A

Major Project

On

WIRELESS SENSOR NETWORK DEPENDABLE MONITORING FOR URBAN AIR QUALITY

(Submitted in partial fulfillment of the requirements for the award of Degree)

BACHELOR OF TECHNOLOGY

In

COMPUTER SCIENCE AND ENGINEERING

By

M.VEDANGANA (197R1A05N3)

G.ALEKHYA (197R1A05L3)

K.PRABHATH (197R1A05L9)

Under the Guidance of

Mrs. D. SANDHYA RANI

(Assistant Professor)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CMR TECHNICAL CAMPUS

UGC AUTONOMOUS

(Accredited byNAAC, NBA, Permanently Affiliated to JNTUH, Approved by AICTE, New Delhi)
Recognized Under Section 2(f) & 12(B) of the UGCAct.1956,
Kandlakoya (V), Medchal Road, Hyderabad-501401.

2019-2023

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the project entitled **" WIRELESS SENSOR NETWORK DEPENDABLE MONITORING FOR URBAN AIR QUALITY "** being submitted by **M.VEDANGANA (197R1A05N3), G.ALEKHYA (197R1A05L3)** and **K.PRABHATH (197R1A05L9)** in partial fulfillment of the requirements for the award of the degree of B.Tech in Computer Science and Engineering to the Jawaharlal Nehru Technological University Hyderabad, is a record of bonafide work carried out by them under our guidance and supervision during the year 2022-23.

The results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

Mrs. D. SANDHYA RANI
(Assistant Professor)
INTERNAL GUIDE

Dr. A. Raji Reddy
DIRECTOR

Dr. K. Srujan Raju
HOD

EXTERNAL EXAMINER

Submitted for viva voice Examination held on _____

ACKNOWLEDGEMENT

Apart from the efforts of us, the success of any project depends largely on the encouragement and guidelines of many others. We take this opportunity to express our gratitude to the people who have been instrumental in the successful completion of this project.

We take this opportunity to express my profound gratitude and deep regard to my guide **D. Sandhya Rani,** Assistant Professor for her exemplary guidance, monitoring and constant encouragement throughout the project work. The blessing, help and guidance given by her shall carry us a long way in the journey of life on which we are about to embark.

We also take this opportunity to express a deep sense of gratitude to the Project Review Committee (PRC) **Dr. Punyaban Patel, Ms. Shilpa, Dr. M. Subha Mastan Rao & J. Narasimha Rao** for their cordial support, valuable information and guidance, which helped us in completing this task through various stages.

We are also thankful to **Dr. K. Srujan Raju**, Head of the Department of Computer Science and Engineering, **Dr. Ashuthosh Saxena**, Dean R&D, and **Dr. D T V Dharmajee Rao**, Dean Academics for providing encouragement and support for completing this project successfully.

We are obliged to **Dr. A. Raji Reddy,** Director for being cooperative throughout the course of this project. We also express our sincere gratitude to Sri. **Ch. Gopal Reddy,** Chairman for providing excellent infrastructure and a nice atmosphere throughout the course of this project.

The guidance and support received from all the members of **CMR Technical Campus** who contributed to the completion of the project. We are grateful for their constant support and help.

Finally, we would like to take this opportunity to thank our family for their constant encouragement, without which this assignment would not be completed. We sincerely acknowledge and thank all those who gave support directly and indirectly in the completion of this project.

M. VEDANGANA (197R1A05N3)
G.ALEKHYA (197R1A05L3)
K. PRABHATH (197R1A05L9)

ABSTRACT

This project presents an Internet of Things enabled low-cost wireless sensor network with newly-developed dependable schemes to improve reliability for monitoring air quality in suburban areas. The system features sensing units for router communications with energy savings from dynamic conservation. Based on the reliability function and mean time to failure, a continuous time Markov chain model is used to analyze the monitoring performance. The proposed dependable monitoring network is shown to achieve high availability with regards to energy consumption and data assurance with the survival probability of over 80% during a minimum period of 72-hour operation for monitoring air quality in a suburb. Distributions of fine particle concentrations studied over a 6-month period demonstrate feasibility of the developed system in its high correlations to benchmark monitoring stations with the Pearson's coefficients obtained at 0.903 and 0.817 respectively for PM2.5 and PM10. Statistical analysis is conducted for performance evaluation in association with two extreme events, one with bushfires and the other with pandemic lockdown. The results obtained indicate enhancements in reliability and accuracy of the collocated dependable low-cost sensors network proposed for wireless monitoring of air quality in urban conditions.

LIST OF FIGURES/TABLES

RESULTS

TABLE OF CONTENTS

1. INTRODUCTION

1. INTRODUCTION

1.1 PROJECT SCOPE

This project is titled " Wireless Sensor Network Dependable Monitoring for Urban Air Quality". This project presents an Internet of Things-enabled low-cost wireless sensor network with newly-developed dependable schemes to improve reliability for monitoring air quality in suburban areas. The system features sensing units for router communications with energy savings from dynamic conservation.

1.2 PROJECT PURPOSE

This project has been developed towards environmental sustainability and social resilience in metropolitan areas, it is essential for residents to have clean air. In this regard, technical measures are needed for monitoring and improving air quality, whereby IoT-enabled wireless sensors networks are promising among available monitoring systems for healthy built environment and air quality management.

1.3 PROJECT FEATURES

The main feature of this project is, the proposed dependable monitoring network is shown to achieve high availability with regards to energy consumption and data assurance with the survival probability of over 80% during a minimum period of 72-hour operation for monitoring air quality in a suburb. Distributions of fine particle concentrations studied over a 6-month period demonstrate feasibility of the developed system in its high correlations to benchmark monitoring stations.

2. LITERATURE SURVEY

2.LITERATURE SURVEY

2.1 A foundational framework for smart sustainable city development: Theoretical, disciplinary, and discursive dimensions and their synergies.

ABSTRACT: In the subject of smart sustainable cities, the underlying theories are a foundation for practice. Moreover, scholarly research in the field of smart sustainable cities operates out of the understanding that advances in the underlying knowledge necessitate pursuing multifaceted questions that can only be resolved from the vantage point of interdisciplinarity or transdisciplinarity. Indeed, research problems in this field are inherently too complex to be addressed by single disciplines. The PhD study addressing the topic of smart sustainable city development falls within the broad research field of sustainability transition and sustainability science where ICT is seen as a salient factor given its transformational, disruptive, and synergetic effects as an enabling, integrative, and constitutive technology. In light of this, the approach to the PhD study is of an applied theoretical kind, and its aim is to investigate and analyze how to advance and sustain the contribution of sustainable urban forms to the goals of sustainable development with support of ICT of pervasive computing. This is to primarily create a framework for strategic smart sustainable city development based on scientific principles, theories, and academic disciplines and discourses used to guide urban actors in their practice towards sustainability and analyze its impact. This involves the application of a set of integrative foundational elements drawn from urban planning, urban design, sustainability, sustainable development, sustainability science, data science, computer science, complexity science, systems theory, systems thinking, and ICT. Accordingly, it is deemed of high significance to devise a multidimensional framework consisting of relevant theories and academic disciplines and discourses that underpin the development of smart sustainable cities as a set of future practices. This framework in turn emphasizes the interdisciplinary and transdisciplinary nature and orientation of the topic of smart sustainable cities and thus the relevance of pursuing an interdisciplinary and transdisciplinary approach into studying this topic. Therefore, this paper endeavors to systematize the very complex and dense scientific area of smart sustainable cities in terms of identifying, distilling, and structuring the core dimensions of a foundational framework for smart sustainable city development as a set of future practices.

In doing so, it focuses on a number of fundamental theories along with academic disciplines and discourses, with the aim of setting a framework that analytically relates city development, sustainability, and ICT, while emphasizing how and to what extent sustainability and ICT have particularly become influential in city development in modern society. In addition, this paper offers an in–depth interdisciplinary and transdisciplinary discussion covering topics of high relevance to the PhD study and at the heart of the very synergic relationship between the theoretical, disciplinary, and discursive dimensions of the foundational framework underpinning smart sustainable city development. These dimensions thus form the basis for the framework for strategic smart sustainable city development that is under investigation and will be developed based on a backcasting approach to strategic planning. This study provides an important lens through which to understand a set of influential theories and established academic disciplines and discourses with high potential for integration, fusion, and practicality in relation to the practice of smart sustainable city development.

2.2 AIR louisville: Addressing asthma with technology, crowdsourcing, cross-sector collaboration, and policy

ABSTRACT: Cross-sector partnerships benefit public health by leveraging ideas, resources, and expertise from a wide range of partners. In this study we documented the process and impact of AIR Louisville (a collaboration forged among the Louisville Metro Government, a nonprofit institute, and a technology company) in successfully tackling a complex public health challenge: asthma. We enrolled residents of Louisville, Kentucky, with asthma and used electronic inhaler sensors to monitor where and when they used medication. We found that the use of the digital health platform achieved positive clinical outcomes, including a 78 percent reduction in rescue inhaler use and a 48 percent improvement in symptom-free days. Moreover, the crowdsourced real-world data on inhaler use, combined with environmental data, led to policy recommendations including enhancing tree canopy, tree removal mitigation, zoning for air pollution emission buffers, recommended truck routes, and developing a community asthma notification system. AIR Louisville represents a model that can be replicated to address many public health challenges by simultaneously guiding individual, clinical, and policy decisions.

2.3 Sensing data fusion for enhanced indoor air quality monitoring

ABSTRACT: Multisensor fusion of air pollutant data in smart buildings remains an important input to address the well-being and comfort perceived by their inhabitants. An integrated sensing system is part of a smart building where real-time indoor air quality data are monitored round the clock using sensors and operating in the Internet-of-Things (IoT) environment. In this work, we propose an air quality management system merging indoor air quality index (IAQI) and humidex into an enhanced indoor air quality index (EIAQI) by using sensor data on a real-time basis. Here, indoor air pollutant levels are measured by a network of waspmote sensors while IAQI and humidex data are fused together using an extended fractional-order Kalman filter (EFKF). According to the obtained EIAQI, overall air quality alerts are provided in a timely fashion for accurate prediction with enhanced performance against measurement noise and nonlinearity. The estimation scheme is implemented by using the fractional-order modeling and control (FOMCON) toolbox. A case study is analysed to prove the effectiveness and validity of the proposed approach.

