

## Review on Optimised Environmental Data Acquisition Technique for Monitoring Air Quality and Crop Plantation for Developing a Smart City Using LoRa Network

Twinkle H. Agrawal<sup>1</sup>, Assi. Prof. Sunil Kuntawar<sup>2</sup>

<sup>1</sup>Department of Electronics and Communication, Ballarpur Institute of Technology Ballarpur, India

<sup>2</sup>Department of Electronics and Communication, Ballarpur Institute of Technology Ballarpur, India

---

**Abstract:** Progressions in low power and ease calculation and correspondence innovation have gotten an upset remote detecting and checking applications. As of now, there are many contending gauges and advances endeavoring to take a hold of WSN, particularly the zone of remote detecting and correspondence innovation. LoRa Network is one of these advancements picking up ubiquity in the use of Wireless Sensor Networks (WSNs). The capacity of LoRa Network to build up correspondence connects over long separations with generally basic hubs, negligible foundation, low power prerequisites and usage of permit free ISM groups give it an extensive edge of its rivals. In spite of the fact that a great deal of research work has been done about the adequacy of LoRa Network for low power remote sensor systems, there are still holes in the writing about the reasonable parts of structure and execution of such frameworks. This venture centers around issue of actualizing a limited sensor organize for a keen air quality investigation and yield estate framework for a brilliant city application utilizing LoRa Network as the fundamental correspondence innovation. A framework for checking air nature of the earth and yield estate is executed utilizing minimal effort arrangements accessible in the market.

**Keywords:** LaRa WSN, Low-Power Networks

---

Date of Submission: 22-06-2019

Date of acceptance: 05-07-2019

---

### I. Introduction

With the headway in processing innovation in the ongoing decades, smaller, low power and economical microchips have pushed the enthusiasm for continuous gadgets. This brought about a requirement for vigorous, low power and adaptable correspondence conventions to suit the necessities of constant applications in both urban and provincial situations. Ongoing gadgets must most likely work on battery control for extensive stretches of time. A system of such gadgets can be utilized to screen and report different physical and ecological factors like weight, dampness, temperature, sound, movement and so on. These alleged 'Remote Sensor Networks' or WSNs can gather information from a wide zone and report to a focal sink where it tends to be transferred to the showing gadgets and examined. In a couple of years, there could be as much as a billion WSNs 14 associated with the web at the same time. Clearly, there is a requirement for a foundation less correspondence convention to suit these necessities. The OECD (Organization for Economic co-operation and Development) appraises the monetary expense of air contamination to be \$1.72T (in OECD part nations). Air contamination is in charge of a wide scope of ailments. Current air contamination observing frameworks comprise of costly stations that measure a constrained scope of parameters. As a result of the staggering expense of these stations, it isn't functional for urban communities to quantify air quality over a boundless region in detail. Thus, urban areas normally don't have the sort of estimating framework set up to actualize better air quality projects. By executing an air contamination observing arrangement traded off of sensors and entryways installed with LoRa Network Technology and a clever low power wide zone organize dependent on the LoRa Network convention, urban areas can all the more likely measure quality and give the kind of information important to drive change for their natives. Yield estate is the most imperative segment of India economy which assumes a definitive job in financial improvement of any city. As indicated by the ongoing reports, around 70-80% of rural ozone depleting substance discharges, for example, nitrous oxide originates from use of nitrogen manures. So one must apply the required measure of nitrogen compost in the wake of knowing the prerequisite of the yields. Indeed, even the providing water to rural fields ought to be in controlled way with the goal that it won't wash away the minerals added to soil just as cause soil disintegration. All these require continuous observing to the horticultural field and yield development. Henceforth it requires utilization of present day procedures in rural fields which helps in progress of yield profitability with adequate utilization of assets.

