  

A MinorProject Report

on

**IOT BASED WIRELESS SENSOR NETWORK FOR AIR POLLUTION MONITORING**

Submitted in partial fulfilment of requirements for the award of the

Degree of

**BACHELOR OF ENGINEERING**

in

**ELECTRONICS AND COMMUNICATION ENGINEERING**

Under the guidance of

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**BONAFIDE CERTIFICATE**

Certified that this project report **“IOT BASED WIRELESS SENSOR NETWORK FOR AIR POLLUTION MONITORING SYSTEM”**is the bonafide work of **“BOOPALANALAKSHMI, DEEPA P(11BEC1095), LAKSHMI V(11BEC1098)”** who carried out the project work under my supervision in the academic year 2022-2023.

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**Vision and Mission of the Institute and Department**

**Vision**

* To emerge as a leader among the top institutions in the field of technical education.

**Mission**

* Produce smart technocrats with empirical knowledge who can surmount the global challenges.
* Create a diverse, fully-engaged, learner-centric campus environment to provide quality education to the students.
* Maintain mutually beneficial partnerships with our alumni, industry and professional associations.

**Department of Electronics and Communication Engineering**

**Vision**

* To empower the Electronics and Communication Engineering students with Emerging Technologies, Professionalism, Innovative Research and Social Responsibility.

**Mission**

* Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.
* Inculcate the students in problem solving and lifelong learning ability.
* Provide entrepreneurial skills and leadership qualities.
* Render the technical knowledge and industrial skills of faculties.

**PROGRAM EDUCATIONAL OBJECTIVES (PEO'S)**

* **PEO1:** Graduates will have a successful career in academia or industry associated with electronics and communication engineering.
* **PEO2:** Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of electronics and communication engineering.
* **PEO3:** Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadership quality

**PROGRAM OUTCOMES(PO'S)**

* **PO1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
* **PO2: Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
* **PO3: Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
* **PO4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
* **PO5: Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
* **PO6: The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
* **PO7: Environment and sustainability:**Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
* **PO8: Ethics :**Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
* **PO9: Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
* **PO10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
* **PO11: Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
* **PO12: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**PROGRAM SPECIFIC OUTCOMES(PSO'S)**

* **PSO1**: Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.
* **PSO2**: Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrial expectations**.**

**MAPPING OF PROJET WITH POs AND PSO**

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| **Abstract** | **Matching with POs , PSOs** |
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**ABSTRACT**

*Sensor networks are currently an active research area mainly due to the potential of their applications. In this paper we investigate the use of Wireless Sensor Networks (WSN) for air pollution monitoring in Mauritius. With the fast growing industrial activities on the island, the problem of air pollution is becoming a major concern for the health of the population. We proposed an innovative system named*

*Wireless Sensor Network Air Pollution Monitoring System (WAPMS) to monitor air pollution in Mauritius through the use of wireless sensors deployed in huge numbers around the island. The proposed system makes use of an Air Quality Index (AQI) which is presently not available in Mauritius. In order to improve the efficiency of WAPMS, we have designed and implemented a new data aggregation algorithm named Recursive Converging Quartiles (RCQ). The algorithm is used to merge data to eliminate*

*duplicates, filter out invalid readings and summarise them into a simpler form which significantly reduce the amount of data to be transmitted to the sink and thus saving energy. For better power management we used a hierarchical routing protocol in WAPMS and caused the motes to sleep during idle time.*

