks and ad hoc networks, to our understanding. Analytical models of WUSNs'dynamicconnectivityhavebeendevelopedtocapture the effects of environmental and system parameters, including soil composition, moisture content, antenna burial depths and sink antenna heights, compactness of sensors and devices, the tolerable latency of WUSNs and the mobility of above- ground sinks. Using a systematic approach, lower and upper limits of the connection probability may be determined to offer advice for the design and deployment of WUSNs under different ecological circumstances There is increasing pressure on businesses in today's market to increase the efficiency of their processes, to adhere to environmental rules, and to accomplish their own financial goals. Industrial mechanisation systems must be intelligent and low-cost in order to increase the productivity and efficiency of various industrial systems, which are becoming more old and dynamic. Self-organization, fast deployment, adaptability, and inherent cognitive process- ing capabilities are only some of the benefits of industrial wireless sensor networks (IWSNs) over conventional cable industrial monitor and control systems. A highly dependable and self-healing manufacturing system that reacts quickly to real-time events may be created by using IWSN. When it comes to hardware and software development, the technical challenges and design concepts are laid forth in this document initially. There has been a lot of discussion on radio technology, energy harvesting, and cross-layer architecture for IWSNs. For system owners who aim to deploy new IWSN technologiesinindustrialautomationapplications,standardsare also offered. So that the decision-making process may be more efficient and direct, this article aims to present a contemporary view of the current IWSN state of affairs and highlight open research concerns. There are several real- world examples of how wireless sensor network knowledge may improve our everyday lives. This study introduces the conceptofusingwirelesssensornetworkstosafeguardcultural heritage. At Korea's most significant UNESCO cultural prop- erty, Bul-guk-sa Temple, we installed wifi antenna networks. Application design through network system administration are all discussed in detail in this article about our wireless sensor network system for monitoring and safeguarding intellectual property (IP). In accordance with IEEE1451.2, an Indoor Environmental Monitoring System (IEMS) has been created to monitor the concentrations of indoor air pollutants and indoor ecological parameters. In order to create thesensor array, electrochemical sensors are used as input devices. The PIC18F4550 microcontroller is used to implement the Smart Transducer Interface Module (STIM). In LabVIEW 9.0, the Network Capable Application Processor (NCAP) is based on theIEEE1451.1standardfornetworkingprocessors.AUSB 2.0 Transducer Independent Interface connects the NCAP to theSTIM.TheNCAP'sgraphicaluserinterface(GUI)displays information about the STIM's indoor environment characteris- tics. The potentiometer adjustment approach of signal training circuits is used to calibrate sensors. The IEMS is a lightweight, low-cost, and energy-efficientdevice.

WORKS UNDER CONSIDERATION

The wireless communi- cation between the sink node and the base stations is carried out using GSM modules. Air quality monitoring devices for homes are shown in Figure 1. With the newly built air quality monitoring (AQM) system, greenhouse gases including $CO2$, CO, $NO2$, and $SO2$ can be quantified in real time. Separately developed and implemented versions of the two subsystems are available. The sensor node's power consumption is cut in half by eliminating the require- ment for extraneous voltages and switching to a single source.. A battery powers theAQMstation'smotor.Usingavoltageregulator,thebattery voltage is maintained at 5 volts. The GSM module and the remainder of the sensor array are powered by two different regulators.

A sensor array is a set of sensors collectively referred to as the sensing unit..Theprecisionandlowpowerconsumption of the antenna were important considerations while making our choice. The electrochemical and infrared gas sensors outperformed the others in the AQM station's development. These sensors are quite selective when it comes to detecting the desiredgas.

Oxygen Sensors: Electrochemical, SO2 and NO2

When measuring CO, SO2, and NO2, we employ the identical signal conditioning circuitry for all three electro- chemicalsensorsfromSGXantennaTech;thegainsaresimply altered to accommodate differences in sensor sensitivity and measurement ranges. There is an explanation of how the sensors' circuitry was created .The benefits and drawbacks of electrochemical sensors. The chemicalprocesses occurring on the sensing electrode's façade modify the probability at S as the gas concentration varies. As a result, you run the risk of taking measurements that are off. Potentiostatic route mode has been used with amplifier A1. The Op-amp (A1)providesthecounterelectrodewiththecurrentitneedsto balance the current needed by the sensor electrode (C). The non-inverting terminal of A1 receives the offset from the output of U4. When the input from the position electrode is compared to the inverting terminal, the difference is expanded and sent to the counter electrode. The potentiostatic circuit's feedback architecture allows the reference and sensing elec- trodes to closely track the input voltage from

U4. For this reason, A1 has a very low input bias voltage of less than 5 nA since there is always some current flowing from the reference electrode. Adding R1 and C1 provides an extralevel of stability and reduces noise. In order to maintain a constant voltageacrossbothelectrodes,thepowermustbeturnedoff.

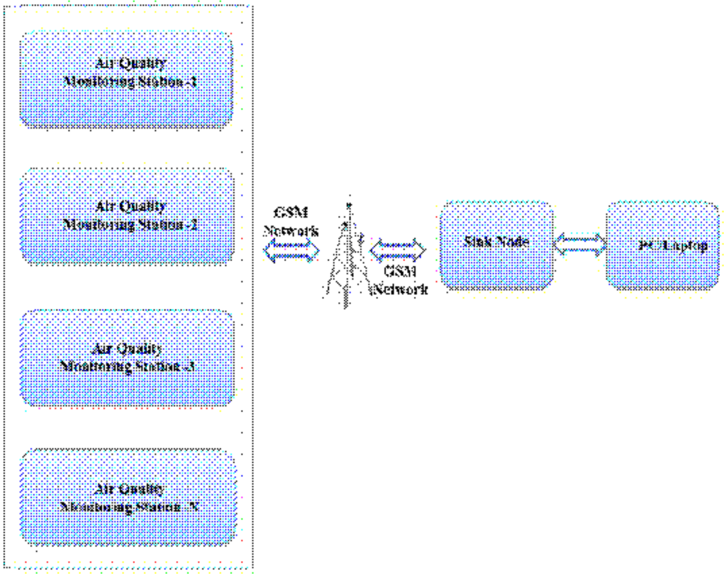

Figure.1 CSM Network.