2.4 Modeling traffic congestion based on air quality for greener environment: An empirical study

ABSTRACT: The primary focus of this paper is to govern traffic congestion on urban road networks based upon a cumulative approach comprising of traffic flow modeling, vehicle emission modeling, and air quality modeling. Based upon the traffic conditions, a simulation model is proposed and further tested for performance metrics, which is relative to three main aspects, namely, the waiting time of the vehicles at the junctions/intersections/signals, the type of pollutant emitted by a vehicle, and the traveling time. The experimental analysis and validation are carried out for different case studies in Malaysia, such as Petaling Jaya, Shah Alam, Mont Kiara, and Jalan Tun Razak. Three different scenarios (morning, afternoon, and evening) are analyzed and tested to explore the traffic usage parameter. The results showed that when traffic is modeled and governed based upon traffic flow, vehicle emission, and air quality index (AQI), nearly 75% of traffic congestion is mitigated, hence making the atmosphere pollution free as well as avoiding Urban Heat Island (UHI) effect due to the heat generated from vehicles. The experimental results are tested, validated, and compared with existing solutions for performance analysis. The proposed model is aimed toward overcoming the major drawbacks of existing approaches, such as single-path suggestions, traffic delay during peak hours/emergencies, non-recurring congestion consideration, congestion avoidance instead of recovering from it, improper reporting of road accidents, and notifications about traffic jam ahead to the users and high vehicle usage rate.

2.5 Urban air pollution estimation using unscented Kalman filtered inverse modeling with scaled monitoring data

ABSTRACT: The increasing rate of urbanization requires effective and reliable techniques for air quality monitoring and control. For this, the Air Pollution Model and Chemical Transport Model (TAPM-CTM) has been developed and used in Australia with emissions inventory data, synoptic data and terrain data used as its input parameters. Since large uncertainties exist in the emissions inventory (EI), further refinements and improvements are required for accurate air quality prediction. This study evaluates the performance of urban air quality forecasting, using TAPM-CTM, and improves accuracy of air pollution estimation by using a two-stage optimization technique to upgrade EI with validation from monitoring data. The first stage is based on statistical analysis for EI correction and the second stage is based on the unscented Kalman filter (UKF) to take into account the spatio-temporal distributions of air pollutant levels utilizing a Matérn covariance function. The predicted nitrogen monoxide (NO) and nitrogen dioxide (NO) concentrations with emissions are first compared with observations at monitoring stations in the New South Wales (NSW). Ozone (O) is also considered since at the ground level it represents a major air pollutant affecting human health and the environment. In the second stage, with the improved EI, TAPM-CTM model errors are reduced further by using the UKF to calibrate EI. Results obtained show effectiveness of the proposed technique, which is promising for air quality inverse modeling, an important aspect of air pollution control in smart cities to achieve environmental sustainability.

3. SYSTEM ANALYSIS

3. SYSTEM ANALYSIS

SYSTEM ANALYSIS

System Analysis is the important phase in the system development process. The System is studied to the minute details and analyzed. The system analyst plays an important role of an interrogator and dwells deep into the working of the present system. In analysis, a detailed study of these operations performed by the system and their relationships within and outside the system is done. A key question considered here is, "what must be done to solve the problem?" The system is viewed as a whole and the inputs to the system are identified. Once analysis is completed the analyst has a firm understanding of what is to be done.

3.1 PROBLEM DEFINITION

This project presents an Internet of Things-enabled low-cost wireless sensor network with newly-developed dependable schemes to improve reliability for monitoring air quality in suburban areas. The system features sensing units for router communications with energy savings from dynamic conservation. Based on the reliability function and mean time to failure, a continuous time Markov chain model is used to analyze the monitoring performance. The proposed dependable monitoring network is shown to achieve high availability with regards to energy consumption and data assurance with the survival probability of over 80% during a minimum period of 72-hour operation for monitoring air quality in a suburb.

3.2 EXISTING SYSTEM

In Australia, along with recent big projects for infrastructure development to meet the urbanization needs, the problem of air quality modelling and control is also of top priority. A network of KOALA (Knowing Our Ambient Local Air Quality) low-cost sensors has been implemented for high spatial resolution air quality monitoring to successfully observe the emissions of fine particles and carbon monoxide during six months before and after a big sports event. These initiatives show benefits and feasibility of a low-cost solution using wireless sensor networks for monitoring air pollution and improving air quality in cities. While global smart city development can offer various dimensions and services covering all aspects of municipal activities, it should be people-centric, addressing directly citizens' well-being and quality of life. Therefore, the needs and preferences of citizens should be considered in public-involved programs to implement of LWSN for environment monitoring.

3.2.1 DISADVANTAGES OF EXISTING SYSTEM

Following are the disadvantages of existing system:

- This would raise concerns on sustainable development and require the need for
  effective measures for environmental monitoring in urban areas.
- Less monitoring quality in terms of availability, reliability.

3.3 PROPOSED SYSTEM

This project aims to develop a framework of dependable low-cost wireless sensor network (DLWSN) for air quality monitoring, which addresses the affordable deployment of a collocated monitoring system for reliable data aggregation and accurate assessment of urban air quality using the IoT-enabled system with enhanced availability. Here, the reliability analysis for the proposed system is conducted via the mean time to failure (MTTF) derived from the reliability function of the monitoring system, whereby the survival and failing probabilities of its sensor modules are calculated by a Markov chain model (MCM). From the reliability analysis, a suitable configuration is selected for sensor motes supplied with a dynamic energy conservation scheme to increase the system's runtime and incorporated with a novel wireless dependable algorithm to improve the accurate, reliable and fail-safe operations of the overall system in monitoring outdoor air quality. The availability, reliability and resilience of the proposed DLWSN against environmental volatility are verified in extreme events such as bushfires and pandemic lockdown conditions.

3.3.1 ADVANTAGES OF PROPOSED SYSTEM

Following are the advantages of existing system:

- The proposed dependable monitoring network is shown to achieve high availability with regards to energy consumption and data assurance with the survival probability.
- Enhancements in reliability and accuracy of the collocated dependable low-cost sensors network proposed for wireless monitoring of air quality in urban conditions.

3.4 FEASIBILITY STUDY

The feasibility of the project is analyzed in this phase and a business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. Three key considerations involved in the feasibility analysis:

- Economic Feasibility
- Technical Feasibility
- Social Feasibility

3.4.1 ECONOMIC FEASIBILITY

The developing system must be justified by cost and benefit. Criteria to ensure that effort is concentrated on a project, which will give best, return at the earliest. One of the factors, which affect the development of a new system, is the cost it would require.

The following are some of the important financial questions asked during preliminary investigation:

- The costs conduct a full system investigation.
- The cost of the hardware and software.
- The benefits in the form of reduced costs or fewer costly errors.

Since the system is developed as part of project work, there is no manual cost to spend for the proposed system. Also all the resources are already available, it give an indication that the system is economically possible for development.

3.4.2 TECHNICAL FEASIBILITY

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

3.4.3 BEHAVIORAL FEASIBILITY

This includes the following questions:

- Is there sufficient support for the users?
- Will the proposed system cause harm?

3.5 HARDWARE & SOFTWARE REQUIREMENTS

3.5.1 HARDWARE REQUIREMENTS:

Minimum hardware requirements are very dependent on the particular software being developed by a given Enthought Python / Canopy / VS Code user. Applications that need to store large arrays/objects in memory will require more RAM, whereas applications that need to perform numerous calculations or tasks more quickly will require a faster processor.

- Operating system: windows, linux
- Processor : minimum intel i3
- Ram : minimum 4 gb
- Hard disk : minimum 250gb

3.5.2 SOFTWARE REQUIREMENTS:

The functional requirements or the overall description documents include the product perspective and features, operating system and operating environment, graphics requirements, design constraints and user documentation. The appropriation of requirements and implementation constraints gives the general overview of the project in regards to what the areas of strength and deficit are and how to tackle them.

- Python idel 3.7 version (or)
- Anaconda 3.7 (or)
- Jupiter (or)
- Google colab

3.6 FUNCITONAL REQUIREMENTS

1.Data Collection
2.Data Preprocessing
3.Training And Testing
4.Modiling
5.Predicting

3.7 NON FUNCITONAL REQUIREMENTS

Non functional requirement (NFR) specifies the quality attribute of a software system. They judge the software system based on Responsiveness, Usability, Security, Portability and other non-functional standards that are critical to the success of the software system. Example of nonfunctional requirement, “how fast does the website load?” Failing to meet non-functional requirements can result in systems that fail to satisfy user needs. Non- functional Requirements allows you to impose constraints or restrictions on the design of the system across the various agile backlogs. Example, the site should load in 3 seconds when the number of simultaneous users are > 10000. Description of non-functional requirements is just as critical as a functional requirement.

- Usability requirement
- Serviceability requirement
- Manageability requirement
- Recoverability requirement
- Security requirement
- Data Integrity requirement
- Capacity requirement
- Availability requirement
- Scalability requirement
- Interoperability requirement
- Reliability requirement
- Maintainability requirement
- Regulatory requirement
- Environmental requirement

4. ARCHITECTURE

4. ARCHITECTURE

4.1 PROJECT ARCHITECTURE

This project architecture shows the procedure followed for classification, starting from input to final output.

