

WiFi Based Remotely Environment Monitoring System

Puja Ravindra Patil, Prof. M.K.Kodmelwar

Department of Computer Engineering, TSSM's BSCOER, Narhe, Pune, India

ABSTRACT: For last few years, challenges of monitoring and control of distant environmental parameters accurately has emerged as new field of research. The concept of Internet of Things (IOT) is also emerging very fast where everything around us comes with an internet connectivity for monitoring and control. Monitoring the environmental parameters and initiating a control action from internet is also part of this concept. In our proposed work, we design an environment monitoring system, capable of monitoring and control of environmental parameters like temperature, pressure and humidity. Also, we focus on design of a low cost system that is capable of not only remotely monitoring the environment variables like temperature, pressure and humidity but also initiates some control action like switching devices ON/OFF from the internet. This system uses Wireless sensor Networks for sensing the environment parameters in the area under supervision. Sensors Node has been designed to measure the temperature, pressure and humidity. The Control node has been designed to initiate the control action. The Central Monitoring is based on ARM11 raspberry pi board.

KEYWORDS: RASPBERRY PI, Humidity Sensor,

I. INTRODUCTION

Environment monitoring system is a system that is capable of measuring several environmental parameters like temperature, humidity, pressure, illumination and quantity of gasses like LPG etc. These parameters are important in many applications like in industry, smart homes Greenhouse and weather forecasting. Advanced Environment monitoring systems offer many features like remote access to the measurement data and also can initiate some control action from distant location. These systems use Wireless sensor Networks for sensing the environment parameters. Wireless Sensor Network (WSN) has sensors to sense the physical parameters and they are interconnected wirelessly to exchange information. They have a central monitoring system that is connected to the internet to access the data remotely. Several sensors are equipped in each remote location to measure environmental parameters and these measurements are sent to the central office for storage and analysis purpose. In addition, the central office can give command to remote location for output control execution. These features offer a way to maintain condition and allow obtaining caution on occurrence of any abnormal conditions like parameters exceeding. A WSN allows deployment of number of sensor nodes which configure themselves depending upon the network topology and neighborhood situation. After sensing their physical environment and processing the obtained data locally, nodes communicate their data (or an extract) towards a network sink, where data is further processed and made available for readout. As transmitted data should find the best route towards its destination automatically, the network can be remotely controlled and therefore be handled as one large measurement instrument. Some systems also offer the remote logging facilities that are the parameters can be stored at regular intervals at the remote server so that they can be referred any time.

A. MOTIVATION

One of the greatest problems that the world is facing today is that Environmental pollution. It consists of soil, water and air pollution. The first and foremost Environmental pollution is air pollution which causes Global warming and Climate change. It also affect on human health. Environment monitoring is one of the major application of wireless sensor network. WSN consist of different sensors which are widely distributed to monitor different environment parameters like temperature, humidity, gases, pressure, wind speed etc. WSN consists of sensor nodes which are low cost devices with limited power. Energy efficiency is the biggest problem when these sensors are used for large scale environment

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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monitoring as the sensors are battery powered. Therefore it is necessary to improve the energy efficiency of monitoring system. Several techniques are used to improve the energy consumption. This paper performs the review on different environmental air pollution monitoring systems and techniques to improve the energy efficiency of the system.

B. RELEVANCE

Pressing consequences of climate change such as global warming, the melting of glaciers, and recent frequent storm incidents have prompted the emergence of technology-driven improvements of the current environmental monitoring systems. For instance, recent advances in electronics have enabled the development of low power sensors that can be used to continuously monitor the environment. A wireless sensor network (WSN) generally consists of a large number of low-cost and low-power multifunctional sensor nodes that are deployed in a region of interest. In WSN, the nodes communicate wirelessly over short distances and are capable of organizing themselves in an autonomous multi-hop mesh network. A WSN can be generally described as a network of nodes that cooperatively sense and may control the environment enabling interaction between persons or computers and the surrounding environment. A typical sensor node in a WSN consists of a wireless communication unit, a microprocessor, a data acquisition unit, memory unit, and sensor boards. The microprocessor and the memory unit control how often the sensor measurements are taken or transmitted. The measurements can be taken in fixed time intervals or based on an event driven model. The data collected by the sensors is then sent to a base station where the data can be stored for analysis and processing. The application of WSN for environmental monitoring has been studied in the literature. For example, in, WSNs were used to gather forest temperature data and the amount of rainfall. In, MasliNET, a multimodal environmental monitoring system built for microclimate and pest monitoring in olive groves, was introduced. In this paper, we present the implementation and testing of a real time environmental monitoring system using wireless sensor networks, capable of measuring temperature and greenhouse gas concentration levels including CO, CO₂ and CH₄ levels. The network consists of two nodes and a base station. A ZigBee wireless communication module, based on IEEE 802.15.4, is used as the wireless communication unit in the sensor nodes. ZigBee is selected as it is a low-cost and low-power wireless communication protocol and it has been shown to be a viable technology for sensor applications. These wireless modules are easy to configure and suitable for point-to-point, multipoint and convertible to a mesh network. The captured data is made available to the user through a graphic application programming interface (API). The designed network is suitable for the monitoring of temperature and greenhouse gases in warehouses and factory settings.