This is to ensure that the sensors stable as early as possible when the power is switched on, rather than taking many hours. This was done using a shorting FET transistor (J177). Transistor A1 acts as an open circuit while the control is on to ensure that the sensing electrode and reference electrode are maintained at the same potential. To provide zero bias voltage when there is no power, the transistor works as a short path between the sensing/reference electrodes and the transistor. A transimpedance amplifier is used to convert the sensor's output to a voltage. An operational amplifier A2 is employed to increase the sensor output current since the sensor output current is low. The OPAMP A2 is utilised in a transimpedance pattern foramplification.

CO2 Detection Using an Infrared Sensor

A nondispersive infrared CO2 sensor is being studied (or NDIR sensor). CO2 concentrations in the ppm levels are difficult to measure using other methods. Infrared radiation comes from a light within the sensor. Pyro-detectors are used to monitor the radiation as it travels via two channels.IR radiation goes through one of the channels without being altered. Active or sensing channels are located in this other canal. The IR radiation in the active channel is effectively attenuated by the target gas's absorption of it. The emission travelling via the active and reference channels is detected by two pyro detectors. The pyro detectors' outputs are compared, and the difference between them is attributed to the amount of gas present. In order to eliminate any noise from the pyro detectors' output, they must be amplified and filtered. Using a microcontroller, the outputs may be measured. It is necessary to estimate the peak-to-peak production in order to compute the volume of gas in the system. The IR11BD antenna from SGX Sensor Tech is utilised.. At 4Hz and 50 percent duty cycle the antenna's internal illumination is powered by the 555 timer.

It was decided to use the dsPIC30F4013 MCU for all of the sensor node processing. Based on the Harvard architecture, it is a 16-bit microcontroller (MCU). For the system, it was a perfect fit because of its broad working voltage range (2.5V to 5.5V). The system's 12-bit ADC and 13 input channels are more than enough for its needs. C is the programming language of choice for the microcontroller (MCU). An inter- rupt is triggered after it has sampled every possible signal from all of the sensors. Sample data is used to compute thegas concentration. UART is the serial interface used by the MCU and GSM module to interact. The gas absorption data is delivered wirelessly to the GSM through the GSM. This microcontrollerhasbothstrengthsandweaknesses.

Wireless communication is used to link the sensor node inthefieldwiththecentralstation.Onlytheairqualitymonitoring station transmits data in this case, making it a one-way exchange. Wireless communication is accomplished via the use of GSM modems[19-28]. To connect to the cellular network,GSMmodemsneedauniquesubscriberidentification module (SIM) card. Except for Vodacom SIM cards, any SIM card may be used. The 900 MHz and 1.8 GHz frequency bands are used by GSM in South Africa. Vodacom's network reaches more of South Africa than any other service provider and is more dependable. From any location in South Africa where Vodacom services are accessible, the sensor node may broadcast. Different wireless communication protocols were under consideration. Every time the modem is turnedoff,theSIMcard'sIPaddresschanges.Shortmessaging service (SMS) was a determined choice for communication. The system must bear the increased expense of sending SMSes. There are a wide variety of GSM modules on the market from a variety of manufacturers. Each of them has a unique set of interface and power specifications. The modem of choice was the Arduino GSM shield. The gadget can be easily communicated with since the unit employs normal ATinstructions. It can run on either 3 or 5 volts, which is enough to cover the system's power needs. With an on-board antenna, the module is permanently attached to the system. Inserting and removing the SIM card is a cinch because to the module's built-in SIM card port. The module is tiny, lightweight, and inexpensive. The GSM Ardunio module's benefit, command, specification, anddifficulty

III. CONCLUSION

Based on the IEEE/ISO/IEC 21451 standard, we havedevel- oped an air quality monitoring system (AQMS). Tests of the system were carried out at a laboratory (in-situ environment). Preliminary components include an air quality monitoring station, a data member of staff and a sink node module. We've created a sink node with a PC data server based on GSM modules. The real-time data is recorded on a microSD card and also on the data server (PC). We've decided to useMySQL as the database management system for our database.CO, CO2, SO2, and NO2 concentrations were measured usingelec- trochemical and infrared sensors. These sensors are energy- efficient and precise. The base station and remote sensor node communicate wirelessly using GSM modules. GSM modules can communicate across vast distances since they use cellular networks. The sensor node's whole operation is managed by a microcontroller (MCU). Sensor outputs are sampled by the MCU's internal ADC, which is then used to determine the gas concentration and communicate the data through GSM. A gas cylinderwasusedtofillatestincubatorwithgas.Itistestedby putting the sensor node into a gas-filled incubator and seeing how much capacity the sensor node takes up. It has a sink node that is serially coupled to a CPU that runs the graphical user interface (GUI). Sending data from a distant antenna node to a computer is done through the sink or receiving node.Afterwards, the data is plotted on the GUI and saved in text files. The following summarises the subject matter that has been suggested for further research: A solar panel may be used to replenish the batteries that power the antenna nodes. To test the sensor node's performance, it was designed and built. A simple rectangular plastic box with an openingononesideisallthatisneededtoincubateafoetus.

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