## **II. Literature Review**

Goal of this work is to build up air contamination estimation and forecast framework for a shrewd city which stores the information in the cloud. Cloud information is utilized for information examination which can be utilized for taking the choice to limit contamination and diminish the impact of contamination on condition. Since advanced mobile phones and portable applications have reformed the human life, same work can be incorporated to versatile applications. In future, different gas sensors for nitrogen dioxide and sulfur dioxide and clamor level observing additionally could be incorporated. Urban air contamination rate has developed to disturbing state over the India. The vast majority of the urban communities are confronting issue of poor air quality which neglects to fulfill guidelines of air for good wellbeing. It is to be sure important to build up an air contamination estimation and expectation framework for a shrewd city. This proposed work procures carbon dioxide and carbon monoxide level noticeable all around alongside Global Positioning System (GPS) area by utilizing contamination recognition sensor and transfers into Azure cloud administrations. Minimal effort installed Beagle bone board alongside gas sensors are utilized for information securing. Microsoft's Azure Machine learning administration is utilized to foresee the contamination measurements with the assistance of past information. Handled information is gotten and spoken to by Power BI apparatus. Aligned gas sensor information is brought from sensors and effectively transferred into cloud. Information put away in cloud is used by various cloud administrations to make the information significant. Proposed framework is executed and helpful to screen and lessen the contamination in a keen city by keeping away from the contamination cause [1].

Horticulture assumes an imperative job in development of Indian economy, consequently strategies for improving harvest yield assumes a critical job. The above work encourages one to screen the measure of NPK present in the dirt and its dampness content. In this way, above work gives an answer for increment the yield of harvests utilizing current innovation of sensors and LoRa. The data acquired from sensors is investigated and data with respect to measure of supplements and water required by yields is given to end client utilizing email and portable. The utilization of LoRa Technology covers substantial geological land with low power utilization. In this manner, expanding the productivity of activity. This work helps remote observing of fields to ranchers just as helps increment in yield. As a major aspect of future work automatons can be utilized to cover bigger geological zone and gather information from generous number of hubs and transfer it to cloud for remote observing. Farming is the broadest monetary part and assumes a key job in the generally speaking financial advancement of country. There are numerous issues identified with ranchers which dependably hamper the course of our advancement. A standout amongst the best answers for handle these issues is to urge ranchers to utilize present day systems as they help in expanding farming efficiency and chop down the information cost. This paper proposes, answer for measure minerals present in rural land, for example, nitrogen, phosphorous, and potassium just as mugginess, soil dampness and temperature utilizing sensors, LoRa and Cloud innovation. The information acquired from the sensors will be gathered into the cloud database which will be utilized to offer data to end client. The methodology utilizes the blend of LoRa and distributed computing that advances the quick improvement of horticultural modernization and acknowledges shrewd answer for agribusiness and productively comprehend the issues identified with ranchers from a remote area [2].

We displayed a thorough report on the plausibility of the LoRaWAN organization for vast city checking applications. Two practical system organizations for the Greater London territory dependent on the prerequisites of air quality and blockage checking have been recreated. The test system is then used to assess the specialized execution of the system. The outcomes demonstrated the capability of LoRaWAN as a functional low power long range ICT answer for savvy urban communities. We additionally done a short monetary examination and created plans of action for the planned LoRa WAN considering distinctive speculation return plans. We imagine that LoRa will be an energizing innovation zone for keen urban communities for a long time to come [3].

In this work, we concentrated on the utilization of remote sensor systems for air contamination checking and specifically the location of limit intersections. We tended to the sending issue and proposed two enhancement models guaranteeing contamination inclusion and system network with the base expense. In contrast to the lacking related works, which depend on a basic and conventional discovery show, we dependent on barometrical scattering displaying to consider the idea of the tended to marvel. We like wise proposed in the second model a joint detailing of inclusion and network dependent on streams, which diminishes the computational weight as per our reproduction results. We assessed the effect of the parameters of the models on the organization results and concentrated the effect of the climate situations set on the inclusion quality. Air contamination has turned into a noteworthy issue of present day megalopolis in view of modern outflows and expanding urbanization alongside automobile overloads and warming/cooling of structures. Checking urban air quality is along these lines required by regions and by the common society. Current checking frameworks depend on reference detecting stations that are exact however huge, expensive and along these lines

only here and there. In this paper, we center on an option or integral methodology, with a system of minimal effort and autonomic remote sensors, going for a better spatiotemporal granularity of detecting. Conventional arrangement models of the writing are not adjusted to the stochastic idea of contamination detecting. Our fundamental commitment is to plan whole number direct programming models that process sensor arrangements catching both the inclusion of contamination under time-differing climate conditions and the availability of the framework. We assess our sending models on a genuine informational index of Greater London. We break down the execution of the proposed models and demonstrate that our joint inclusion and availability detailing is tight and smaller, with a sufficiently sensible execution time. We likewise lead broad reenactments to infer building experiences for successful organizations of air contamination sensors in an urban situation [4].