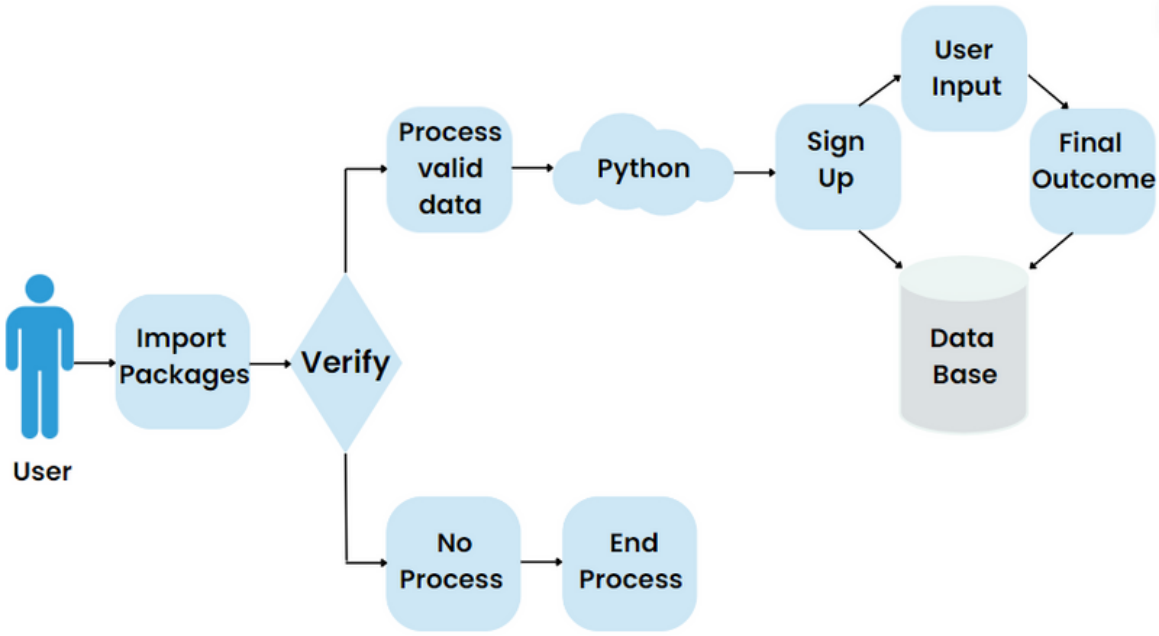


Figure 4.1: Project Architecture of wireless sensor network dependable monitoring for urban air quality.

4.2 DESCRIPTION

This project presents an internet of things-enabled low-cost wireless sensor network with newly-developed dependable schemes to improve reliability for monitoring air quality in suburban areas. The system features sensing units for router communications with energy savings from dynamic conservation. Based on the reliability function and mean time to failure, a continuous time Markov chain model is used to analyze the monitoring performance.

4.3 MODULES

➤ **Tensorflow:**

TensorFlow is a free and open-source software library for dataflow and differentiable programming across a range of tasks. It is a symbolic math library, and is also used for machine learning applications such as neural networks. It is used for both research and production at Google. TensorFlow was developed by the Google Brain team for internal Google use. It was released under the Apache 2.0 open-source license on November 9, 2015.

➤ **Numpy:**

Numpy is a general-purpose array-processing package. It provides a high-performance multidimensional array object, and tools for working with these arrays.
It is the fundamental package for scientific computing with Python. It contains various features including these important ones:

- A powerful N-dimensional array object
- Sophisticated (broadcasting) functions
- Tools for integrating C/C++ and Fortran code
- Useful linear algebra, Fourier transform, and random number capabilities

Besides its obvious scientific uses, Numpy can also be used as an efficient multi-dimensional container of generic data. Arbitrary data-types can be defined using Numpy which allows Numpy to seamlessly and speedily integrate with a wide variety of databases.

➤ **Pandas:**

Pandas is an open-source Python Library providing high-performance data manipulation and analysis tool using its powerful data structures. Python was majorly used for data munging and preparation. It had very little contribution towards data analysis. Pandas solved this problem. Using Pandas, we can accomplish five typical steps in the processing and analysis of data, regardless of the origin of data load, prepare, manipulate, model, and analyze. Python with Pandas is used in a wide range of fields including academic and commercial domains including finance, economics, Statistics, analytics, etc.

➤ **Matplotlib:**

Matplotlib is a Python 2D plotting library which produces publication quality figures in a variety of hardcopy formats and interactive environments across platforms. Matplotlib can be used in Python scripts, the Python and IPython shells, the Jupyter Notebook, web application servers, and four graphical user interface toolkits. Matplotlib tries to make easy things easy and hard things possible. You can generate plots, histograms, power spectra, bar charts, error charts, scatter plots, etc., with just a few lines of code. For examples, see the sample plots and thumbnail gallery.

For simple plotting the pyplot module provides a MATLAB-like interface, particularly when combined with IPython. For the power user, you have full control of line styles, font properties, axes properties, etc, via an object oriented interface or via a set of functions familiar to MATLAB users.

➤ **Scikit – learn:**

Scikit-learn provides a range of supervised and unsupervised learning algorithms via a consistent interface in Python. It is licensed under a permissive simplified BSD license and is distributed under many Linux distributions, encouraging academic and commercial use.

4.4 USE CASE DIAGRAM

In the use case diagram, we have basically one actor who is the user in the trained model. A use case diagram is a graphical depiction of a user's possible interactions with a system. A use case diagram shows various use cases and different types of users the system has. The use cases are represented by either circles or ellipses. The actors are often shown as stick figures.

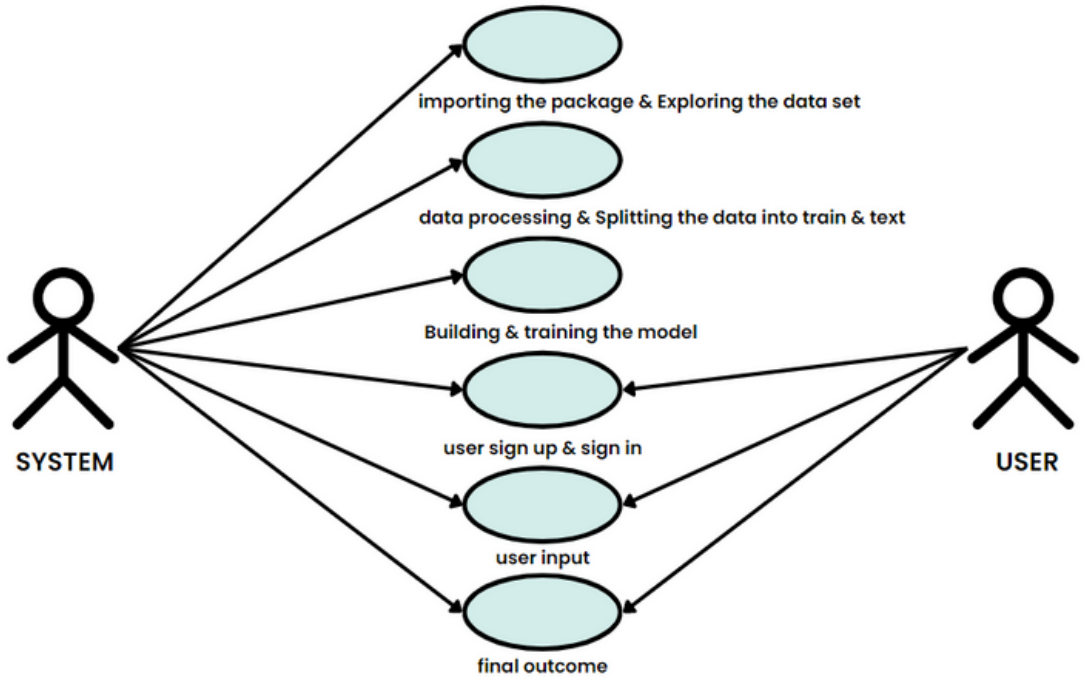


Figure 4.4: Use Case Diagram of wireless sensor network dependable monitoring for urban air quality.

4.5 CLASS DIAGRAM

Class diagram is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among objects.

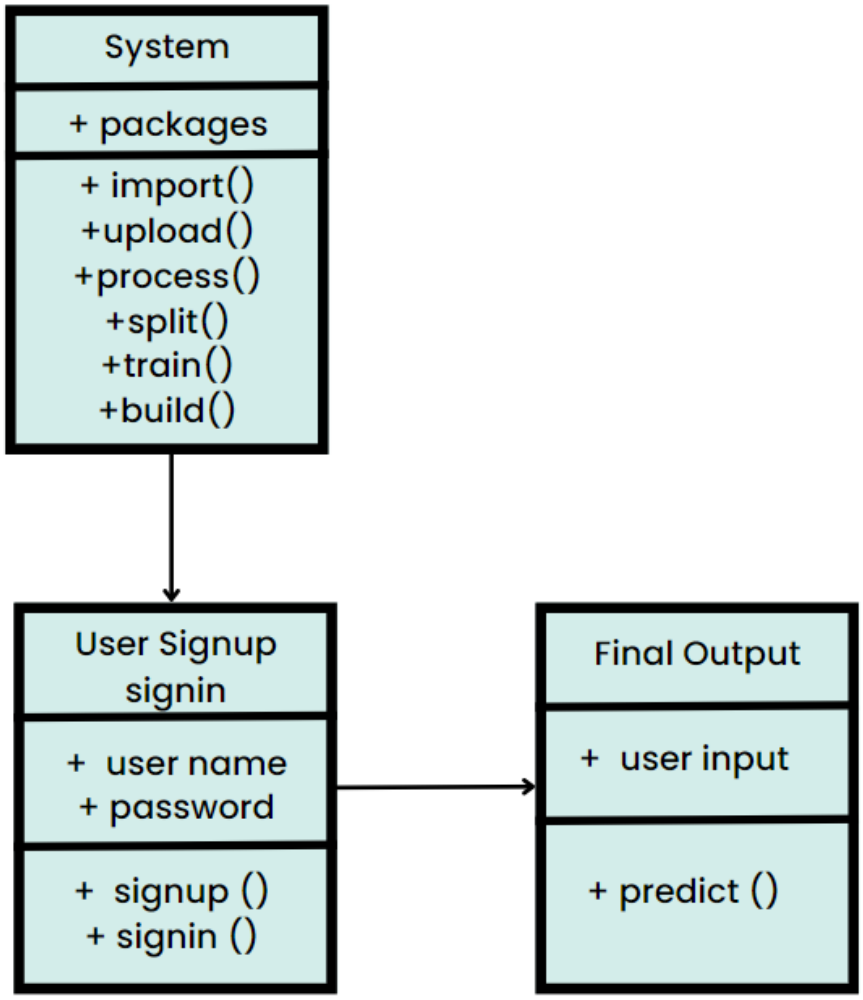


Figure 4.5: Class Diagram of wireless sensor network dependable monitoring for urban air quality.

4.6 SEQUENCE DIAGRAM

A sequence diagram shows object interactions arranged in time sequence. It depicts the objects involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the logical view of the system under development.