***INTRODUCTION***

Sensor networks are dense wireless networks of small, low-cost sensors, which collect and

disseminate environmental data. Wireless sensor networks facilitate monitoring and controlling of physical environments from remote locations with better accuracy [1]. They have applications in a variety of fields such as environmental monitoring, indoor climate control, surveillance, structural monitoring, medical diagnostics, disaster management, emergency response, ambient air monitoring and gathering sensing information in inhospitable locations [2, 3, 4, 5]. Sensor nodes have various energy and computational constraints because of their inexpensive nature and ad-hoc method of deployment. Considerable research has been focused at overcoming these deficiencies through more energy efficient routing, localization algorithms and system design. In this paper we proposed a wireless sensor network air pollution monitoring system (WAPMS)

for Mauritius. Indeed, with the increasing number of vehicles on our roads and rapid

urbanization air pollution has considerably increased in the last decades in Mauritius. For the past thirty years the economic development of Mauritius has been based on industrial activities and the tourism industry. Hence, there has been the growth of industries and infrastructure works over the island. Industrial combustion processes and stone crushing plants had contributed to the deterioration of the quality of the air.

Mauritius has led to a major increase in the number of vehicles on the roads, creating additional air pollution problem with smoke emission and other pollutants. Air pollution monitoring is considered as a very complex task but nevertheless it is very important. Traditionally data loggers were used to collect data periodically and this was very

time consuming and quite expensive. The use of WSN can make air pollution monitoring less

complex and more instantaneous readings can be obtained [6, 7]. Currently, the Air Monitoring Unit in Mauritius lacks resources and makes use of bulky instruments. This reduces the flexibility of the system and makes it difficult to ensure proper control and monitoring. WAPMS will try to enhance this situation by being more flexible and timely. Moreover, accurate data with indexing capabilities will be able to obtain with WAPMS. The main requirements identified for WAMPS are as follows:

1. Develop an architecture to define nodes and their interaction

2. Collect air pollution readings from a region of interest

3. Collaboration among thousands of nodes to collect readings and transmit them to a gateway, all the while minimizing the amount of duplicates and invalid values

4. Use of appropriate data aggregation to reduce the power consumption during transmission

of large amount of data between the thousands of nodes

5. Visualization of collected data from the WSN using statistical and user-friendly methods

such as tables and line graphs

6. Provision of an index to categorize the various levels of air pollution, with associated

colours to meaningfully represent the seriousness of air pollution

7. Generation of reports on a daily or monthly basis as well as real-time notifications during

serious states of air pollution for use by appropriate authorities

At present, our scientific understanding of air pollution is not sufficient to be able to accurately

predict air quality at all times throughout the country. This is where monitoring can be used to

fill the gap in understanding. Monitoring provides raw measurements of air pollutant

concentrations, which can then be analysed and interpreted. This information can then be

applied in many ways. Analysis of monitoring data allows us to assess how bad air pollution is

from day to day, which areas are worse than others and whether levels are rising or falling. We can see how pollutants interact with each other and how they relate to traffic levels or industrial activity. By analysing the relationship between meteorology and air quality, we can predict which weather conditions will give rise to pollution episodes.

**2. RELATED WORKS**

Wireless Sensor Network (WSN) is an active field of research due to its emerging importance in many applications including environment and habitat monitoring, health care applications,

traffic control and military network systems [8]. With the recent breakthrough of Micro-Electro- Mechanical Systems (MEMS) technology [9] whereby sensors are becoming smaller and more versatile, WSN promises many new application areas in the near future. Typical applications of WSNs include monitoring, tracking and controlling. Some of the specific applications are habitat monitoring, object tracking, nuclear reactor controlling, fire detection, traffic monitoring, etc. Initial development into WSN was mainly motivated by military applications. However, WSNs are now used in many civilian application areas for commercial and industrial use, including environment and habitat monitoring, healthcare applications, home automation, nuclear reactor controlling, fire detection and traffic control [8]. This transition from the use of WSN solely in military applications has been motivated due to the nature of WSNs which can be deployed in wilderness areas, where they would remain for many years, to monitor some environmental variables, without the need to recharge/replace their power supplies. Such characteristics help to overcome the difficulties and high costs involved in monitoring data using wired sensors. Below are some areas where WSN have been successfully deployed to monitor the environment.