Air quality is a vital issue that straightforwardly influences human wellbeing. In this paper, we have introduced the advancement of air contamination discovery sensors dependent on the NB-IoT organize for savvy urban communities. The framework improvement comprises of the air identification sensors, microcontroller, NB-IoT module, database and web observing. The constant information are checked, for example, the carbon dioxide: CO, ozone: O<sub>3</sub>, particulate issue: PM<sub>10</sub>, nitrogen dioxide: NO<sub>2</sub>, and sulfur dioxide: SO<sub>2</sub> in Sai Mai District, Bangkok, Thailand. These sensors expend little power and are extremely precise. Also, the information handling is sent by means of NB-IoT module for air interface with LTE organizes. For the information preparing, the microcontroller is utilized both Adriano MEGA 2560 and Raspberry Pi 3 so as to test the information on web of observing. As of now, air contamination is a major issue for individuals wellbeing in urban areas that experienced the more factors, for example, the traffic, modern, or timberland fire or dirtied skies. This paper displays an improvement of air contamination recognition sensors and observing for shrewd city, Thailand 4.0. The advancement is structured by utilizing five standard sensors, for example, carbon dioxide: CO, ozone: O<sub>3</sub>, particulate issue: PM<sub>10</sub>, nitrogen dioxide: NO<sub>2</sub> and sulfur dioxide: SO<sub>2</sub> separately, and web screen demonstrates the diagram of the air quality list (AQI). To screen the air quality, the information handling is registered by utilizing Adriano MEGA 2560 and Raspberry Pi 3 to interface with Narrowband Internet of Things (NB-IoT) module organize. Test setup, the estimation area is inspected at Sai Mai District, Bangkok. As the outcome, we found that the AQI dimension of estimated area is great air quality. We accentuate that the observing of air contamination in savvy urban areas is critical [5].

In this paper, we built up a Nonlinear Principle Component Analysis (NPCA) based Exponentially Weighted Moving Average (EWMA) - generalized likelihood ratio (GLRT) for FD of an AQMN: air quality monitoring network. The goal of the NPCA-based GLRT is to manage nonlinear case to additionally improve the checking execution of the PCA-dependent on the blend of EWMA and GLRT strategy. In the created method, NPCA show is built utilizing nonlinear capacity, and afterward EWMA-GLRT is connected utilizing this model to upgrade the deficiency identification capacities. The created NPCA-based EWMA-GLRT strategy has indicated improved discovery with lower FAR and MDR, when contrasted with established PCA procedure. Air contamination in urban zones could be considered as a standout amongst the most risky kinds of contamination that can cause sway wellbeing and the environment. Thus, observing air quality systems have enthralled the enthusiasm of different research examines. In this unique circumstance, this paper manages Fault Detection of an Air Quality Monitoring Network. The proposed methodology depends on nonlinear central segment investigation to adapt to demonstrating of nonlinear information. Moreover, the issue discovery would be improved by joining exponentially weighted moving normal with speculation testing method: summed up probability proportion test. The assessment was completed on an Air Quality Monitoring Network (AQMN). The outcomes uncovered great outcomes contrasted with the established PCA [6].