C. OBJECTIVES

- In WSN various Environment monitoring sensors are placed inside the field, sensors include Gas sensors (ie. So₂, Co₂, Co, No₂), temperature sensor & humidity sensor.
- Using this information, Environment monitoring parameters calculated remotely at control system and display on the remote station android mobile wirelessly.
- This Unit consists of a Wi-Fi module, sensors, a microcontroller, and power sources.

II. REVIEW OF LITERATURE

“ISSAQ: Integrated Sensing Systems for Real-Time Indoor Air Quality Monitoring” Jung-Yoon Kim, Chao-Hsien Chu, and Sang-Moon Shin [1] The system aims to detect the level of seven gases, ozone (O₃), particulate matter, carbon monoxide (CO), nitrogen oxides (NO₂), sulfur dioxide (SO₂), volatile organic compound, and carbon dioxide (CO₂), on a real-time basis and provides overall air quality alert timely. Health, Safety, productivity, comfort. Effect of bad air, room size, people density, air flow, location, wind.

“Automated Irrigation System Using a Wireless Sensor Network and GPRS Module” Joaquín Gutiérrez, Juan Francisco Villa-Medina, Alejandra Nieto-Garibay, and Miguel Ángel Porta-Gándara [2] The system has a distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a web application. Feasible and cost effective.

“Sentinella: Smart Monitoring of Photovoltaic Systems at Panel Level” Bruno Andò, Senior Member, IEEE, Salvatore Baglio, Fellow, IEEE, Antonio Pistorio [3]

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The system is based on a Wireless Sensor Networks with sensing nodes. The monitoring of photovoltaic (PV) systems is important for the optimization of their efficiency. In this paper, a low-cost smart multisensory architecture equipped with voltage, current, irradiance, temperature, and inertial sensors, for the monitoring (at the panel level) of a PV system, is presented with the aim of detecting the causes of efficiency losses. Distributed monitoring and diagnosis of PV panels, to improve the reliability. To detect anomalous aging processes and accidental causes leading to efficiency loss in PV panels.

“Low-Complex Synchronization Algorithms for Embedded Wireless Sensor Networks” Achim Berger, Student Member, IEEE, Markus Pichler, Member, IEEE, Johannes Klinglmayr[4] In industrial applications of wireless sensor networks (WSNs), synchronized sampling of data on each sensor node is often required. Thus, the wireless communication protocol needs to support accurate timing synchronization. If due to a high sampling rate also high data throughput is required, WSNs based on the IEEE 802.15.4 physical layer often do not provide sufficient data rate. high data throughput, improving synchronization accuracy. At the expense of less accuracy.

“IMA: An Integrated Monitoring Architecture with Sensor Networks” Zhongwen Guo, Member, IEEE, Pengpeng Chen, Hao Zhang, Mingxing Jiang, and Chunrong Li[5] The integrated monitoring has become an important approach for investigation, detection, and policy decision in many fields. Unfortunately, current monitoring systems are commonly developed by different organizations using specific technologies and platforms, bringing a lot of difficulties for the seamless integration and unified access. Efficiency is improved remarkably, architecture proved to be feasible. Necessary to effective, security and privacy such as data encryption, decryption.

“Quantification of Individual Gases/Odors Using Dynamic Responses of Gas Sensor Array With ASM Feature Technique” Sunny, V. N. Mishra, R. Dwivedi, and R. R. Das[6] Utilizes the newly developed feature method in the first stage and the specially designed neural quantifiers in the next subsequent stages. The ability of the proposed method has been insured by applying it on the published dynamic responses of the thick film gas sensor array. Better separation among different clusters of test gases, 100% accurate as compared to the results obtained. gases/odors is a critical requirement in industrial/home environment to avoid unhappy losses.

“Wi-Fi Enabled Sensors for Internet of Things: A Practical Approach” Serbulent Tozlu, Murat Senel, Wei Mao, and Abtin Keshavarzian, Robert Bosch LLC [7] Internet of Things calls for connectivity not only to consumer electronics and home appliances, but also to small battery powered devices which cannot be recharged. Such small devices, often various types of sensors and actuators, are required to sustain reliable operation for years on batteries even in the presence of heavy interference. The IEEE 802.11 standard has established itself as one of the most popular wireless technologies offering connectivity. Operate at higher data rates; provide full coverage for all potential sensor locations.

