United States of America

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The Director

of the United States Patent and Trademark Office has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this United States

Patent

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Acting Director of the United States Patent and Trademark Office

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If the application for this patent was filed on or after June 8, 1995, the term of this patent begins on the date on which this patent issues and ends twenty years from the filing date of the application or, if the application contains a specific reference to an earlier filed application or applications under 35 U.S.C. 120, 121, 365(c), or 386(c), twenty years from the filing date of the earliest such application ("the twenty-year term"), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b), and any extension as provided by 35 U.S.C. 154(b) or 156 or any disclaimer under 35 U.S.C. 253.

If this application was filed prior to June 8, 1995, the term of this patent begins on the date on which this patent issues and ends on the later of seventeen years from the date of the grant of this patent or the twenty-year term set forth above for patents resulting from applications filed on or after June 8, 1995, subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b) and any extension as provided by 35 U.S.C. 156 or any disclaimer under 35 U.S.C. 253.

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(12) **United States Patent**
Chatterjee et al.

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(45) **Date of Patent: May 27, 2025**

(54) **POLLUTION MONITORING SYSTEM AND METHOD THEREOF**

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(73) Assignee: **INDIAN INSTITUTE OF TECHNOLOGY DELHI**, New Delhi (IN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 413 days.

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B01D 46/42 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***G01N 33/0073*** (2013.01); ***B01D 46/4245*** (2013.01); ***B01D 46/429*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G01N 33/0031; G01N 33/0063; G01N 33/0073; G01N 33/0075; G01N 1/2273;
(Continued)

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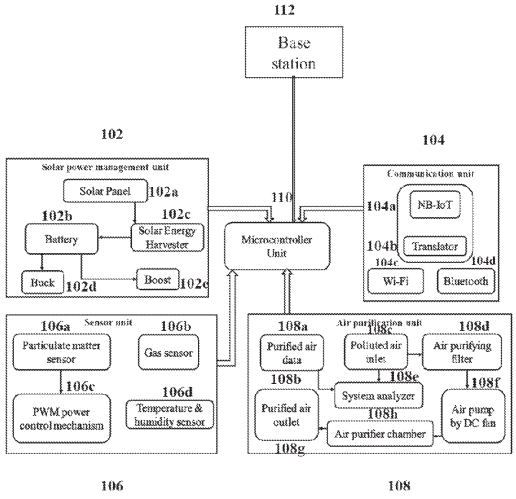
Primary Examiner — Benjamin R Schmitt
(74) *Attorney, Agent, or Firm* — Jacob M. Ward; Ward Law Office LLC

(57) **ABSTRACT**

A pollution monitoring system and a method is disclosed. The pollution monitoring system comprises an on-board sensor unit having a plurality of sensors, configured for monitoring air quality by measuring pollution data in the air and a power control unit connected with the on-board sensor unit for controlling the operation of the on-board sensor unit. The pollution monitoring system further comprises microcontroller configured for generating control signals to be transmitted to the power control unit for controlling operation of on-board sensor unit. The microcontroller is configured for receiving information from a base station regarding operation of the on-board sensor unit. Further, the pollution monitoring system comprises an air purification unit configured for receiving the pollution data from the microcontroller and enabling activation or deactivation of the air purification unit based on comparison of the pollution data with predefined threshold values.

14 Claims, 6 Drawing Sheets



(51) **Int. Cl.**

B01D 46/44	(2006.01)
B01D 46/46	(2006.01)
H02S 10/20	(2014.01)
G01N 1/22	(2006.01)
H02J 7/35	(2006.01)

(52) **U.S. Cl.**

CPC ***B01D 46/442*** (2013.01); ***B01D 46/448*** (2013.01); ***B01D 46/46*** (2013.01); ***G01N 33/0031*** (2013.01); ***G01N 33/0063*** (2013.01); ***G01N 33/0075*** (2013.01); ***H02S 10/20*** (2014.12); *G01N 1/2273* (2013.01); *H02J 7/35* (2013.01)

(58) **Field of Classification Search**

CPC B01D 46/442; B01D 46/4245; B01D 46/429; B01D 46/448; B01D 46/46

See application file for complete search history.

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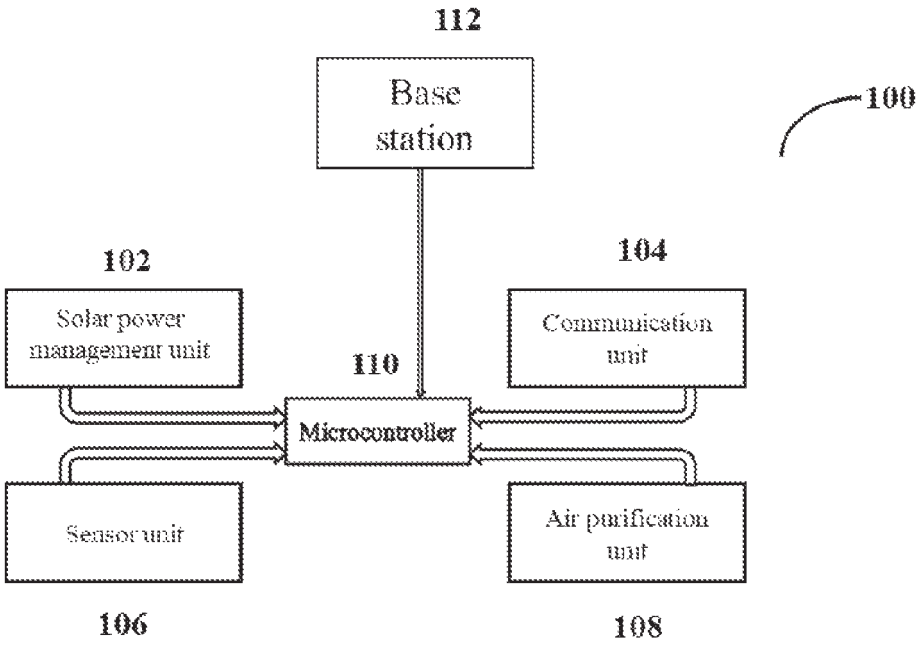
112
Base station
100
102
Solar power management unit
104
Communication unit
110
Microcontroller
Sensor unit
Air purification unit
106
108