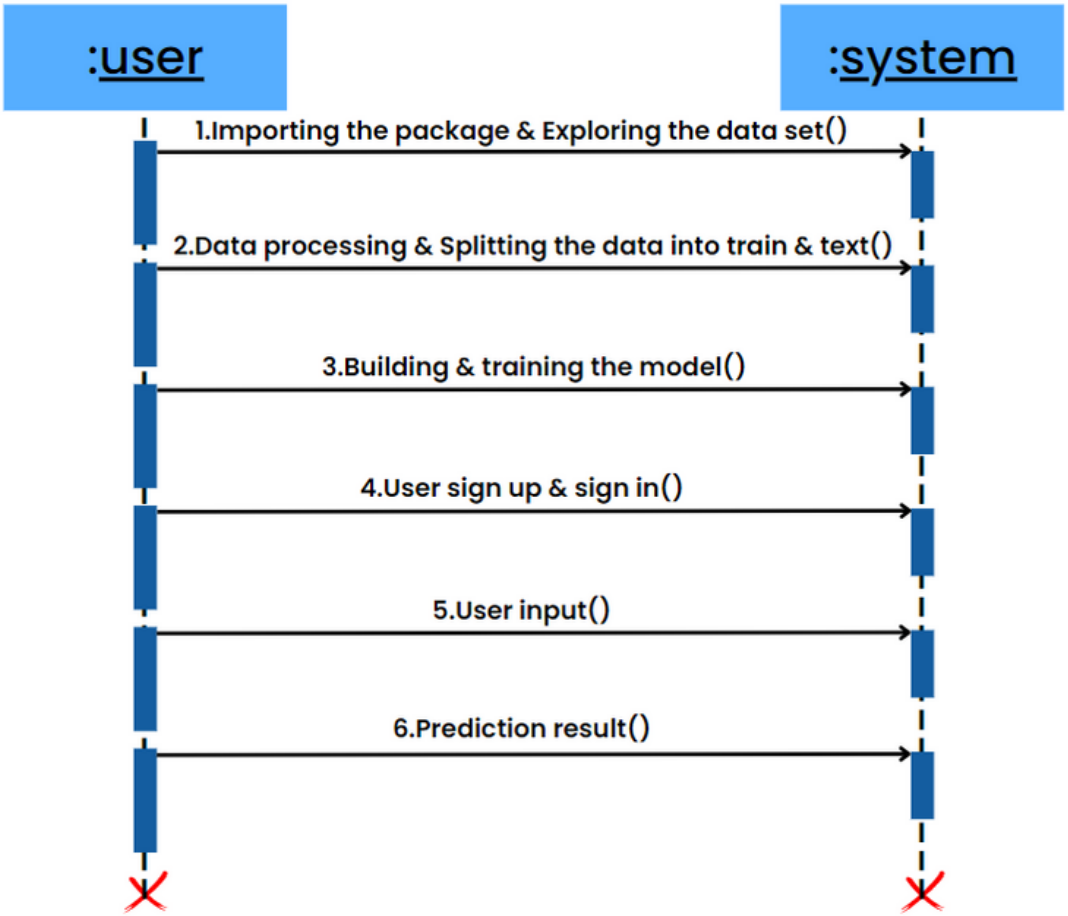


Figure 4.6: Sequence Diagram of wireless sensor network dependable monitoring for urban air quality.

4.7 ACTIVITY DIAGRAM

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. They can also include elements showing the flow of data between activities through one or more data stores.

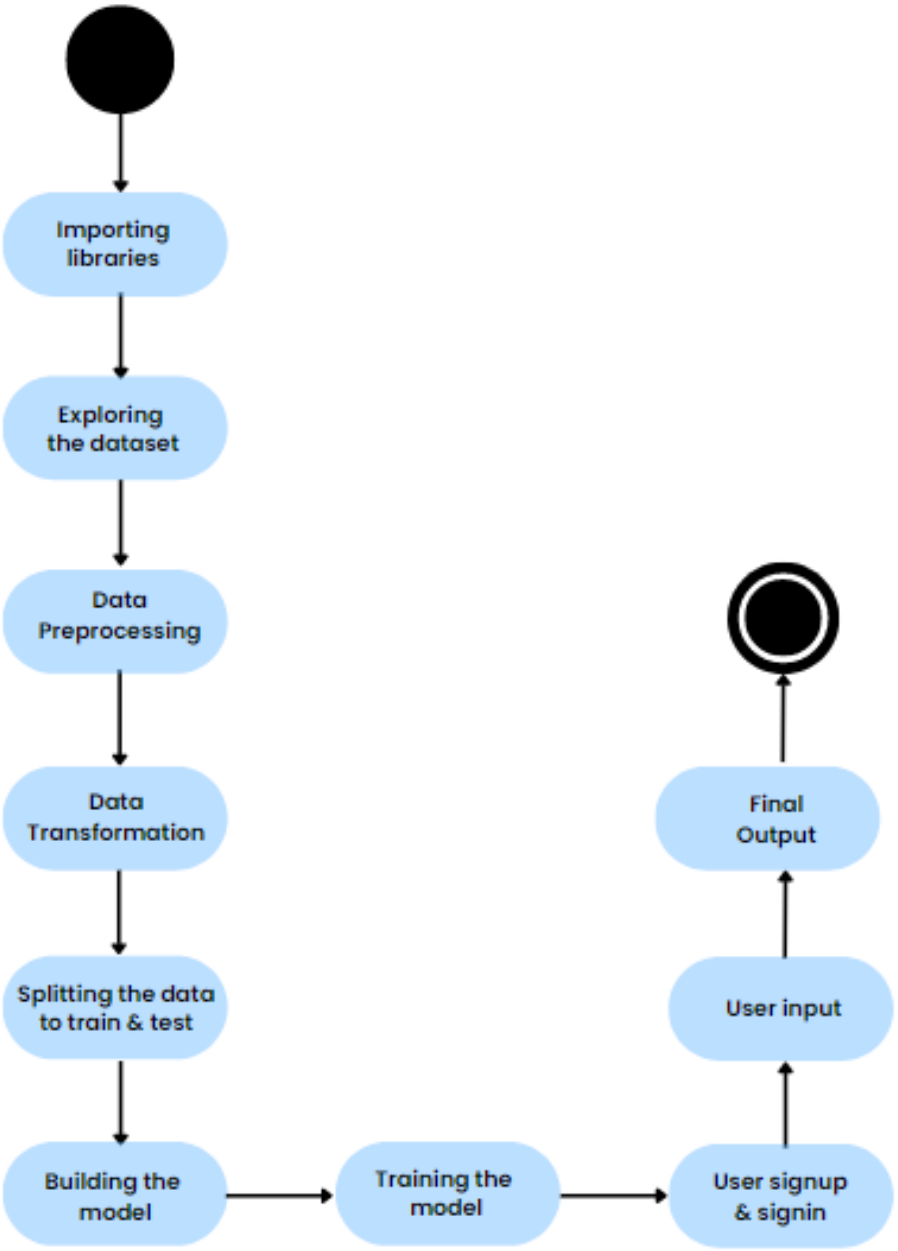


Figure 4.7: Activity Diagram of wireless sensor network dependable monitoring for urban air quality.

5. IMPLEMENTATION

5.1 SAMPLE CODE

```
from flask import Flask, render_template, request
import joblib
import numpy as np
import pickle
import sqlite3

app = Flask(__name__)

lr = joblib.load("Models/model.pkl")

@app.route('/')
def home():
  return render_template('home.html')

@app.route('/logon')
def logon():
  return render_template('signup.html')

@app.route('/login')
def login():
  return render_template('signin.html')

@app.route("/signup")
def signup():

  username = request.args.get('user','')
  name = request.args.get('name','')
  email = request.args.get('email','')
  number = request.args.get('mobile','')
  password = request.args.get('password','')
  con = sqlite3.connect('signup.db')
  cur = con.cursor()
  cur.execute("insert into `info` (`user`,`email`, `password`,`mobile`,`name`) VALUES (?,
?, ?, ?, ?)",(username,email,password,number,name))
  con.commit()
  con.close()
  return render_template("signin.html")
```

```
@app.route("/signin")
def signin():

  mail1 = request.args.get('user','')
  password1 = request.args.get('password','')
  con = sqlite3.connect('signup.db')
  cur = con.cursor()
  cur.execute("select `user`, `password` from info where `user` = ? AND `password` = ?",
(mail1,password1,))
  data = cur.fetchone()

  if data == None:
    return render_template("signin.html")

  elif mail1 == 'admin' and password1 == 'admin':
    return render_template("index.html")

  elif mail1 == str(data[0]) and password1 == str(data[1]):
    return render_template("index.html")
  else:
    return render_template("index.html")

@app.route("/index")
def index():
  return render_template('index.html')

@app.route('/predict', methods = ['POST'])
def predict():
  if request.method == 'POST':
    T, TM, Tm, SLP, H, VV, V, VM = float(request.form['T']), float(request.form['TM']),
float(request.form['Tm']), float(request.form['SLP']), float(request.form['H']),
float(request.form['VV']), float(request.form['V']), float(request.form['VM'])
    lr_pm = lr.predict([[T, TM, Tm, SLP, H, VV, V, VM]])
```

```
# print(lr_pm)

  return render_template("result.html", lr_pm = np.round(lr_pm,3))


@app.route('/notebook')
def notebook():
  return render_template('NOtebook.html')

@app.route('/about')
def about():
  return render_template('about.html')

if __name__ == "__main__":
  app.run(debug = True)
```

6. RESULTS

Home Screen

This is the home screen of wireless sensor network dependable monitoring for urban air quality. This is an login page where the user needs to login if he/she already has an account or else need to create an account using sign up option.