“Performance Study of Multilayer Perceptrons in a Low-Cost Electronic Nose” Lei Zhang and Fengchun Tian[8] Nonselective gas sensor array has different sensitivities to different chemicals in which each gas sensor will also produce different voltage signals when exposed to an analyze with different concentrations. Estimation accuracy and the time consumption of algorithm convergence.

III. SYSTEM ARCHITECTURE

A. EXISTING SYSTEM

The existing system contains the low level accuracy of Environment related information. This model used GSM wireless technology which will produce the wastage of cost & low speed not follow any standard. The microcontroller is able to communicate using gsm module communication, the design and implementation of Environment monitoring & controlling system is the model with the ability to perform data acquisition on gas sensors attached. And it can give these sensors data to ADC Port of LPC2148. It can also upload the data continuously to memory card in LABVIEW with the help of RS232 Cable and also receives SMS with the help of GSM. System is based on UART protocol, the android application not fully secure.

Disadvantage:-

1. Not follow any standard for efficient & reliable work.
2. Only monitor the Environment Monitoring related information.
3. Hardware cost is increased due to both side requirement of GSM module.

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B. PROPOSED SYSTEM

The proposed system consists of the Wireless Sensor Network for acquiring climate data locally. In WSN various Environment monitoring sensors are placed inside the field, sensors include Gas sensors (ie. So₂, Co₂, Co, No₂), temperature sensor & humidity sensor. Using this information, Environment monitoring parameters calculated remotely at control system and display on the remote station android mobile wirelessly. This Unit consists of a Wifi module, sensors, a microcontroller, and power sources. Several WSUs can be deployed in-field to monitor as a distributed sensor network for accurate Environment monitoring system. This setup can also be used to measure the temperature of atmosphere using temperature sensor, humidity level using humidity sensor, Gas related information using sensor & electrochemical sensor. Each unit is based on the microcontroller RASPBERRY PI that controls the Wifi module and processes information came from the all sensors.

Advantage

- Maintain accuracy & efficiency by implementing the IEEE standard using wifi
- This project can be used to save power.
- Enhanced for monitoring & controlling of atmosphere conditions.

C. EXISTING ARCHITECTURE

In Existed model a GSM based system that let users monitor real time sensor information of the Environment and display them through a PC as well as maintain the data related to the sensor is stored in the database of the computer. This model uses Gas related sensors to indicate the Environment Monitoring of Environment. Gas sensors are used to monitor the CO level, NO₂ level, SO₂ level, CO₂ level in Environment and display the real time sensor value through a PC based application. The system is connected to this PC application using GSM connectivity for communication. The model has an option of monitoring devices by either sending commands or sending SMS, making the overall system user friendly and easy to manage.

IV. SYSTEM ANALYSIS

First of all a Block diagram of the complete system is prepared. The each part of the block has been implemented step by step. Methodology for this research work can be detailed in the following steps.

A. PROPOSED DESIGN

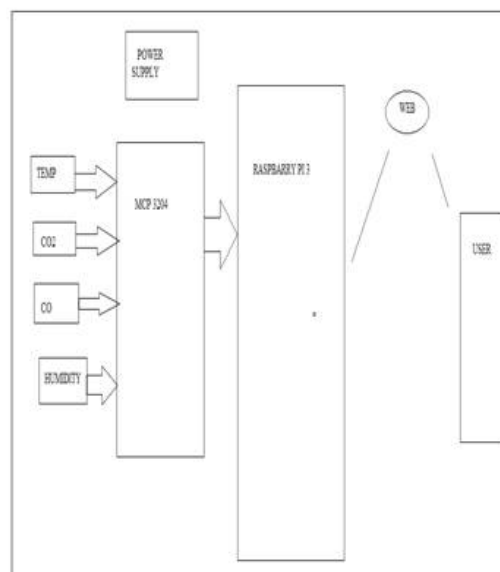


Fig.1. Block Diagram

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B. WORKING

In Existed model an Wi-Fi based system that let users monitor real time information of the sensor devices through an android apps. Our model uses Gas sensors to check for the Environment Monitoring level indicated in atmosphere, Gas sensors used in system are CO₂ sensor, CO sensor, NO₂ sensor, SO₂ sensor to measure the air level of different gases in. Temperature sensor is monitor the temperature in the climate as well as the humidity sensor is used to measure the humidity in Environment. Also monitor the real time value through android based mobile apps. The system is connected to this application using internet. Figure.1 shows the block representation of the proposed Environment monitoring and control system. It has the following parts.