FIGURE 1

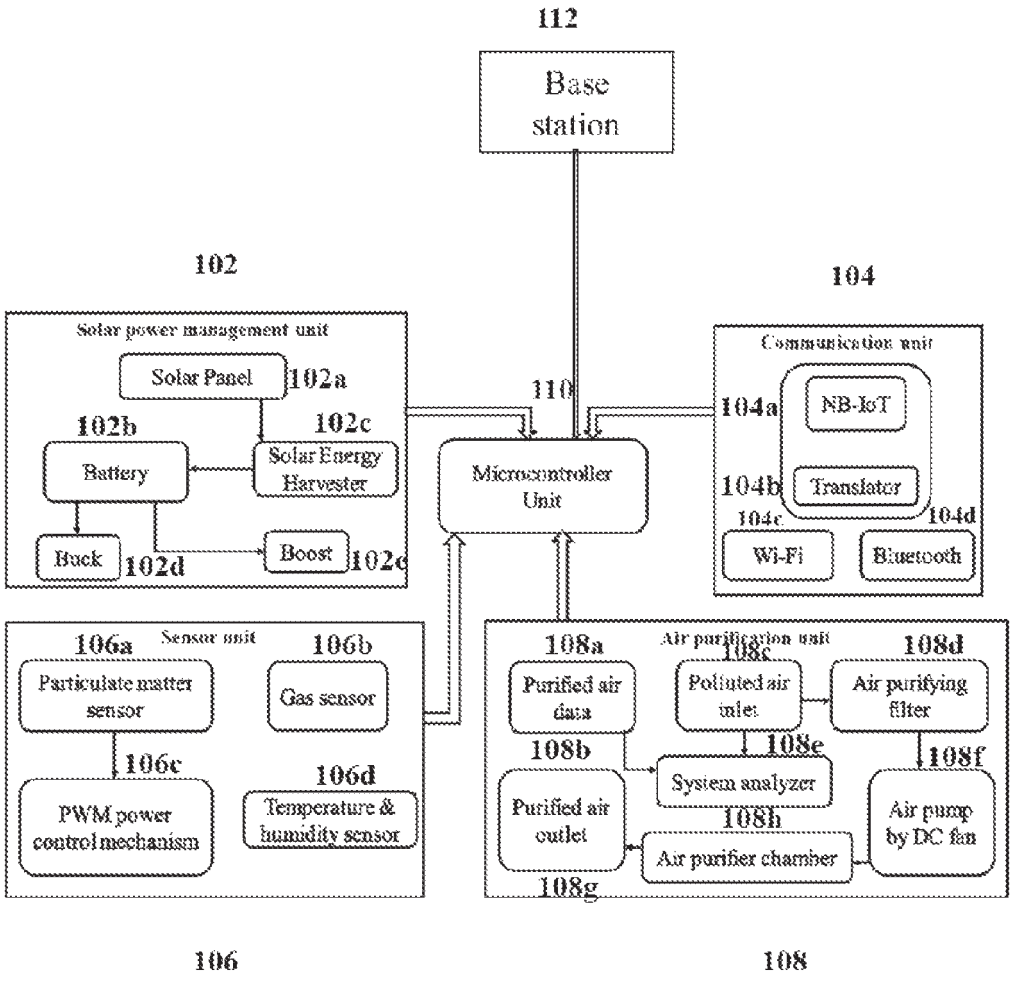
112
Base station
102
Solar power management unit
Solar Panel
102a
102b
102c
Battery
Solar Energy Harvester
Buck
102d
Boost
102e
110
Microcontroller Unit
104
Communication unit
104a
NB-IoT
104b
Translator
104c
104d
Wi-Fi
Bluetooth
106
Sensor unit
106a
Particulate matter sensor
106b
Gas sensor
106c
PWM power control mechanism
106d
Temperature & humidity sensor
108
Air purification unit
108a
Purified air data
108c
Polluted air inlet
108d
Air purifying filter
108b
Purified air outlet
108e
System analyzer
108f
Air pump by DC fan
108h
Air purifier chamber
108g

FIGURE 2

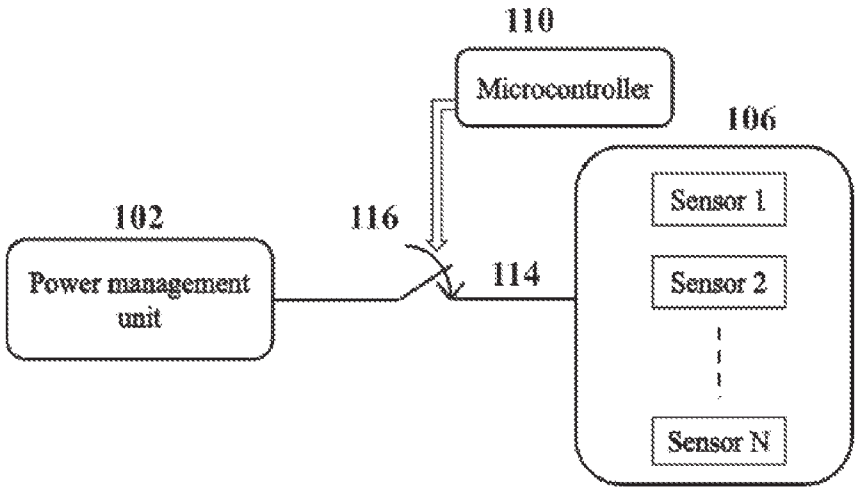
110
Microcontroller
106
Sensor 1
Sensor 2
Sensor N
102
Power management unit
116
114