Screenshot 6.1: Home screen

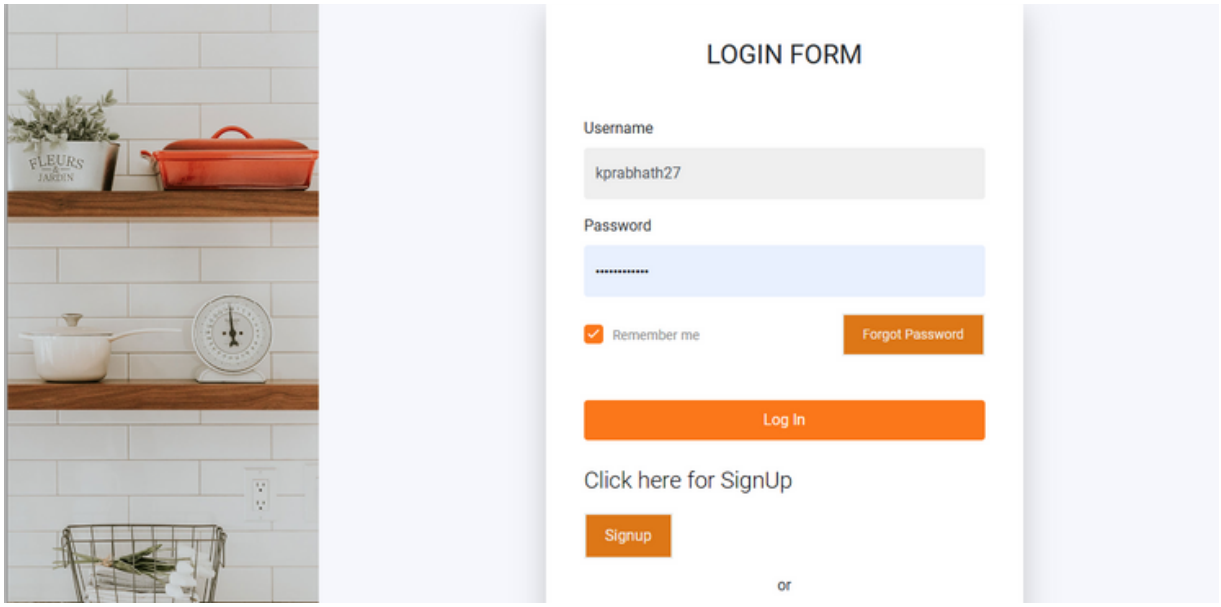
Result page

This is the result page of wireless sensor network dependable monitoring for urban air quality. These are the results for the input given by the user.

Screenshot 6.2: Result page

Login page

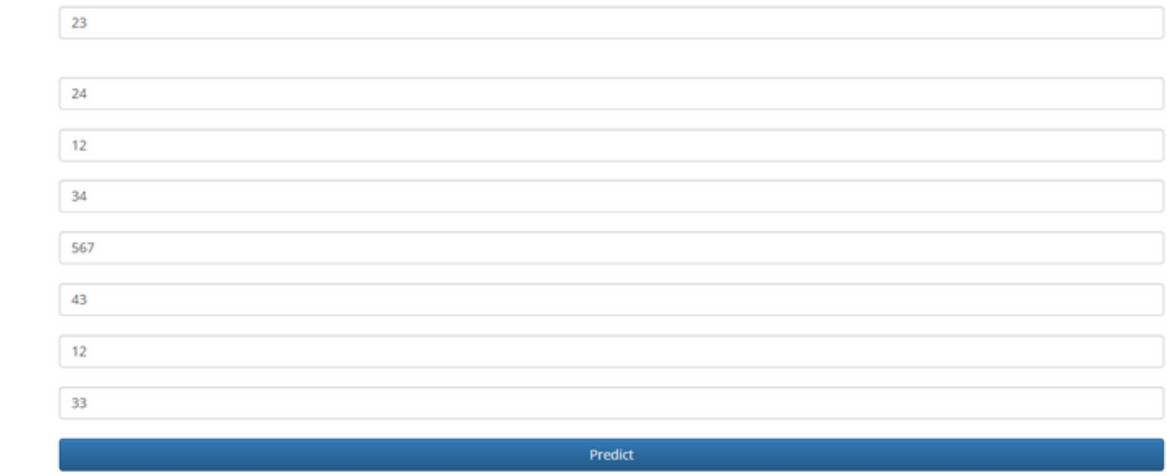
This is the login page of wireless sensor network dependable monitoring for urban air quality. The login page is redirected from home screen. Here the user has to fill the details like user name, password and login to the page respectively.



Screenshot 6.3: Login page

User input page

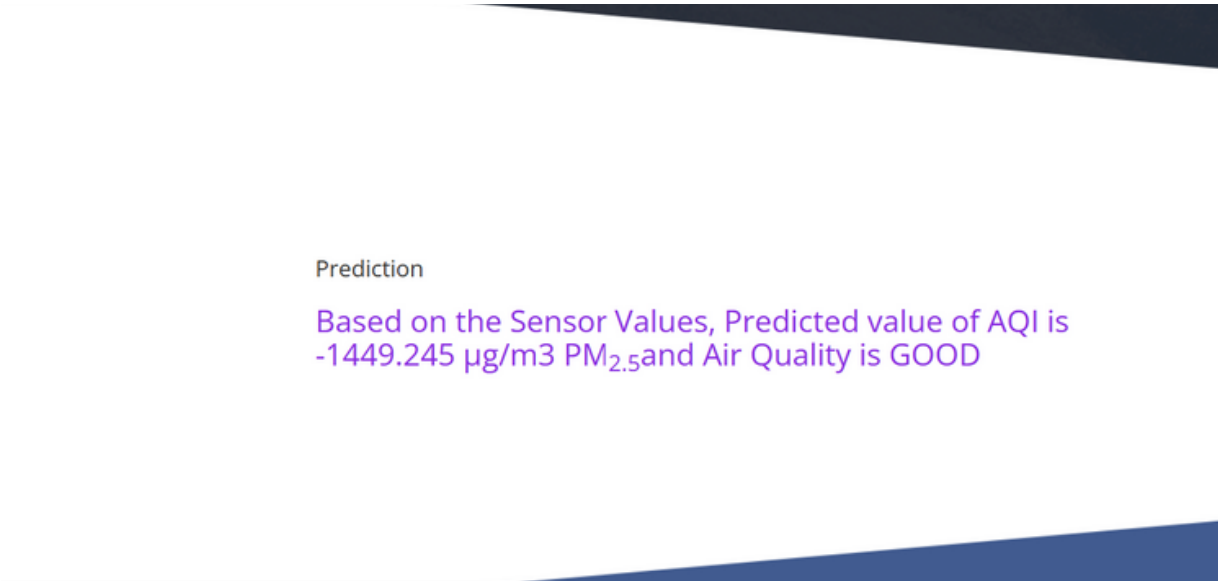
This is the user input page of wireless sensor network dependable monitoring for urban air quality. Here the user has to give different temperatures as an input from the given database. Hence the given inputs is used to predict the air quality.



Screenshot 6.4: User input page

Prediction

This is the prediction of wireless sensor network dependable monitoring for urban air quality. Based on the user's input the air quality is predicted.



Screenshot 6.5: Prediction

7. TESTING

7. TESTING

7.1 INTRODUCTION TO TESTING

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, subassemblies, assemblies and/or a finished product. It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of tests. Each test type addresses a specific testing requirement.

7.2 TYPES OF TESTING

7.2.1 UNIT TESTING

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .It is done after the completion of an individual unit before integration. This is a structural testing that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

7.2.2 INTEGRATION TESTING

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

7.2.3 FUNCTIONAL TESTING

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.
Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.
Invalid : identified classes of invalid input must Input be rejected.
Functions : identified functions must be exercised.
Output : identified classes of application outputs must be exercised.
Systems/Procedures : Interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases.

7.3 TEST CASES

7.3.1 CLASSIFICATION

Test case ID	Test case name	Purpose	If available	If not available
1	User signup	To purpose of user sign up is to get registered.	User gets registered into the application	There is no process.
2	User signin	The purpose of user signin is to login into application.	User get login into the application.	There is no process.
3	Enter input for prediction	The purpose of giving input is to predict the result and to display on the screen.	Prediction result displayed.	There is no process.

8. CONCLUSION

8. CONCLUSION & FUTURE SCOPE

8.1 PROJECT CONCLUSION

This project has presented a new development for a reliable environmental monitoring system built on the combination of physical and communication redundancies. By colocation of similar sensor motes to monitor the same parameters, increasing the time to failure for each module via energy management, and incorporating an effective IoT-enabled dependable control algorithm, the proposed low-cost wireless sensor network can significantly improve the monitoring quality in terms of availability, reliability with high correlations (0.903 for PM2.5, 0.817 for PM10) and fault tolerance with a high survival probability above 80%. The continuous-time Markov model and statistical tools are utilized in the design and performance verification. The system architecture is described along with hardware implementation. The developed system has been successfully tested in laboratory conditions as well as applied to real-world monitoring of air quality profiles of a construction site in a suburb, considering the impact of construction activities as well as different weather events such as bushfires, COVID-19 lockdown and heavy rain. The obtained results show feasibility and advantageous merits for the proposed low-cost wireless sensor network for environmental monitoring, particularly for air pollution assessment. They also indicate a promising application in microclimate analysis for cities.

8.2 FUTURE SCOPE

The potential idea behind the idea of the project is, statistical analysis is conducted for performance evaluation in association with two extreme events, one with bushfires and the other with pandemic lockdown. The results obtained indicate enhancements in reliability and accuracy of the collocated dependable low-cost sensors network proposed for wireless monitoring of air quality in urban conditions.

9. BIBLIOGRAPHY

9. BIBLIOGRAPHY

9.1 REFERENCES

[1] U. N. DESA. 2018 Revision of World Urbanization Prospects. Accessed: May 24, 2021. [Online]. Available: https://www.un.org/de velopment/desa/publications/2018-revision-of-world% -urbanizationprospects.html

[2] S. E. Bibri, ‘‘A foundational framework for smart sustainable city development: Theoretical, disciplinary, and discursive dimensions and their synergies,’’ Sustain. Cities Soc., vol. 38, pp. 758–794, Apr. 2018.

[3] M. Barrett, V. Combs, J. G. Su, K. Henderson, and M. Tuffli, ‘‘AIR louisville: Addressing asthma with technology, crowdsourcing, cross-sector collaboration, and policy,’’ Health Affairs, vol. 37, no. 4, pp. 525–534, Apr. 2018.

[4] Q. P. Ha, S. Metia, and M. D. Phung, ‘‘Sensing data fusion for enhanced indoor air quality monitoring,’’ IEEE Sensors J., vol. 20, no. 8, pp. 4430–4441, Apr. 2020.

[5] S. S. Anjum, R. M. Noor, N. Aghamohammadi, I. Ahmedy, L. M. Kiah, N. Hussin, M. H. Anisi, and M. A. Qureshi, ‘‘Modeling traffic congestion based on air quality for greener environment: An empirical study,’’ IEEE Access, vol. 7, pp. 57100–57119, 2019.