1. Central Monitoring Unit
2. Sensor and Control Nodes

Central Monitoring Unit (CMU) is connected to the internet. Through internet it can communicate with any internet enabled computer terminal or a mobile terminal which can be a smart phone. The sensor data is displayed on remote computer terminal and mobile terminal. The control command can also be initiated from the remote computer terminal or mobile terminal. The system makes use very fast and accurate Google spreadsheet service to log the data online. The control action is initiated using the Google forms service. As the response is received the central monitoring unit detects the response and gives the command to the control node. Sensor node continuously monitors the temperature and humidity and sends the value to control unit which then stores values in the Google spreadsheet. This spreadsheet can hold the data for any amount of time and this data can be used for analysis purpose. So Record of data is always available online.

Central Monitoring Unit(CMU):-

Central Monitoring Unit have been designed using 32 bit ARM controller based single board Linux based board called raspberry pi. A Zigbee series 2 modules is interfaced with the raspberry pi through the UART interface. A python script runs on central monitoring unit which performs the task of continuously polling the sensor node for the reading of temperature and humidity. It also gives command to the control node when there is some control action required. Central Monitoring Unit can be connected to the internet either through the available Wi-Fi or Ethernet. Both raspberry pi and Zigbee work on 3.3V. The Zigbee module connected with the raspberry pi is configured as the coordinator in AT mode. This coordinator is able to communicate with other nodes in which the Zigbee modules are configured as Router AT. Interfacing Zigbee with Raspberry pi both the raspberry pi and Zigbee work on 3.3V hence their pins can be connected directly without any level shifter in between. Pin 8 of raspberry pi is the TX pin and it is connected to the Data In of Zigbee that is pin 3. Pin 10 of raspberry pi is RX and it is connected to Data out of Zigbee that is pin 2. This circuit operates on 5V and it this can be provided with any mobile charger that gives 5V at 500 ma. The raspberry pi has USB ports that can be used to connect any USB device and it also has Ethernet port. A USB Wi-Fi dongle can also be connected to the raspberry pi to have the internet access from the available Wi-fi Network. This is very compact and highly portable Central Monitoring unit that can be deployed anywhere.

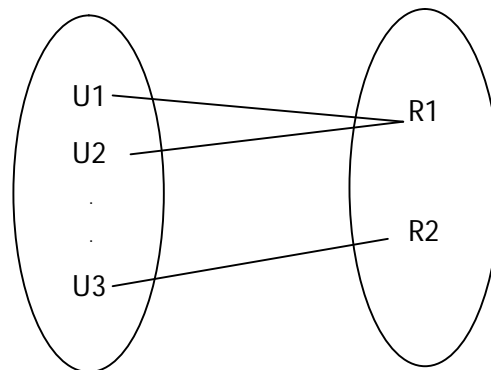
Programming using python Python have been used to program the raspberry pi. UART have been used to communicate with Zigbee. Also raspberry stores the data in the Google spreadsheet. Following libraries are required to be installed before writing down the main program. The python script starts at the boot and it looks for the available internet connection and if there is active internet connection then it sends the command to the nodes to get the latest values of the sensor parameters then it store these values to the spreadsheet.

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C. MATHEMATICAL MODEL MAPPING:-



Many users can obtain one result or multiple results.

Set Theory:

$S = \{s, e, X, Y, \Phi\}$

Where,

s = Start of the program.

1. Log in user.
2. Get the data from sensors or Hardware (Temperature sensor, Humidity sensor and Environment Monitoring sensor, electrochemical sensor, IR sensor).

e = End of the program.

1. Display the captured data on the screen (monitor or mobile).
2. Log out the user.

X = Input of the program.

Input should be sensors data.

Y = Output of the program.

Finally we display the captured data on the screen (monitor or mobile).

$X, Y \in U$

Let U be the Set of System.

$U = \{\text{Client, I, S, H, A, D, R}\}$

Where Client, I, S, H, A, D, R are the elements of the set.

Client=User

I=Input data (sensors data).

S=Sensor.

H=Hardware.

A=Application (Web or Mobile).

D= Display captured data.

R=Result or output.

Space Complexity:

The space complexity depends on Presentation and visualization of discovered patterns. More the storage of data more is the space complexity.

Time Complexity:

Check No. of patterns available in the database= n

If $(n > 1)$ then retrieving of information can be time consuming.

So the time complexity of this algorithm is $O(n^n)$.

Above mathematical model is NP-Complete

Φ = Failures and Success conditions.

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Failures:

- Huge database can lead to more time consumption to get the information.
- Hardware failure.
- Software failure.

Success:

Search the required information from available in Datasets.
User gets result very fast according to their needs.

VI. CONCLUSION

Averting environmental pollution is one of the tedious tasks since the humans are responsible for this hazardous nature which poses threat to whole world. And we are responsible to eradicate pollution problems. Virtually all emissions vary from time to time. It is an excellent concept that will show a new dimension. Although the general and specific objective is very similar, the Technological solutions employed are very different.

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