FIGURE 3

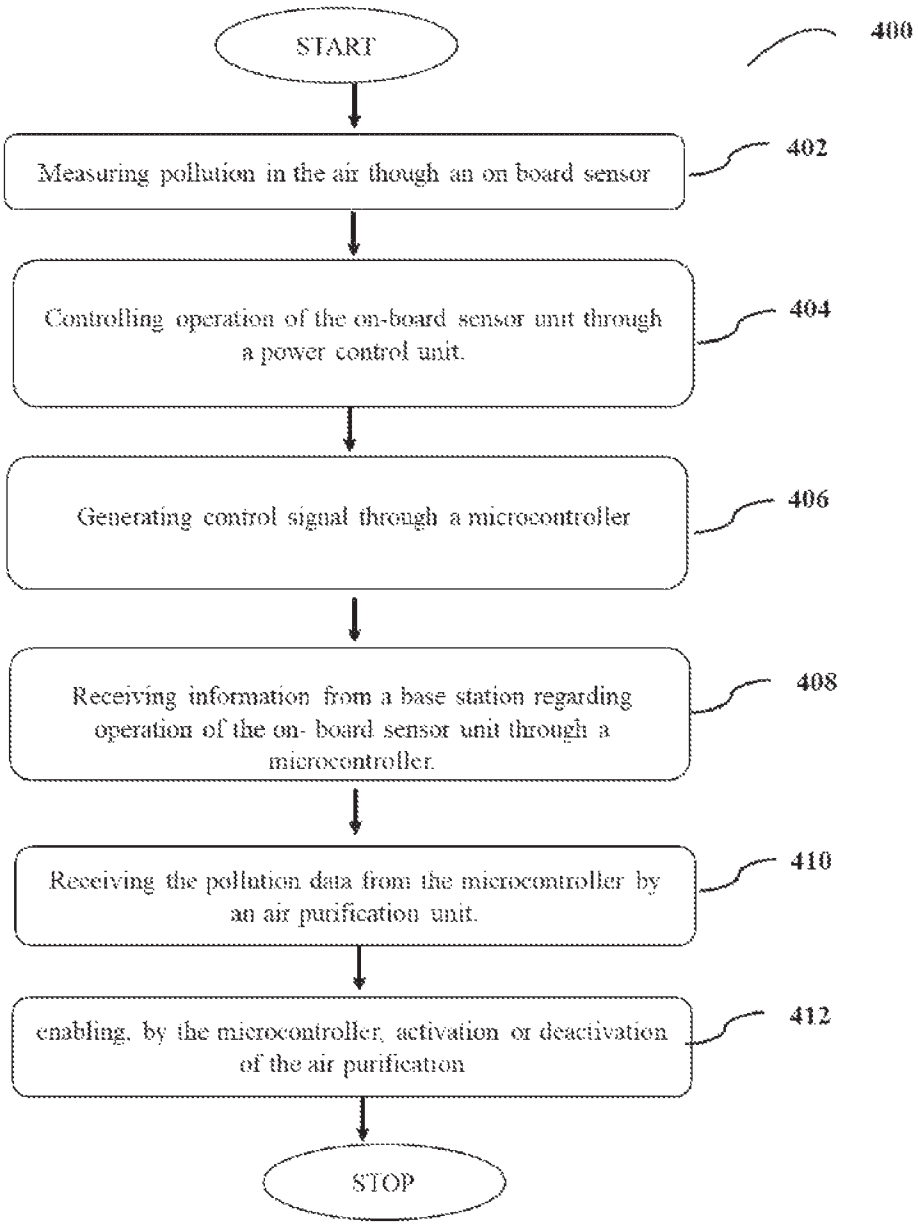
START
400
Measuring pollution in the air though an on board sensor
402
Controlling operation of the on-board sensor unit through a power control unit.
404
Generating control signal through a microcontroller
406
Receiving information from a base station regarding operation of the on- board sensor unit through a microcontroller.
408
Receiving the pollution data from the microcontroller by an air purification unit.
410
enabling, by the microcontroller, activation or deactivation of the air purification
412
STOP

FIGURE 4

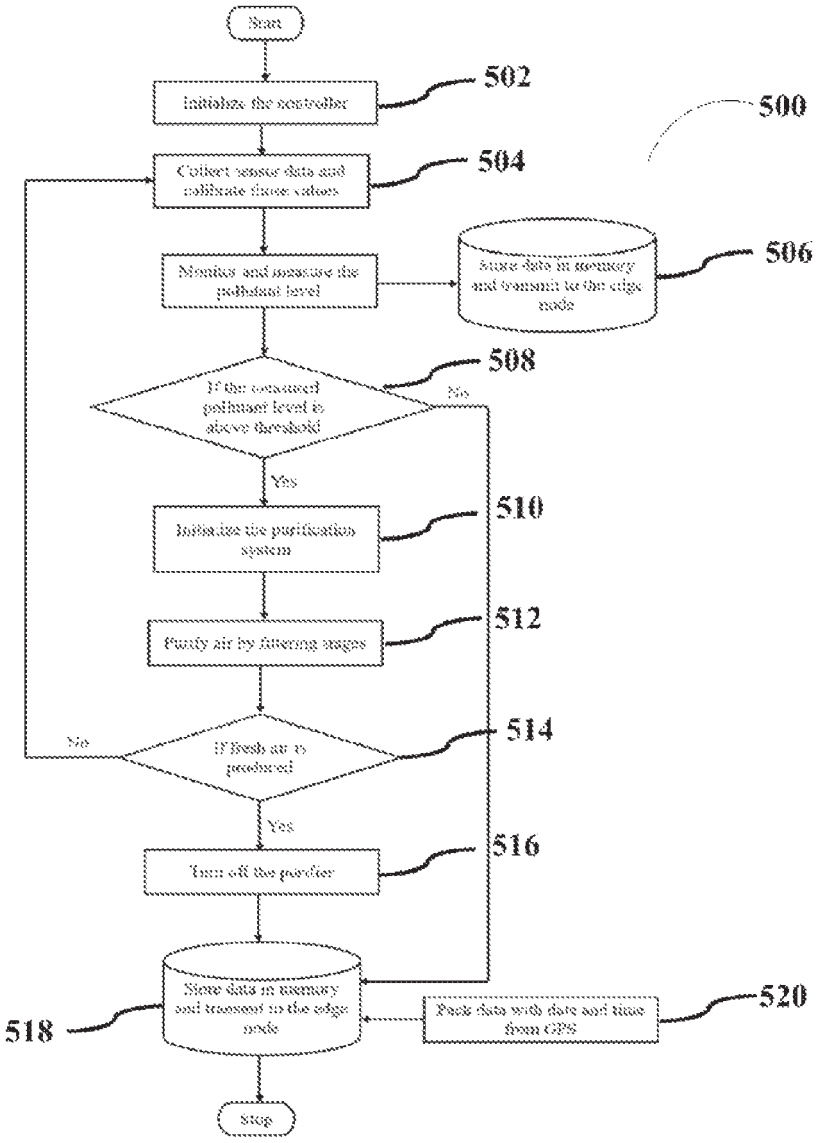
Start
Initialize the controller
502
500
Collect sensor data and calibrate those values
504
Monitor and measure the pollutant level
Store data in memory and transmit to the edge node
506
If the measured pollutant level is above threshold
508
No
Yes
Initialize the purification system
510
Purify air by filtering stages
512
If fresh air is produced
514
No
Yes
Turn off the purifier
516
Store data in memory and transmit to the edge node
518
Pack data with date and time from GPS
520
Stop