[6] L. Ricaurte, ‘‘The array of things, Chicago,’’ Urban Planning for Transitions. London, U.K.: Wiley, 2021, pp. 171–182.

[7] O. GonzÆlez, G. Camprodon, and V. BarberÆn, ‘‘Sensor monitoring experiences and technological innovations,’’ iSCAPE, Spain, Tech. Rep. D7.8, 2020.

[8] S. Metia, Q. P. Ha, H. N. Duc, and Y. Scorgie, ‘‘Urban air pollution estimation using unscented Kalman filtered inverse modeling with scaled monitoring data,’’ Sustain. Cities Soc., vol. 54, Mar. 2020, Art. no. 101970.

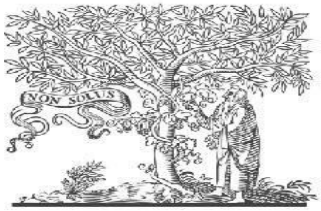
9.2 GITHUB LINK

https://github.com/kph27/major-project.git

10. PAPER PUBLICATION

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

COPY RIGHT



ELSEVIER SSRN

IJIEMR Transactions, online available on 14th Mar 2023. Link :http://www.ijiemr.org/downloads.php?vol=Volume-12&issue=Issue 04

10.48047/IJIEMR/V12/ISSUE 04/142

Title **WIRELESS SENSOR NETWORK DEPENDABLE MONITORING FOR URBAN AIR QUALITY**

Volume 12, ISSUE 04, Pages: 1114-1121

Paper Authors

M Vedangana,G Alekhya, K Prabhath,D Sandhya Rani

USE THIS BARCODE TO ACCESS YOUR ONLINE PAPER

To Secure Your Paper As Per UGC Guidelines We Are Providing A Electronic Bar Code

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

WIRELESS SENSOR NETWORK DEPENDABLE MONITORING FOR URBAN AIR QUALITY

M Vedangana[1],G Alekhya[2], K Prabhath[3],D Sandhya Rani[4]

[1]M VEDANGANA, B.TECH STUDENT, DEPT OF CSE, CMR Technical Campus, Hyderabad, Telangana, India. vedangana42001@gmail.com

[2]G ALEKHYA, B.TECH STUDENT, DEPT OF CSE, CMR Technical Campus, Hyderabad, Telangana, India. alekhyagopidi@gmail.com

[3]K PRABHATH, B.TECH STUDENT, DEPT OF CSE, CMR Technical Campus, Hyderabad, Telangana, India. kprabhath27@gmail.com

[4]D SANDHYA RANI, ASSISTANT PROFESSOR, DEPT OF CSE, CMR Technical Campus, Hyderabad, Telangana, India. davu.sandhya@gmail.com

ABSTRACT: This venture shows a minimal expense remote detecting network permitted by the Web of Things, with newly made solid strategies to increment trustworthiness for following air quality in private districts. The device has dynamic conservation-based energy-saving detecting modules for network connections. A consistent time Markov tie model is utilized to break down following execution in light of the steadfastness capability and interim to disappointment. The recommended dependable checking network is displayed to accomplish high accessibility concerning energy use and information security, with a survivor opportunity of over 80% for following air quality in an area throughout a negligible season of 72 hours. The strong connections to standard keeping objections in the scatterings of fine particle totals examined in excess of a 6-month stretch of time show the common sense of the made system, with Pearson's coefficients found at 0.903 and 0.817 for PM2.5 and PM10, independently. Corresponding to two serious occasions, one including bushfires and the other including pandemic quarantine, execution is assessed utilizing factual investigation.The results indicate that the collocated, low-cost, and reliable sensor network that was proposed for wirelessly tracking air quality in metropolitan areas has increased in precision and dependability.

Keywords *– Low-cost wireless sensor networks, Internet of Things, air quality, dependability, monitoring systems.*

1. INTRODUCTION

Almost 70% of the total populace will live in urban communities by 2050, as per a new UN gauge [1]. Travel, modern result, foundation, and energy all face huge interest because of urbanization's propensity. This would require the execution of effective natural reconnaissance methods in metropolitan regions and raise concerns with respect to practical development. The establishment for brilliant, manageable city improvement has been laid by between and transdisciplinary endeavors in independent frameworks, information science, software engineering, frameworks hypothesis, the Internet of Things (IoT), and artificial intelligence (AI) [2]. For metropolitan inhabitants to accomplish normal practicality and cultural security, clean air is fundamental. IoT-empowered remote sensor networks are promising among the ongoing observing frameworks for sound fabricated conditions and air quality administration. Specialized measures are expected in such manner for observing and further developing air quality. For example, in AIR Louisville [3], an openly supporting and cross-region cooperation drive, electronic nebulizer contraptions with IoT development were used to give prosperity estimations as well as regular characteristics for technique ideas on air pollution the leaders and control. [4] makes a savvy building coordinated checking framework that utilizes IoT-empowered multisensor combination to constantly follow continuous information on inside air quality.

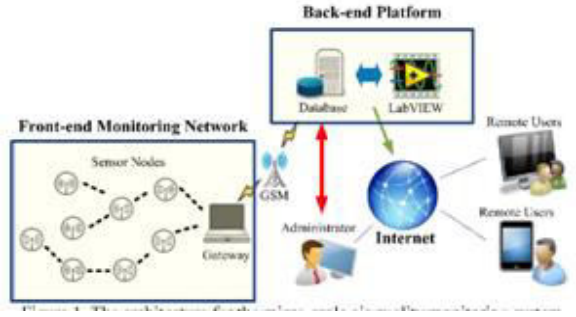


Fig.1: Example figure

In [5,] a PC model is used to see the traffic states of metropolitan road associations, which directly influence vehicle tainting. An open-source information base and recorded information from metropolitan detecting networks were utilized to address individual cases of air pollutants [6]. For a bigger scope, the partnered project iSCAPE (Working on the Shrewd Control of Air Contamination in Europe), which covers six European urban areas and expects to raise resident consciousness of natural maintainability by sending low-cost wireless sensor networks (LWSN) in their homes [7] The issue of air quality demonstrating and the executives is a main pressing issue in Australia [8], alongside late enormous framework improvement undertakings to satisfy the needs of urbanization. For high spatial goal air quality following, an organization of minimal expense KOALA (Knowing Our Ambient Local Air Quality) gadgets was set up. This permitted specialists to really identify carbon monoxide and fine particulate contamination a half year when a significant game [9]. For following air contamination and further developing metropolitan air quality, these endeavors exhibit the advantages and suitability of a minimal expense arrangement in light of remote detecting organizations.

2. LITERATURE SURVEY

A foundational framework for smart sustainable city development: Theoretical, disciplinary, and discursive dimensions and their synergies:

The training depends on the essential ideas of smart reasonable networks. Moreover, scholastic examination in the field of shrewd, feasible urban communities depends on the possibility that extending essential information requires digging into mind boggling issues that must be tended to from a between or transdisciplinary vantage point. Certainly, the issues of pack in this space are fundamentally excessively puzzled to conceivably be managed by a singular school. The expansive field of manageability change and maintainability science envelops the PhD concentrate on savvy practical city improvement. In this field, ICT is viewed as a critical variable because of its groundbreaking, troublesome, and synergistic impacts as an empowering, integrative, and constitutive innovation. Considering this, the PhD study utilizes an applied hypothesis way to deal with examine and dissect how omnipresent figuring ICT can progress and keep up with the commitment of feasible metropolitan structures to maintainable improvement objectives. This is basically to build a framework for key wise sensible city improvement considering consistent guidelines, speculations, educational fields, and ways of thinking used to facilitate metropolitan players in their preparation towards reasonability and to separate its effect. Metropolitan preparation, metropolitan plan, maintainability, economical turn of events, supportability science, information science, software engineering, intricacy science, frameworks hypothesis, frameworks thinking, and data and correspondence innovation are undeniably used to achieve this. As a result of this, it is believed to be critical to foster a far reaching structure in view of relevant hypotheses, scholarly fields, and philosophies that will act as the reason for the production of shrewd, supportable urban communities as an assortment of future practices. Thusly, this worldview underlines the subject's multidisciplinary and transdisciplinary character and heading, as well as the meaning of leading exploration on this point utilizing an interdisciplinary and transdisciplinary technique. Thusly, the objective of this paper is to characterize, consolidate, and coordinate the major parts of a crucial structure for brilliant supportable city development as an assortment of future practices to organize the very thick and complex logical field of savvy economical urban communities.

Determined to lay out a structure that scientifically interfaces city improvement, supportability, and ICT, as well as featuring how and how much manageability and ICT have become particularly compelling in city improvement in present day culture, it centers around various principal hypotheses as well as scholarly teaches and talks. Likewise, the hypothetical, disciplinary, and rambling components of the central system that supports savvy practical city improvement are firmly connected in this paper, which gives a top to bottom interdisciplinary and transdisciplinary conversation on subjects of high significance to the PhD study. Subsequently, these viewpoints will shape the reason for the structure for key shrewd economical city improvement that is being investigated and will be created utilizing a backcasting way to deal with key preparation. This study offers a significant perspective for fathoming an assortment of notable hypotheses, deep rooted scholarly fields, and conversations that have a high potential for

reconciliation, combination, and utility comparable to savvy, supportable city improvement rehearses.

AIR louisville: Addressing asthma with technology, crowdsourcing, cross-sector collaboration, and policy:

By using the thoughts, assets, and capacities of a different gathering of colleagues, cross-area coordinated efforts help general wellbeing. We recorded how the Louisville Metro Government, a cause, and an innovation organization framed the organization known as AIR Louisville, which was fruitful in tending to a mind boggling general medical problem: asthma. We enrolled asthmatic occupants in Louisville, Kentucky, and used robotized nebulizer contraptions to follow where and when they used medicine. We found that using the mechanized prosperity stage achieved great clinical results, for instance, a 78% decreasing in emergency inhaler use and a 48% addition in secondary effect free days. Moreover, when ecological information and publicly supported genuine information on inhaler use were consolidated, strategy suggestions were made for things like extending the covering of trees, lessening the effect of tree evacuation, drafting for emanation cradles against air contamination, suggesting truck courses, and making a local area asthma notice framework. By at the same time coordinating individual, proficient, and legislative decisions, AIR Louisville is a model that can be reproduced to address various general medical problems.