**THE PROPOSED AIR POLLUTION MONITORING SYSTEM**

The proposed wireless sensor network air pollution monitoring system (WAPMS) comprises of an array of sensor nodes and a communications system which allows the data to reach a server. The sensor nodes gather data autonomously and the data network is used to pass data to one or more base stations, which forward it to a sensor network server. The system send commands to the nodes in order to fetch the data, and also allows the nodes to send data out autonomously.



Below is a brief description of each component of WAMPS:

· *Reading Sensor:* generates a random value whose range is set based on the value of a

“seriousness” variable.

· *Reading Transmitter:* gets the generated value from the reading sensor and transmits it

through the communicator.

· *Power Controller:* Each node will have a method called “turn on” that will start the node

and we just call it. As for power-saving modes, this will depend on what the simulator will

provide to us.

· *Communicator:* this is implemented by the simulator. Inter-Process communication is

usually done using sockets; so, we expect the simulator to provide us with sockets as well

as methods such as “send” and “receive”.

· *Launcher:* informs the data collector to start collection based on the delivery mode set by

the user.

· *Data Collector:* gets a list of nodes from which it has to collect readings, then sends

messages to inform them and finally receives the required values.

· Aggregator: implements the RCQ algorithm for data aggregation that we will discuss in the

next section.

· *Data Extractor:* Use SQL queries to extract data from database

· *Data Displayer:* This extracts data as required by the user and displays them in a table as

well as evaluates the AQI for the selected area.

· *Trend Analyser:* Gets previous readings and determines relationship between them to be

able to extrapolate future readings.

· *Nodes Deployment Viewer:* Displays deployment of nodes in the WSN field and their AQI

colours.

· *Connection Initiator:* The java Driver Manager allows for a method to open a database,

providing it the name of the database, user name and password as parameters. So, this

component just has to make a call to this method and store the return reference to the

connection.

· *Connection Destructor:* Connection object, in java.sql package, usually provides for a

close method that closes the latter safely and frees associated memory as well as save the

state of the latter. Therefore, this component just has to call this method.

**CONCLUSION**

As discussed in this paper, recent technological developments in the miniaturization of

electronics and wireless communication technology have led to the emergence of

Environmental Sensor Networks (ESN). These will greatly enhance monitoring of the natural

environment and in some cases open up new techniques for taking measurements or allow

previously impossible deployments of sensors. WAPMS is an example of such ESN. WAPMS

will be very beneficial for monitoring different high risk regions of the country. It will provide

real-time information about the level of air pollution in these regions, as well as provide alerts in

cases of drastic change in quality of air. This information can then be used by the authorities to

take prompt actions such as evacuating people or sending emergency response team.

WAPMS uses an Air Quality Index to categorise the various levels of air pollution. It also

associates meaningful and very intuitive colours to the different categories, thus the state of air

pollution can be communicated to the user very easily. The major motivation behind our study

and the development of the system is to help the government to devise an indexing system to

categorise air pollution in Mauritius. The system also uses the AQI to evaluate the level of

health concern for a specific area.

WAPMS uses a novel technique to do data aggregation in order to tackle the challenge of power

consumption minimisation in WSN. We have named this novel technique as Recursive

Converging Quartiles. It also uses quartiles to summarise a list of readings of any length to just

three values. This highly reduces the amount of data to be transmitted to the sink, thus reducing

the transmission energy required and at the same time representing the original values

accurately.

Another strength of WAPMS is the high quality of results it produces. The collected readings

are saved in a database and these can be accessed individually in a table or summarised areawise

in a line graph. The table uses the AQI to provide the results using the associated colours

and it also provided the level of health concern for a particular area. The line graph allows the

user to view the trend of air pollution for several areas at a time. WAPMS also displays a map

of the town of Port Louis, showing the locations of the deployed sensors nodes and the readings

collected by each one. Thus, WAPMS is very flexible, very easy and yet very powerful due to

its ability to provide highly summarised results as well as fine-grain results at the level of

sensors.

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