FIGURE 5

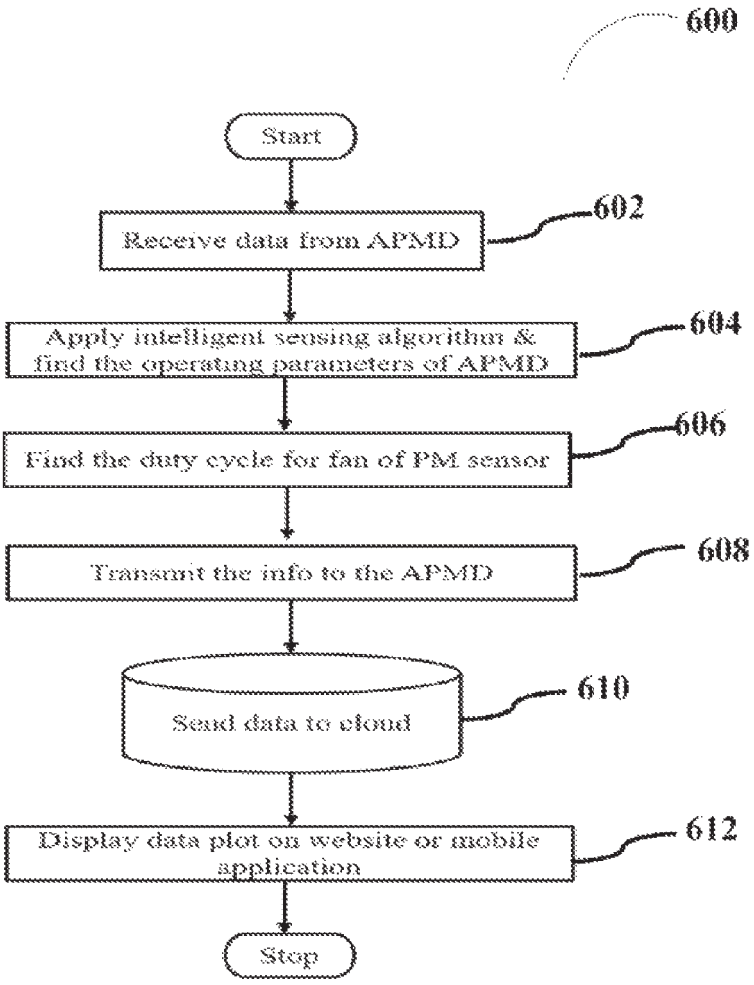
600
Start
Receive data from APMD
602
Apply intelligent sensing algorithm & find the operating parameters of APMD
604
Find the duty cycle for fan of PM sensor
606
Transmit the info to the APMD
608
Send data to cloud
610
Display data plot on website or mobile application
612
Stop

FIGURE 6

POLLUTION MONITORING SYSTEM AND METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS AND PRIORITY

The present application claims priority to Indian application no. 202111043780, filed on Sep. 27, 2021.

TECHNICAL FIELD

The present subject matter described herein, in general, relates to pollution monitoring. More particularly, the present subject matter relates to an air pollution monitoring system and method.

BACKGROUND

Rapid industrial development, urbanization, has increased population and use of vehicles has proportionally increased the pollution levels specially in urban areas. Increased air pollution level is adversely affecting the health of the human and animal. Harmful effects of pollution include mild allergic reactions such as irritation of the throat, eyes and nose as well as some serious problems like bronchitis, heart diseases, pneumonia, lung and aggravated asthma. Thus, there is a need for large scale, fine-granular, and near-real-time pollution sensing along with pollution localization to timely reduce the air pollution levels.

Numerous technologies have been reported to monitor the pollution level. The reported pollution monitoring systems use advanced Internet of Things (IoT) based techniques to detect humidity, temperature, formaldehyde, CO2 and PM2.5. Further, advanced pollution monitoring device includes handheld devices with different applications pollution monitoring devices designed with multiple communication interfaces which include LoRa, NBIoT, RS485 and Wi-fi. The major drawback of these system is use of resistive heating and low battery lifetime. The wearable pollution monitoring sensors developed may be used along with smartphones to monitor environment CO, NO_2, O_3, temperature humidity and barometric pressure are being sensed with mote via Bluetooth. However, these sensors are not energy efficient and have complex system architecture. The battery-operated pollution monitoring system integrated with Bluetooth technologies for communication with cloud server have low communication range and may not be very useful for monitoring pollution over a large-scale area. Further, the pollution server is interfaced with Google Maps to display real time pollution value and further the sensing system may upload the gathered sensor data to the server using mobile network. However, any field testing or validation is not disclosed that may validate the data acquired.