In this paper, a programmed checking framework for air contamination with basic tasks, little size, and ease is structured, reproduced and created. It can identify the temperature, mugginess, and particulate issue, whose qualities are shown on the LCD, and the comparing light alarm flags and sound alarm signals are discharged when the deliberate qualities are past their sheltered reaches. A great deal of reasonable aptitudes about the computerized sensor, simple sensor, single-chip microcomputer, A/D converter, LCD show, and bell circuit have been obtained. The equipment test includes the utilization of millimeter, and the product configuration includes the use of Keil programming and Proteus reenactment. These days, existing air checking stations depend on cumbersome and costly instruments introduced in constrained regions. This compact sensor can identify encompassing air contamination progressively, which can be generally utilized in the family or individual observing of air contamination in some private spots. There is likewise some further work should be possible on this structure. Another residue sensor with higher affectability could be received to build the dependability of this gadget. Notwithstanding PM<sub>2.5</sub>, there are likewise numerous gases that reason air contamination, for example, NO, SO<sub>2</sub>, O<sub>3</sub>, and VOC, which could likewise be distinguished in the later plan. Air contamination is turning into an undeniably major issue, prompting numerous natural issues, for example, the haze fog climate marvel, which can make extraordinary damage human wellbeing. This paper centers around the plan and manufacture of a compact tactile

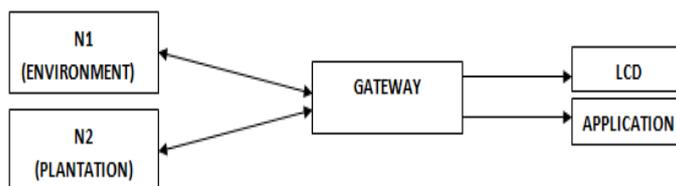
framework for air contamination observing, which can identify the temperature, moistness and particulate matter (PM). This will be utilized as a device to help diminish the mischief of air contamination on individuals. This sensor fundamentally comprises of a miniaturized scale modified control unit, a temperature and humidity sensor DHT11, a dust sensor GP2Y1010AU0F, LCD, keys and, LEDs. Surrounding dust fixations, temperature and mugginess esteems will be shown on the LCD. The relating light alarm flags and sound alarm signals are sent when the deliberate qualities are past their protected extents [7].

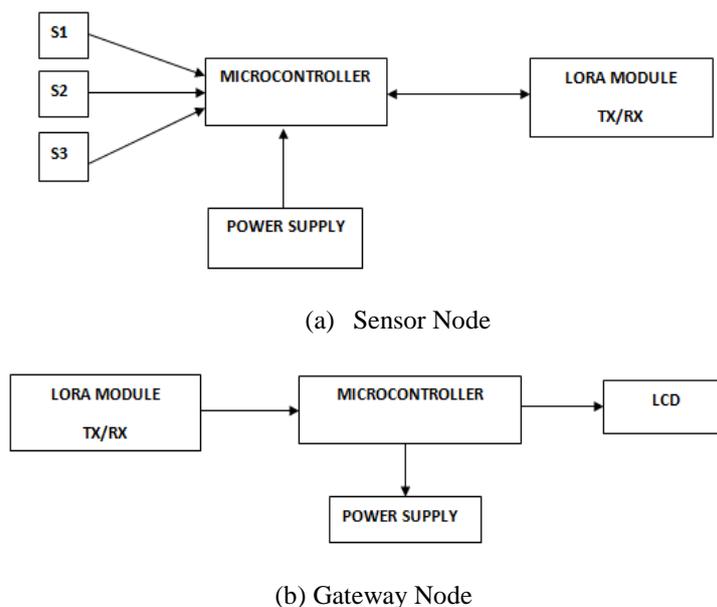
People are viewed as in charge of this dirtied and risky condition. This is a noteworthy worry for the entire world. Therefore, a keen method to screen the different natural parameters utilizing a Raspberry Pi module has been talked about in this paper. The idea of IoT improves the nature of air; screen the dimension of commotion, temperature and dampness. It is a minimal effort, exact and proficient technique for checking. The checking of aggregated information in the distributed storage breaks down the different examples in the ecological parameters and likewise tells the general population. In ongoing day situation, the unremitting increment in air and sound contamination end up being a disturbing issue. It has turned out to be obligatory to control and suitably screen the circumstance with the goal that the expected strides to check the circumstance can be embraced. In this task, an IOT-based strategy to screen the Air Quality Index and the Noise Intensity of a district, have been proposed. The prescribed innovation includes four modules specifically, the Air Quality Index Monitoring Module, the Air Quality Index Monitoring Module, the Cloud-based Monitoring Module and the Anomaly Notification Module. Right off the bat, the Air Quality Index is estimated considering the nearness of the five criteria air contaminations. At that point the sound force is recognized utilizing separate sensor. From that point onward, the Cloud-based Monitoring Module guarantees the way toward obtaining the information with the assistance of Wi-Fi-module present in Raspberry Pi which satisfies the target of investigation of data on a periodical premise. At last, the Anomaly Notification Module alarms the client if there should be an occurrence of an undesired condition [8].