Sensing data fusion for enhanced indoor air quality monitoring:

Cross-area coordinated efforts benefit general wellbeing by using a different gathering of colleagues' thoughts, assets, and abilities. We recorded how the organization known as AIR Louisville, which was fruitful in tending to a mind boggling general medical problem, was shaped by the Louisville Metro Government, a foundation, and an innovation organization: asthma. Utilizing mechanized nebulizer gadgets, we followed where and when asthmatics in Louisville, Kentucky, took their prescription. Using the mechanized prosperity stage brought about certain clinical results, like a 78% diminishing in the utilization of emergency inhalers and a 48% increment in the quantity of days without secondary effects. Besides, when regular data and freely upheld genuine data on inhaler use were joined, methodology proposition were made for things like broadening the haven of trees, decreasing the impact of tree clearing, drafting for release supports against air tainting, recommending truck courses, and making a neighborhood cautioning system. AIR Louisville is a model that can be utilized to address an assortment of general medical problems since it all the while coordinates individual, proficient, and legislative choices.

Modeling traffic congestion based on air quality for greener environment: An empirical study:

The objective of this paper is to utilize a mix of traffic stream displaying, vehicle emanation demonstrating, and air quality displaying to control gridlock on metropolitan street organizations. A recreation model is proposed and further tried for execution measurements comparable to three primary viewpoints — the holding up season of vehicles at intersections, crossing points, and signals, the sort of poison produced by a vehicle, and travel time — in light of the traffic conditions. Contextual analyses in Petaling Jaya, Shah Alam, Mont Kiara, and JalanTunRazak in Malaysia act as the reason for the trial examination and approval. The traffic utilization boundary is analyzed and tried in three particular situations — morning, evening, and night. The discoveries showed that when traffic is demonstrated and controlled by traffic stream, vehicle discharges, and the air quality index (AQI), almost 75% of gridlock is decreased. This outcomes in a contamination free environment and forestalls the Urban Heat Island (UHI) impact brought about by vehicle heat. The preliminary outcomes are attempted, endorsed, and differentiated and existing responses for execution assessment. Single-way ideas, traffic delays during top hours or crises, non-repeating clog thought, blockage evasion as opposed to recuperation, mistaken revealing of street mishaps, warnings to clients about gridlocks ahead, and a high vehicle utilization rate are significant blemishes that the proposed model looks to address.

Urban air pollution estimation using unscented Kalman filtered inverse modeling with scaled monitoring data:

The expanding pace of urbanization requires viable and solid procedures for air quality checking and control. For this, the Air Pollution Model and Chemical Transport Model (TAPM-CTM) has been created and utilized in Australia with outflows stock

information, concise information and landscape information utilized as its feedback boundaries. Since huge vulnerabilities exist in the emissions inventory (EI), further refinements and enhancements are expected for exact air quality expectation. This review assesses the presentation of metropolitan air quality determining, utilizing TAPM-CTM, and further develops precision of air contamination assessment by utilizing a two-stage streamlining strategy to overhaul EI with approval from checking information. The primary stage depends on measurable investigation for EI remedy and the subsequent stage depends on the unscented Kalman filter (UKF) to consider the spatio-transient disseminations of air poison levels using a Matérn covariance capability. The anticipated nitrogen monoxide (NO) and nitrogen dioxide (NO) fixations with outflows are first contrasted and perceptions at checking stations in the New South Wales (NSW). Ozone (O) is likewise considered since at the ground level it addresses a significant air poison influencing human wellbeing and the climate. In the subsequent stage, with the better EI, TAPM-CTM model blunders are diminished further by utilizing the UKF to adjust EI. Results got show viability of the proposed method, which is promising for air quality opposite demonstrating, a significant part of air contamination control in shrewd urban areas to accomplish natural manageability.

3.METHODOLOGY

The preparation and the executives of air quality is a significant issue in Australia, alongside ongoing huge foundation improvement undertakings to address industrialization's issues. For high spatial goal air quality following, an organization of minimal expense KOALA (Knowing Our Ambient Local Air Quality) screens was used. This empowered the specialists to successfully identify carbon monoxide and fine particulate contamination a half year when a significant game. For following air contamination and further developing metropolitan air quality, these endeavors exhibit the advantages and suitability of a minimal expense arrangement in view of remote detecting organizations. Despite the fact that worldwide brilliant city improvement can give many highlights and administrations that cover all parts of government tasks, it should zero in on individuals and straightforwardly address the prosperity and personal satisfaction of occupants. In this way, out in the open included projects to execute LWSN for natural observation, occupants' necessities and needs ought to be thought about.

Disadvantages:

1. This would necessitate the implementation of efficient environmental surveillance techniques in metropolitan areas and raise concerns regarding sustainable growth.

2. In terms of dependability and availability, there is less quality monitoring.

This task expects to foster a structure for dependable low-cost wireless sensor networks (DLWSN) for air quality observing. It centers around the practical organization of a gathered observing framework for exact and dependable information conglomeration and evaluation of metropolitan air quality utilizing a superior IoT-empowered framework. The mean time to failure (MTTF) of the global positioning framework's dependability capability is utilized to decide the proposed framework's unwavering quality, and a Markov chain model (MCM) is utilized to compute the endurance and disappointment paces of its sensor modules. A reasonable design for sensor bits with a powerful energy protection plan to broaden framework runtime and an original remote trustworthy calculation to improve the general framework's exactness, trustworthiness, and safeguard tasks in observing open air quality is chosen in view of the dependability examination. In extreme circumstances like pandemic quarantine and bushfires, the arranged DLWSN's accessibility, constancy, and protection from climatic variances are scrutinized.

Advantages:

1. With the survivor chance, it is demonstrated that the suggested reliable surveillance network achieves high availability in terms of energy consumption and data security.

2. enhancements to the suggested collocated, low-cost sensor network's dependability and precision for wirelessly monitoring urban air quality.

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

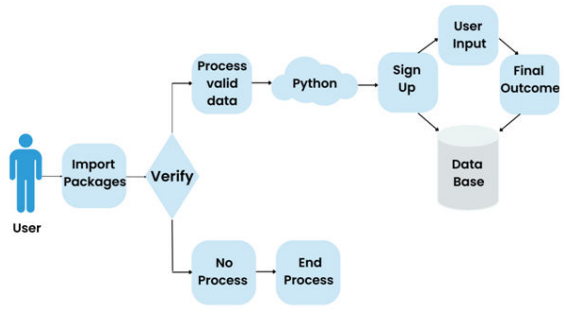


Fig.2: System architecture

This project demonstrates a low-cost, internet-of-things-permitted wireless sensing network with newly developed, dependable methods for increasing dependability when tracking air quality in residential areas. The device has dynamic conservation-based energy-saving detecting modules for network connections. A consistent time Markov tie model is utilized to break down following execution in light of the steadfastness capability and interim to disappointment.

MODULES:

For this project, we created the following modules.

Tensorflow: TensorFlow is a dataflow and differentiable programming system free of charge and open source programming that can be utilized for the vast majority various things. A delegate mathematical pack is moreover utilized in simulated intelligence applications like mind associations. Google utilizes it for both examination and creation. TensorFlow was created by the Google Cerebrum group for use inside Google. It was delivered under the Apache 2.0 open-source permit on November 9, 2015.

A broadly useful library for handling clusters is Numpy. It incorporates devices for controlling multi-layered exhibits as well as an elite execution object for them. It is the major logical figuring Python library. The most outstanding of its numerous qualities are: A productive N-layered exhibit object, high level capabilities (for broadcasting), devices for incorporating C/C++ and Fortran code, and information on straight polynomial math, the Fourier change, and irregular numbers are useful. Despite its obvious intelligent applications, Numpy may be used as a useful complex compartment of general data. Numpy can rapidly and effectively interface with a great many information bases since it can indicate any information type.

Pandas: Pandas is an open-source Python library that uses strong data plans to give first class execution data control and assessment. Fundamentally, Python was utilized for information readiness and munging. It just made a little commitment to the investigation of the information. Pandas tackled this issue. Regardless of what the start of the data load, we could achieve five typical stages in data dealing with and assessment using Pandas: prepare, change, model, and examine. The scholar and business fields of money, financial aspects, insights, investigation, etc all utilize Python with Pandas.

Matplotlib is a Python 2D plotting bundle that can deliver figures of distribution quality across stages in an assortment of printed copy and intuitive organizations. Matplotlib is a Python library that can be utilized in four graphical UI tool stash, the Jupyter Journal, Python scripts, the Python and IPython shells, and web application servers. Matplotlib endeavors to make troublesome assignments feasible while working on the straightforward. Plots, histograms, power spectra, bar outlines, mistake diagrams, disperse plots, and different charts can be generally made with only a couple of lines of code. Models can be found in the thumbnail exhibitions and test plots. The pyplot module gives a plotting point of interaction that is equivalent to that of MATLAB for use with IPython. Utilizing an item situated interface or an assortment of MATLAB-like capabilities, the power client has full oversight over line styles, text style properties, pivot properties, etc.

Get using Scikit: Through a standard Python interface, Scikit-learn gives an assortment of directed and solo learning techniques. It is remembered for various Linux dispersions and is authorized under a free and basic BSD permit, which empowers both intellectual and business use.

4. IMPLEMENTATION

To further develop steadfastness for air quality observing in rural regions, this study proposes a minimal expense remote sensor network that is empowered by the Internet of Things and consolidates recently created dependable techniques. The gadget has dynamic preservation based energy-saving identifying modules for

International Journal for Innovative Engineering and Management Research
PEER REVIEWED OPEN ACCESS INTERNATIONAL JOURNAL
www.ijiemr.org

network associations.

In metropolitan regions, where clean air is crucial for occupants, this drive means to advance natural supportability and social strength. IoT-empowered remote sensor networks are promising among the ongoing observing frameworks for solid constructed conditions and air quality administration. Specialized measures are expected in such manner for checking and further developing air quality.