Further, majority of the existing technologies use wi-fi or Bluetooth as the communication interface, which are having low range and consumes high power during communication. This drawback makes the sensor node hard for massive outdoor deployment. For massive deployment of sensor nodes, energy consumption is the major challenge that none of the existing technologies have addressed. Since consumption of PM sensor is typically high due to the high-power consuming fan used in it for inletting air inside the chamber, the Battery powered systems cannot serve this goal efficiently.

SUMMARY

Before the present pollution monitoring system and method is described, it is to be understood that this application is not limited to a particular pollution monitoring system and method, as there may be multiple possible embodiment, which are not expressly illustrated in the present disclosure. It is also to be understood that the terminology used in the description is for the purpose of describing the particular implementations, versions, or embodiments only, and is not intended to limit the scope of the present application. This summary is provided to introduce aspects related to pollution monitoring system and method thereof. This summary is not intended to identify essential features of the claimed subject matter nor is it intended for use in determining or limiting the scope of the claimed subject matter.

In one implementation, a pollution monitoring system is disclosed. The system comprises an on-board sensor unit having a plurality of sensors, configured for monitoring air quality by measuring pollution data in the air and a power control unit connected with the on-board sensor unit for controlling the operation of the on-board sensor unit. The system further comprises a microcontroller configured for generating control signals to be transmitted to the power control unit for controlling the operation of the on-board sensor unit. The microcontroller is configured for receiving information from a base station, regarding operation of the on-board sensor unit at each measurement cycle of measuring the pollution data and the information comprises sampling interval of the on-board sensor unit and number of sensors to be activated from the plurality of sensors in a next measurement cycle. The activation of the number of sensors is identified at the base station based on the pollution data collected by the microcontroller at a previous measurement cycle. Further, an air purification unit configured for receiving the pollution data from the microcontroller and enabling activation or deactivation of the air purification unit based on comparison of the pollution data with predefined threshold values.

In one implementation, a method facilitating pollution monitoring is disclosed. The method comprising measuring, through an on-board sensor unit having a plurality of sensors, pollution data in the air and controlling, through a power control unit connected with the on-board sensor unit, operation of the on-board sensor unit. The method further comprises generating, through a microcontroller, control signals to be transmitted to the power control unit for controlling the operation of the on-board sensor unit and receiving, through the microcontroller, information from a base station, regarding operation of the on-board sensor unit at each measurement cycle of measuring the pollution data. The information comprises sampling interval of the on-board sensor unit and number of sensors to be activated from the plurality of sensors in a next measurement cycle and the activation of the number of sensors is identified at the base station based on the pollution data collected by the microcontroller at a previous measurement cycle and shared with the base station. The method further comprises receiving, by an air purification unit, the pollution data from the microcontroller and enabling, by the microcontroller, activation or deactivation of the air purification unit based on comparison of the pollution data with predefined threshold values.

BRIEF DESCRIPTION OF DRAWING

The foregoing detailed description of embodiments is better understood when read in conjunction with the appended drawings. For illustrating the present subject matter, an example of construction of the present subject

matter is provided as figures; however, the present subject matter is not limited to the specific pollution monitoring system and method thereof.

FIG. **1** illustrates a block diagram of pollution monitoring system, in accordance with an embodiment of the present subject matter.

FIG. **2** illustrates additional details of the pollution monitoring system shown in FIG. **1**, in accordance with an embodiment of the present subject matter.

FIG. **3** illustrates Sensor power management system integrated with the pollution monitoring system, in accordance with an embodiment of the present subject matter.

FIG. **4** illustrates a method facilitating pollution monitoring, in accordance with an embodiment of the present subject matter.

FIG. **5** illustrates flow chart for pollution monitoring system, in accordance with an embodiment of the present subject matter.

FIG. **6** illustrates flow chart for monitoring of the air pollution at the base station, in accordance with an embodiment of the present subject matter.

DETAILED DESCRIPTION

Some embodiments of this disclosure, illustrating all its features, will now be discussed in detail. The words "comprising", "including", "containing", "consisting", and other forms thereof, are intended to be equivalent in meaning and be open ended in that an item or items following any one of these words is not meant to be an exhaustive listing of such item or items, or meant to be limited to only the listed item or items. It must also be noted that as used herein and in the appended claims, the singular forms "a," "an," and "the" include plural references unless the context clearly dictates otherwise. Although any system or method or equivalent to those described herein may be used in the practice, the exemplary pollution monitoring system and method thereof is now described. The disclosed pollution monitoring system and method are merely examples of the disclosure, which may be embodied in various forms.

Various modifications to the embodiment will be readily apparent to those skilled in the art and the generic principles herein may be applied to other embodiments. However, one of ordinary skill in the art will readily recognize that the present disclosure for pollution monitoring system and method is not intended to be limited to the embodiments illustrated but is to be accorded the widest scope consistent with the principles and features described herein.

As disclosed in the background large scale, fine-granular, and near-real-time pollution sensing, and pollution localization are some important requirements for urban and industrial deployments. There are numerous pollution monitoring/controlling devices reported. However, these existing technologies are not energy efficient and having complex system architecture.

The present disclosure is directed to overcome one or more limitations stated above or any other limitation associated with the conventional arts.