After the various study and literature survey, Air pollution monitoring and good air quality are the important aspects to be considered as a research topic. With various studies, we conclude monitoring of air pollutants in Bengaluru city is limited with few of the pollutants like SO<sub>2</sub>, NO<sub>2</sub>, NH<sub>3</sub>, and PM Etc. But the major air pollutant which is the main source of metro cities CO and CO<sub>2</sub> is neither measured nor mentioned. Using WSN technology to monitor the exact concentration of carbon dioxide CO<sub>2</sub> and other pollutants of air in the ambient of metro cities is the major challenge. Deploying a sensor node at wide area to sense the various other pollutants including CO<sub>2</sub> and SPM present in the air at urban level is the next work to be carried out. Using a high efficiency communication protocols along with sensor network to achieve accurate data in real time and processing of them is done at next level. Advanced studies in the technology of sensor network and wireless communications have contributed a wide range of applications of wireless sensor network in environmental monitoring and pollution control. Pollution detection and pollution control are the major Research issue in today's world. We discuss here a detailed study on ambient air pollution monitoring and air quality in metro cities using sensor nodes in a wireless sensor network. This paper mainly focuses on how a sensor network is used in a wide range to monitor the levels of air pollutants such as CO<sub>2</sub>, NO, SO<sub>2</sub>, PM, NH, and other toxic gases present in an urban ambient place where a major human activities and industrial activities takes place. Role of WSN in air pollution monitoring involves deployment of sensor nodes in a large scale at very low cost and to collect the real-time data and produce accurate results. This paper carries a detailed survey work on major contribution of several authors towards air pollution monitoring and determines the air pollutants in several methods using sensor network technology. This work is helpful to forecast and send the warning to the public [9].

### III. Proposed Work

The working of this savvy city application is basically founded on the remote correspondence between the sensors and different gadgets. Subsequently for proficiency reason we are utilizing LoRa Network system, which will give effective and streamlined outcomes. The goal of this venture is to fabricate a savvy city with less multifaceted nature, enhanced power supply, spending well-disposed and proficient aftereffect of correspondence organize.





**Fig.1** Block Diagram of System (a) Sensor node (b) Gateway Node

Here to recognize the climatic parameters we are setting remote sensors which will take note of the contamination gases like carbon mono oxide, methane, butane, alkali, hydrogen sulfide gases, and smoke. We are going to utilize soil dampness and temperature sensor to detect the dampness in the dirt. Subsequent to recording the information it will send to the passage where the ace is available. We are utilizing ESP32 microcontroller as the ace. ESP32 is a progression of minimal effort, low – control framework on chip microcontrollers with incorporated Wi-Fi and double mode Bluetooth. Information gathered from different sensors will be then prepared to create the outcomes. This created data is then shown on the LCD. SX1728 is the LoRa Network module we are going to use for exchanging information starting with one hub then onto the next. We are been utilizing 3 such modules for correspondence reason. The advantage of utilizing this is it has long range for powerful correspondence; around 11kms of WAN territory it can successfully convey the information. The power supply is additionally least. This is how we are getting along to build up a system to recognize the air quality and contamination noticeable all around, and dampness of the dirt so that at whatever point the dampness content is low we can supply the water to the dirt. Soil temperature sensor will help in holding within proper limits the temperature the city and further advances can be taken to keep up the temperature of the city for a savvy city improvement.