5. EXPERIMENTAL RESULTS

Fig.3: Home screen

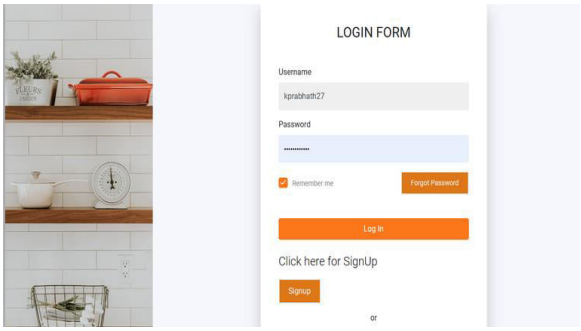


Fig.4: Login page

Fig.5: User input

Fig.6: Prediction

6. CONCLUSION

An original plan for a dependable natural observation framework in view of a mix of transmission and actual reinforcements was shown in this review. By colocating comparative sensor bits to screen similar boundaries, expanding the opportunity to disappointment for every module through energy the board, and consolidating a proficient IoT-empowered trustworthy control calculation, the proposed minimal expense remote sensor organization can fundamentally further develop observing quality concerning accessibility, dependability, and adaptation to non-critical failure with high endurance probabilities above 80%. The ceaseless time Markov model and measurable techniques are used all through the preparation and execution testing stages. Both the equipment application and the framework configuration are top to bottom. Considering the effect of development exercises as well as different climate occasions like bushfires, Coronavirus lockdown, and weighty downpour, the created framework has been effectively tried in the research center and applied to certifiable observing of air quality profiles of a building site in a suburb. The outcomes show that the recommended minimal expense remote detecting organization can be utilized for natural observation, especially to survey air contamination, and that it enjoys benefits. Moreover, they propose a potential application in city weather conditions research.

7. FUTURE SCOPE

The venture's conceivable idea is to lead measurable examination for execution assessment regarding two serious occasions, one including pandemic quarantine

and one including bushfires. The outcomes demonstrate that the gathered, minimal expense, and solid sensor network that was proposed for remotely following air quality in metropolitan regions has expanded in accuracy and trustworthiness.

8. ACKNOWLEDGEMENT

We thank CMR Technical Campus for supporting this paper titled“ WIRELESS SENSOR NETWORK DEPENDABLE MONITORING FOR URBAN AIR QUALITY”, which provided good facilities and support to accomplish our work. Sincerely thank our Chairman, Director, Deans, Head of the Department, Department Of Computer Science and Engineering, Guide and Teaching and Non-Teaching faculty members for giving valuable suggestions and guidance in every aspect of our work

REFERENCES

[1] U. N. DESA. 2018 Revision of World Urbanization Prospects.Accessed: May 24, 2021.[Online]. Available: https://www.un.org/development/desa/publications/2018-revision-of-world% -urbanizationprospects.html

[2] S. E. Bibri, ‘‘A foundational framework for smart sustainable city development: Theoretical, disciplinary, and discursive dimensions and their synergies,’’ Sustain. Cities Soc., vol. 38, pp. 758–794, Apr. 2018.

[3] M. Barrett, V. Combs, J. G. Su, K. Henderson, and M. Tuffli, ‘‘AIR louisville: Addressing asthma with technology, crowdsourcing, cross-sector collaboration, and policy,’’ Health Affairs, vol. 37, no. 4, pp. 525–534, Apr. 2018.

[4] Q. P. Ha, S. Metia, and M. D. Phung, ‘‘Sensing data fusion for enhanced indoor air quality monitoring,’’ IEEE Sensors J., vol. 20, no. 8, pp. 4430–4441, Apr. 2020.

[5] S. S. Anjum, R. M. Noor, N. Aghamohammadi, I. Ahmedy, L. M. Kiah, N. Hussin, M. H. Anisi, and M. A. Qureshi, ‘‘Modeling traffic congestion based on air quality for greener environment: An empirical study,’’ IEEE Access, vol. 7, pp. 57100–57119, 2019.

[6] L. Ricaurte, ‘‘The array of things, Chicago,’’ Urban Planning for Transitions. London, U.K.: Wiley, 2021, pp. 171–182.

[7] O. González, G. Camprodon, and V. Barberán, ‘‘Sensor monitoring experiences and technological innovations,’’ iSCAPE, Spain, Tech. Rep. D7.8, 2020.

[8] S. Metia, Q. P. Ha, H. N. Duc, and Y. Scorgie, ‘‘Urban air pollution estimation using unscented Kalman filtered inverse modeling with scaled monitoring data,’’ Sustain. Cities Soc., vol. 54, Mar. 2020, Art.no. 101970.

[9] T. Kuhn, R. Jayaratne, P. K. Thai, B. Christensen, X. Liu, M. Dunbabin, R. Lamont, I. Zing, D. Wainwright, C. Witte, D. Neale, and L. Morawska, ‘‘Air quality during and after the commonwealth games 2018 in australia: Multiple benefits of monitoring,’’ J. Aerosol Sci., vol. 152, Feb. 2021, Art. no. 105707.

[10] T. Ji, J.-H.Chen, H.-H.Wei, and Y.-C. Su, ‘‘Towards people-centric smart city development: Investigating the citizens’ preferences and perceptions about smart-city services in Taiwan,’’ Sustain. Cities Soc., vol. 67, Apr. 2021, Art.no. 102691.

[11] K. Ekman and A. Weilenmann, ‘‘Behind the scenes of planning for public participation: Planning for air-quality monitoring with low-cost sensors,’’ J. Environ. Planning Manage., vol. 64, no. 5, pp. 865–882, Apr. 2021.

[12] G. Mehmood, M. Z. Khan, A. Waheed, M. Zareei, and E. M. Mohamed, ‘‘A trust-based energy-efficient and reliable communication scheme (trustbased ERCS) for remote patient monitoring in wireless body area networks,’’ IEEE Access, vol. 8, pp. 131397–131413, 2020.

[13] M. Adil and M. K. Khan, ‘‘Emerging IoT applications in sustainable smart cities for COVID-19: Network security and data preservation challenges with future directions,’’ Sustain. Cities Soc., vol. 75, Dec. 2021, Art.no. 103311.

[14] P. Rathore, A. S. Rao, S. Rajasegarar, E. Vanz, J. Gubbi, and M. Palaniswami, ‘‘Real-time urban microclimate analysis using Internet of Things,’’

IEEE Internet Things J., vol. 5, no. 2, pp. 500–511, Apr. 2018.

[15] C. L. Müller, L. Chapman, S. Johnston, C. Kidd, S. Illingworth, G. Foody, A. Overeem, and R. R. Leigh, ‘‘Crowdsourcing for climate and atmospheric sciences: Current status and future potential,’’ Int. J. Climatol., vol. 35, no. 11, pp. 3185–3203, Sep. 2015.

11. CERTIFICATES

IMPACT FACTOR
7.812

International Journal for Innovative Engineering and Management Research

(ISSN 2456 - 5083)

CERTIFICATE

ELSEVIER
SSRN

DOI: 10.48047/IJIEMR/V12/I04/142

This is to Certify that Prof./Dr./Mr./ M Vedangana From CMR Technical Campus, Hyderabad, Telangana, India.Participated in the International Journal of Engineering and Management Research. Presented a Paper Entitled"WIRELESS SENSOR NETWORK DEPENDABLE MONITORING FOR URBAN AIR QUALITY"In the Organizing Commitee of ROYAL SOCIETY FOR SCIENCE.

Published in International Journal of Innovation Engineering and Management Research (IJIEMR), Vol-12,Issue-04 Apr-2023

Hyderabad
2023

RAKESH ORUGANTI
Editor In Chief

+91 9989292561

Huda Techo Enclave, HiTech City Madhapur, Hyderabad, 500081

info.ijiemr@gmail.com

IMPACT FACTOR
7.812

International Journal for Innovative Engineering and Management Research

(ISSN 2456 - 5083)

CERTIFICATE

ELSEVIER
SSRN

DOI: 10.48047/IJIEMR/V12/I04/142

This is to Certify that Prof./Dr./Mr./ G Alekhya From CMR Technical Campus, Hyderabad, Telangana, India.Participated in the International Journal of Engineering and Management Research. Presented a Paper Entitled"WIRELESS SENSOR NETWORK DEPENDABLE MONITORING FOR URBAN AIR QUALITY"In the Organizing Commitee of ROYAL SOCIETY FOR SCIENCE.

Published in International Journal of Innovation Engineering and Management Research (IJIEMR), Vol-12,Issue-04 Apr-2023

Hyderabad
2023

RAKESH ORUGANTI
Editor In Chief

+91 9989292561 Huda Techo Enclave, HiTech City Madhapur, Hyderabad, 500081 info.ijiemr@gmail.com

IMPACT FACTOR
7.812

International Journal for Innovative Engineering and Management Research

(ISSN 2456 - 5083)

CERTIFICATE

ELSEVIER
SSRN

DOI: 10.48047/IJIEMR/V12/I04/142

This is to Certify that Prof./Dr./Mr./ K Prabhath From CMR Technical Campus, Hyderabad, Telangana, India.Participated in the International Journal of Engineering and Management Research. Presented a Paper Entitled"WIRELESS SENSOR NETWORK DEPENDABLE MONITORING FOR URBAN AIR QUALITY"In the Organizing Commitee of ROYAL SOCIETY FOR SCIENCE.

Published in International Journal of Innovation Engineering and Management Research (IJIEMR), Vol-12,Issue-04 Apr-2023

Hyderabad
2023

RAKESH ORUGANTI
Editor In Chief

+91 9989292561 Huda Techo Enclave, HiTech City Madhapur, Hyderabad, 500081 info.ijiemr@gmail.com

IMPACT FACTOR
7.812

International Journal for Innovative Engineering and Management Research

(ISSN 2456 - 5083)

CERTIFICATE

ELSEVIER
SSRN

DOI: 10.48047/IJIEMR/V12/I04/142

This is to Certify that Prof./Dr./Mr./ D Sandhya Rani From CMR Technical Campus, Hyderabad, Telangana, India.Participated in the International Journal of Engineering and Management Research. Presented a Paper Entitled"WIRELESS SENSOR NETWORK DEPENDABLE MONITORING FOR URBAN AIR QUALITY"In the Organizing Commitee of ROYAL SOCIETY FOR SCIENCE.

Published in International Journal of Innovation Engineering and Management Research (IJIEMR), Vol-12,Issue-04 Apr-2023

Hyderabad
2023

RAKESH ORUGANTI
Editor In Chief

+91 9989292561

Huda Techo Enclave, HiTech City Madhapur, Hyderabad, 500081

info.ijiemr@gmail.com