In accordance with an embodiment, FIG. **1** illustrates an exemplary block diagram of a pollution monitoring system **100**. The pollution monitoring system **100** will be described in detail by referring to FIG. **1** and FIG. **2** in combination. The pollution monitoring system **100** comprises an on-board sensor unit **106** having a plurality of sensors (**106***a*-**106***d*) (collectively referred as **106**), configured for monitoring air quality by measuring pollution data in the air. The on-board sensor unit **106** comprise a temperature sensor **106***d*, a humidity sensor **106***d*, a gas sensor **106***b*, and a Particulate Matter (PM) sensor **106***a*.

In an embodiment, the pollution monitoring system **100** comprises a power control unit **102** connected with the on-board sensor **106** for controlling the operation of the on-board sensor unit **106**. The power control unit **102** controls the operation of the on-board sensor unit **106** through a control signal generated by a microcontroller **110** and transmitted to the power control unit **102**. The microcontroller **110** is configured to receiving information from a base station **112**, regarding operation of the on-board sensor unit **106** at each measurement cycle of measuring the pollution data. The information received from the base station **112** comprises sampling interval of the on-board sensor unit **106** and number of sensors to be activated from the plurality of sensors (**106***a*-**106***d*) in a next measurement cycle. Further, the activation of the number of sensors (**106***a*-**106***d*) is identified at the base station **112** based on the pollution data collected by the microcontroller **110** at a previous measurement cycle.

In an embodiment control signal comprises a Pulse Width Modulation (PWM) signal applied at a switch to control activation period of the of fan used in the PM sensor **106***c* configured in the on-board sensor unit **106**. The PWM signal is applied according to a duty cycle decided by the base station **112** and the duty cycle is decided according to availability of a rechargeable battery **102***b* powering the pollution monitoring system **100** along with signal reconstruction error threshold determined by the base station **112**. In an embodiment, the PWM signal activates the fan at different duty cycles when the on-board sensor unit **106** measures the pollution data.

Further, the microcontroller **110** is configured to auto-calibrate the pollution data by using a polynomial regressor. One or more coefficients of the polynomial regressor are computed at the base station **112** and the coefficients are updated periodically at the on-board sensing unit **106** according to the control signal.

Still referring to FIG. **1** and FIG. **2** in combination, the pollution monitoring system **100** comprises a power management unit **102** (also referred as a solar power management unit) configured to power the pollution monitoring system **100**. The power management unit **102** comprise a solar panel **102***a*, the rechargeable battery **102***b*, and solar energy harvester **102***c* for harvesting energy from a solar cell (not shown in Figure) configured in the pollution monitoring system **100**. The rechargeable battery **102***b* is configured for storing the energy harvested by the solar energy harvester **102***c*. The solar energy harvester **102***c* stores the energy in the rechargeable battery **102***b*. During daytime the required power is supplied from the solar cell. However, during night, the energy stored at the rechargeable battery **102***b* is used to continue the sensing and transmission operation of the pollution monitoring system **100**.

In an embodiment, the pollution monitoring system **100** comprises an air purification unit **108** configured for receiving the pollution data from the microcontroller **110**. The air purification unit **108** may be further configured to enable activation or deactivation of the air purification unit **108** based on comparison of the pollution data with predefined threshold values. The threshold value depends on the application of the pollution monitoring system **100** in a particular area. For example, the Air Quality Index (AQI) defining the threshold values for healthy living at one place may be considered as 60 while at some other place the AQI may be considered as 50.

In an embodiment, the air purification unit **108** comprises an air inlet **108***c* for receiving polluted air and a system analyzer **108***e* for comparing the pollution data associated with the polluted air with the predefined threshold values defined according to Air Quality Index (AQI). In case the pollution data exceeds the predefined threshold values, the purification system **108** is activated for producing purified air. Further, the purification unit **108** comprise an air purifying filter **108***d* for purifying the polluted air to be supplied to an air pump by a DC fan **108***f* and the polluted air is further supplied to an air purifier chamber **108***h*. The purification unit **108** further comprises a purified air outlet **108***g* for producing the purified air. Once the purified air is produced, the microcontroller **110** turns off the air purification unit **110** and thus saves the power.

In an embodiment, the pollution monitoring system **100** comprises a Global Positioning System (GPS) integrated with the communication unit **104** for tracking location of the pollution monitoring system **100**. The microcontroller **110** transmits the location to the base station **112** and the location is transmitted at end of each ongoing measurement cycle. The GPS module further comprises a memory module configured for storing the pollution data at end of each monitoring cycle. The communication unit **104** may be further configure for establishing communication between the microcontroller **110** and the base station **112** and the communication unit **104** comprises a 5G eMTC protocol NB-IoT **104***a*, a Wi-Fi module **104***c* or a Bluetooth **104***d*.

In an embodiment, the base station **112** is configured for receiving pollution data from the microcontroller **110** at each measurement cycle. Further, the microcontroller **110** is connected to the on-board sensing unit **106** acting as the sensor node configured for measuring the pollution data. The base station **112** further determines the information regarding operation of the sensor node and the information is determined by using an adaptive sensing algorithm. The information comprises sampling interval of the on-board sensor unit **106** and number of sensors to be activated from the plurality of sensors (**106***a*-**106***d*) configured in the on-board sensing unit **106**, in the next measurement cycle. The number of sensors activated is identified based on pollution data collected by the microcontroller **110** at the previous measurement cycle. In an embodiment the information is used by the microcontroller **110** for generating control signals controlling operation of each of the sensor node and an air purification unit **108** connected to the microcontroller **110** for purifying the air.

In accordance with an embodiment, FIG. **3** shows the activation of the sensors (**106***a*-**106***d*) based on the sampling interval. The sensors are activated by applying the PWM signal at the switches connected to a power line **114** of the on-board sensing unit **106**.

In an embodiment the base station **112** is further configured to enable, auto-calibration of the pollution data through the microcontroller **110** by generating coefficients of the polynomial regressor to be used by the microcontroller **110**. Coefficients of the polynomial regressor determined by the base station **112** are updated periodically at the sensor node **106** according to the control signals.