### Comparison & Proposed Methodology

Technology	Regarding Work
Beagle bone black is used along with gas sensors [1]	CO, CO <sub>2</sub> content in air will be shown by Azure cloud service.
LORA network is used to note the mineral content of the soil including moisture and humidity [2]	Nitrogen, Potassium, Phosphorous, humidity and moisture of soil will be shown by email in mobile.
LORAWAN is used to monitor air in 2 cities [3]	Air quality of 2 cities is compared
Integer linear programming modules are used to compute sensor department [4]	Coverage of pollution under time varying weather condition.
NB-IOT network ( Narrow Band –IOT ) [5]	AQI (Air Quality Index) level of measured location.
NPCA ( Non-Linear Principle Component Analysis ) based EWMA ( Exponentially Weighted Moving Average ) GLRT (Generalized Likelihood Ratio Test) [6]	Fault detection of AQMN (Air Quality Monitoring Network).
Keil programming, Proteus software [7]	NO, SO <sub>2</sub> , O <sub>3</sub> temperature humidity
IOT based Raspberry Pi module [8]	Noise, temperature, humidity.
WSN technology is used to monitor content of hazardous gases [9]	CO <sub>2</sub> , NO, SO <sub>2</sub> , PM, NH

### IV. Conclusion

We have demonstrated an upgraded natural information acquisition method by utilizing LoRa Network arrangement for expansive city checking applications. WAN system arrangements for observing the air quality and soil temperature and dampness substance of a district have been reproduced. The test systems are then used to assess the specialized execution of the system. The outcomes demonstrated the capability of LoRa

Network as a functional low power long range ICT answer for shrewd urban areas. We imagine that LoRa Network will be an energizing innovation zone for savvy urban communities for a long time to come.

### References

- [1] Nitin Sadashiv Desai, John Sahaya Rani Alex "IoT based air pollution monitoring and predictor system on Beagle Bone Black" 2017 IEEE.
- [2] Sushmita Tapashetti, Dr. Shobha K.R. "Precision Agriculture using LoRa" International Journal of Scientific & Engineering Research, Volume 9, Issue 5, May-2018.
- [3] Fanghao Yu, Ziming Zhu, Zhong Fan "Study on the feasibility of LoRa WAN for smart city applications" 2017 Tenth IEEE International Workshop on Selected Topics in Mobile and Wireless Computing.
- [4] Ahmed Boubriima, Walid Bechkit and Hervé Rivano "Optimal WSN Deployment Models for Air Pollution Monitoring" 2017.2658601, IEEE Transactions on Wireless Communications.
- [5] Sarun Duangsuwan, Aekarong Takarn, Punyawit Jamjareegulgarn "A Development on Air Pollution Detection Sensors based on NB-IoT Network for Smart Cities" The 18th International Symposium on Communications and Information Technologies (ISCIT 2018).
- [6] Raoudha Baklouti, Ahmed Ben Hamida, Majdi Mansouri, Mohamed-Faouzi HARKAT, Mohamed Nounou, Hazem Nounou "Effective Monitoring of an air quality network" 4th International Conference on Advanced Technologies For Signal and Image Processing ATSIP2018 March 21-24, 2018 Sousse, Tunisia.
- [7] Xuan Zhao, SimingZuo, Rami Ghannam, Qammer H. Abbasi and Hadi Heidari "Design and Implementation of Portable Sensory System for Air Pollution Monitoring" 2018 IEEE Asia Pacific Conference on Postgraduate Research in Microelectronics and Electronics.
- [8] Arnab Kumar Saha, Sachet Sircar, Priyasha Chatterjee, Souvik Dutta, Anwesha Mitra, Aiswarya Chatterjee, Soumyo Priyo Chattopadhyay, Himadri Nath Saha "A Raspberry Pi Controlled Cloud Based Air and Sound Pollution Monitoring System with Temperature and Humidity Sensing" ©2018 IEEE.
- [9] Nagaraj S, Dr. Rajashree V. Biradar "Applications of Wireless Sensor Networks in the Real-Time Ambient Air Pollution Monitoring and Air Quality in Metropolitan Cities- A Survey" 2017 IEEE.

Twinkle H. Agrawal. " Review on Optimised Environmental Data Acquisition Technique for Monitoring Air Quality and Crop Plantation for Developing a Smart City Using LoRa Network." IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) 14.3 (2019): 16-21.