Referring to FIG. **4**, a method **400** facilitating pollution monitoring, is disclosed in accordance with an embodiment of the present subject matter. The method **400** may be described in the general context of computer executable instructions. Generally, computer executable instructions can include routines, programs, objects, components, data structures, procedures, modules, functions, and the like, that perform particular functions or implement particular abstract data types. The method **400** may also be practiced in a distributed computing environment where functions are performed by remote processing devices that are linked through a communications network. In a distributed computing environment, computer executable instructions may be located in both local and remote computer storage media, including memory storage devices.

The order in which the method **400** is described is not intended to be construed as a limitation, and any number of the described method blocks can be combined in any order to implement the method **400** or alternate methods. Additionally, individual blocks may be deleted from the method **400** without departing from the spirit and scope of the subject matter described herein. Furthermore, the method **400** can be implemented in any suitable system hardware, software, firmware, or combination thereof. However, for ease of explanation, in the embodiments described below, the method **400** may be considered to be implemented in the above described system **100**

At block **402**, the on-board sensors unit **106**, having plurality of sensors **106***a*-**106***d* measure the pollution data in the air.

At block **404**, the operations of the on-board sensor unit **106** may be controlled through a power control unit **102** connected with the on-board sensor unit **106**.

At block **406**, the microcontroller **110** generates the control signal to be transmitted to the power control unit **102** for controlling the operation of the on-board sensor unit **106**.

At block **408**, information regarding operation of the on-board sensor unit **106** at each measurement cycle of measuring the pollution data from the base station **112** may be received through the microcontroller **110**.

At block **410**, the air purification unit **108** receives the pollution data from the microcontroller **110**.

At block **412**, the microcontroller **110** enables activation or deactivation of the air purification unit **100** based on comparison of the pollution data with predefined threshold values.

Details of the method **400** are similar to details of the pollution monitoring system **100** and hence are not repeated for the sake of brevity.

In accordance with an exemplary embodiment illustrated in FIG. **5**, at step **502**, in first measurement cycle of measuring the pollution data, the microcontroller **110** is initialized and collects the pollution data from the on-board sensor unit **106** (at step **504**) and the microcontroller **110** calibrates the sensors **106** according to the coefficients calculated at the base station **112**. Further, the on-board sensor unit **106** further monitors and measures the pollution data from the ambient environment, detects the pollution level and store/transmitted data to the edge node via NB-IoT communication channel (at step **506**). If the measured pollutant level is above the threshold level, then the purification unit activates and purifies the air (steps **510**, **512**). At step **516**, the air purification unit **108** is switched off after producing the purified air (shown in **516**). If the air purification unit **108** is not producing the purified air, the pollution monitoring system **100** again starts the measurement cycle of collecting the pollution data and repeats steps **502** to step **510**. Once the purified air is produced, data associated with the purified air (i.e., Air Quality Index of the purified air) is then stored in the memory (shown in step **518**) and is then again transmitted back to the sensor node **106** (also referred as edge node). The data regarding the purified air is associated with a timestamp from GPS (shown in step **520**).

In an embodiment FIG. **6** illustrates the method details towards monitoring of the air pollution at the base station

112 is now discussed. At step **602**, once the pollution data is received from the pollution monitoring system **100**, the edge node applies learning based intelligent sensing algorithm to find optimum operating parameter like, sampling period of the sensors, optimal sensor set and length of measurement cycle for the pollution monitoring system **100** (shown in step **604**). The optimum operating parameter are then shared with the microcontroller **106** for generating the control signals. As shown on step **606**, to find the optimal duty cycle of the fan of PM sensor **106***d* optimization function is solved at the edge node based on the tradeoff between the error and the energy available at the pollution monitoring system **100**. At step **608**, the information regarding duty cycle is then transmitted back to the pollution monitoring system **100**. After transmitting the information to the microcontroller **106**, the base station **112** sends all the pollution data to a cloud server for further analysis **610**. The pollution data may be accessed from a web browser or mobile application and may also be displayed on a mobile device (as shown in step **612**).

In an embodiment, the disclosed pollution monitoring system **100** consumes in the range 40 mW-50 mW and may be further reduced with incorporation of edge computing aided multivariate learning framework at the sensor nodes. In contrast, the commercially available pollution monitoring systems are much higher power consuming, in the range 2 to 3 W.

Exemplary embodiments discussed above may provide certain advantages. Though not required to practice aspects of the disclosure, these advantages may include those provided by the following features.

Some embodiments of the pollution monitoring system **100** may optimize the power consumption of the PM sensor.

Some embodiments of the pollution monitoring system **100** may enable estimation of duty cycle by solving trade off the energy available at the battery of the APMD and the signal reconstruction error.

Some embodiments of the pollution monitoring system **100** may enable stronger communication over the long range.

The invention claimed is:

1. A pollution monitoring system, comprising:

an on-board sensor unit having a plurality of sensors, configured for monitoring air quality by measuring pollution data in the air;

a power control unit connected with the on-board sensor unit for controlling the operation of the on-board sensor unit;

a microcontroller configured for generating control signals to be transmitted to the power control unit for controlling the operation of the on-board sensor unit, the microcontroller is configured for:

receiving information from a base station, regarding operation of the on-board sensor unit at each measurement cycle of measuring the pollution data, wherein the information comprises a sampling interval of the on-board sensor unit and a number of sensors to be activated from the plurality of sensors in a next measurement cycle, wherein the activation of the number of sensors is identified at the base station based on the pollution data collected by the microcontroller at a previous measurement cycle; and

an air purification unit configured for:

receiving the pollution data from the microcontroller; and

enabling activation or deactivation of the air purification unit based on comparison of the pollution data with predefined threshold values.

2. The pollution monitoring system as claimed in claim **1**, wherein the on-board sensor unit comprises a temperature sensor, a humidity sensor, a gas sensor, and an on-board particulate matter sensor.

3. The pollution monitoring system as claimed in claim **1**, wherein the control signal comprises a pulse width modulation signal applied at the switch to control activation period of a fan used in the particulate matter sensor configured in the on-board sensor unit, wherein the pulse width modulation signal is applied according to a duty cycle decided by the base station, wherein the duty cycle is decided according to availability of a rechargeable battery powering the pollution monitoring system and signal reconstruction error threshold determined by the base station;

wherein the pulse width modulation signal activates the fan at different duty cycles when the on-board sensor unit measures the pollution data.

4. The pollution monitoring system as claimed in claim **1**, wherein the microcontroller is configured for:

auto-calibrating the pollution data by using a polynomial regressor, wherein coefficients of the polynomial regressor are computed at the base station and wherein the coefficients are updated periodically at the on-board sensing unit according to the control signals.

5. The pollution monitoring system as claimed in claim **1**, comprising:

a GPS module for tracking location of the pollution monitoring system, wherein the location is transmitted to the base station through the microcontroller, wherein the location is transmitted after the deployment of the pollution monitoring system to learn its exact geographic location;

a memory module configured for storing the pollution data at end of each monitoring cycle; and

a communication unit configured for establishing communication between the microcontroller and the base station, wherein the communication unit comprises a 5GeMTC protocol NB-IoT, a Wi-Fi module, or a Bluetooth.

6. The pollution monitoring system as claimed in claim **1**, comprising:

a power management unit powering the pollution monitoring system, wherein the power management unit comprises:

a solar cell connected to the pollution monitoring system;

a solar energy harvester for harvesting energy from the solar cell; and

a rechargeable battery for storing the energy harvested by the solar energy harvester.

7. The pollution monitoring system as claimed in claim **1**, wherein the air purification system comprises:

an air inlet for receiving polluted air;

a system analyzer for comparing the pollution data of the polluted air with the predefined threshold values, wherein the air purification unit is activated for producing purified air in case the pollution data is more than the predefined threshold values defined according to air quality index;

an air purifying filter for purifying the polluted air to be supplied to an air pump by a DC fan, wherein the polluted air is further supplied to an air purifier chamber; and

a purified air outlet for producing the purified air, wherein the microcontroller turns off the air purification unit after production of the purified air.

8. The pollution monitoring system as claimed in claim **1**, wherein the base station is configured for:

receiving pollution data from the microcontroller at each measurement cycle, wherein the microcontroller is connected to an on-board sensing unit acting as a sensor node configured for measuring the pollution data;

determining information regarding operation of the sensor node, wherein the information is determined by using an adaptive sensing algorithm wherein the information comprises sampling interval of the on-board sensor unit and number of sensors to be activated from the plurality of sensors configured in the on-board sensing unit, in a next measurement cycle, wherein the activation of the number of sensors is identified based on pollution data collected by the microcontroller at a previous measurement cycle;

wherein the information is used by the microcontroller for generating control signals controlling operation of each of the sensors and an air purification unit connected to the microcontroller for purifying the air.

9. The pollution monitoring system as claimed in claim **1**, wherein the base station is configured for:

enabling auto-calibration of the pollution data by the microcontroller by generating coefficients of a polynomial regressor to be used by the microcontroller, wherein the coefficients are updated periodically at the sensor node according to the control signals.

10. A method facilitating air pollution monitoring, the method comprising:

measuring, through an on-board sensor unit having a plurality of sensors, pollution data in the air;

controlling, through a power control unit connected with the on-board sensor unit, operation of the on-board sensor unit;

generating, through a microcontroller, control signals to be transmitted to the power control unit for controlling the operation of the on-board sensor unit;

receiving, through the microcontroller, information from a base station, regarding operation of the on-board sensor unit at each measurement cycle of measuring the pollution data, wherein the information comprises a sampling interval of the on-board sensor unit and a number of sensors to be activated from the plurality of sensors in a next measurement cycle wherein the activation of the number of sensors is identified at the base station based on the pollution data collected by the microcontroller at a previous measurement cycle and shared with the base station;

receiving, by an air purification unit, the pollution data from the microcontroller; and

enabling, by the microcontroller, activation or deactivation of the air purification unit based on comparison of the pollution data with predefined threshold values.

11. The method as claimed in claim **10**, wherein the control signal comprises a pulse width modulation signal applied at the switch to control the activation period of a fan used in the particulate matter sensor configured in the on-board sensor unit, wherein the pulse width modulation signal is applied according to a duty cycle decided by the base station, wherein the duty cycle is decided according to availability of a rechargeable battery powering the pollution monitoring system and signal reconstruction error threshold determined by the base station;

wherein the pulse width modulation signal activates the fan at different duty cycles when the on-board sensor unit measures the pollution data.

12. The method as claimed in claim **10**, comprising:

auto-calibrating, through the microcontroller, the pollution data by using a polynomial regressor, wherein coefficients of the polynomial regressor are computed at the base station and wherein the coefficients are updated periodically at the on-board sensing unit according to the control signals.

13. A method as claimed in claim **10**, the method comprising:

receiving, at a base station, pollution data from a microcontroller at each measurement cycle, wherein the microcontroller is connected to an on-board sensing unit acting as a sensor node configured for measuring the pollution data; and

determining, at the base station, information regarding operation of the sensor node, wherein the information is determined by using an adaptive sensing algorithm, wherein the information comprises sampling interval of the on-board sensor unit and number of sensors to be activated from the plurality of sensors in a next measurement cycle, wherein the activation of the number of sensors is identified at the base station based on pollution data collected by the microcontroller at a previous measurement cycle;

wherein the information is used by the microcontroller for generating control signals controlling operation of each of the sensor node and an air purification unit connected to the microcontroller for purifying the air.

14. The method as claimed in claim **13**, comprising:

enabling auto-calibration of the pollution data by the microcontroller by generating coefficients of a polynomial regressor, wherein the coefficients are updated periodically at the sensor node according to the control signals.

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