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ATMOSPHERIC MONITORING SYSTEM – A REVIEW OF CURRENT STANDING

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Abstract

This paper takes a critical review of different technologies and principles that are involved in atmospheric monitoring. It went further to look at some exiting embedded systems that are associated with atmospheric monitoring and their limitations. The motive behind this paper is to trace and to establish the progress made so far in this domain in order to be able to unveil areas of further research in atmospheric monitoring. This is crucial because atmospheric pollution is an important issue that has severe effects. The effects of pollution are detrimental to the life and health of people. It was discovered that there are many advanced systems that might be able to monitor more atmospheric parameters. However, it was seen that most of these existing systems usually generalize their measurements over a very large area such as, monitoring real time parameters for a metropolitan area or large suburbs using few observation points. Furthermore, Most of these existing systems seem not to automatically monitor multiple types of air quality parameters at the same time. They seem not to monitor specifically combustible and toxic gases and at the same time monitor the atmospheric conditions such as temperature, humidity and heat Index. This makes getting the whole picture in terms of harmful particles, gases, temperature and humidity very difficult. To provide better solutions to the problem of atmospheric pollution, it is essential to use devices to identify the source of each pollution discharge accurately. Embedded system monitoring approaches to atmospheric monitoring would provide the remote atmospheric pollutant concentration monitoring platform needed. This type of systems would facilitate the cost effective collection of data over time and, to some extent, negate the need for sample, collection, handling, and transport to a laboratory, either on-site or off-site.

Keywords: Atmospheric, Monitoring, Environment, Embedded, System, Pollutions.

Introduction

Earth's environment determines wellness and sustainability of all the living beings. The factors of physical environment, like temperature, humidity, air quality and air pollution, have significant influence on people's health. It may cause diseases, allergies or death in humans; it may also cause harm to other living organisms such as animals and food crops, and may damage the natural or built environment. According to Komolafe *et al*. (2014), human activity and natural processes can both generate air pollution, living habits and surroundings as linked with the different facets of environment.

Furthermore environmental health and the soundness of a human habitat for safe living is crucial as with the development of industry, the environment conditions worsened day by day, human's demand for understanding surrounding environment information is more and more urgent and more also increasing tendencies for technological development and its impact on surrounding environment requires better understanding of relationship between elements within it. Short and long turn modifications on environment caused by such changes must be recorded before any analyzing process could be performed. Seceroval. (2019), Argue that monitoring and recording large time series of data and making them available for studying are the key roles of environmental monitoring systems and being able to store unchanged and reliable information of monitored parameters poses great challenge which must be solved. Real time data collecting in different environments brings new perspective in scientific analysis. Whether such data are used to understand better living environment or to predict and produce warning of potential hazard occurrence, different solutions are developed.

At the international Level, Amegah, & Agyei-Mensah (2016), stated that Environmental monitoring has been a tool to assess environmental conditions and trends, support policy development and its implementation, and develop information for reporting to national policymakers, international forums and the public. Over the past decade, only a few countries of Europe and Central Asia have been able to maintain existing monitoring activities. The monitoring of urban air pollution — an important human health risk — is poor in many cities of the subregion and Africa. Solid and hazardous waste monitoring is weak and industrial emissions are also not well monitored, reducing the effectiveness of policy instruments such as emissions charges and fines. Monitoring of transboundary air pollution also needs strengthening. Moreover, many European and African countries lack uniform national methodologies across different monitoring areas, and their classification systems are often incompatible with international standards.

For the Nigerian case, Olowoporoku *et al,* (2011) observed that since 1988 the Nigerian Government has introduced environmental legislation aimed at reducing the atmospheric impact of various sources of pollution. Emphasis has often been placed on mitigating pollution from the oil and gas industry. However, various studies indicate significant ambient air pollution from other sources due to vehicular traffic growth in urban areas, increased reliance on petrol and diesel fueled generators for electricity supply in homes and other public facilities, uncontrolled open incineration of waste and major thermal power stations within the city limits.

Furthermore, Nigeria as a rapidly industrializing developing country with abundant natural resources, a large human population of about 200 million people and diverse sensitive ecosystems that must be managed in a sustainable manner, has put in place since 1988 institutional and regulatory framework for environmental protection and natural resources conservation. The country has participated actively in most international forum and initiatives on the environment since the 1992 United Nations

Conference on the Environment (UNCED); and has ratified major Multilateral Environmental Agreements (MEAs) including those on chemicals and wastes.

Against all these background many reasons have been advanced for the lack of an effective environmental enforcement programme. One of the reasons often cited is the Existence of ill-equipped instructional framework – An example is the FEPA which is clearly lacking the full or even manageable complement of resources to function effectively. Without functional institutions effective protection of the environment will remain a theoretical goal which may get a lot of lip service from government functionaries without the much needed propensity to reality perform their task (Idowu, 2000)

Understanding Atmospheric Monitoring

According to U.S. Environmental Protection Agency (2021), Monitoring is a general term for on-going collection and use of measurement data or other information for assessing performance against a standard or status with respect to a specific requirement. With regards to EPA's air quality regulatory requirements; there are two basic types of atmospheric monitoring with two different functions:

The fist is the ambient air quality monitoring. This type of monitoring collects and measures samples of ambient air pollutant to evaluate the status of the atmosphere as compared to clean air standards and historical information. The second is the stationary source emissions monitoring which collects and uses measurement data at individual stationary sources of emission. Ambient air quality monitoring is required to determine whether a geographical region or area is meeting the National Ambient Air Quality Standards (NAAQS) for criteria pollutants. Stationary source emissions monitoring is required to demonstrate that a source is meeting the requirements in Federal rules or in State rules that are part of a State Implementation Plan (SIP). Most monitoring that stationary sources must conduct is related to specific regulation resulting from the Clean Air Act (CAA).

Types of Atmospheric Monitoring Devices

Gas Detection monitoring devices can be classified in one of three ways. A fixed system refers to a monitoring system permanently installed in the workplace (stationary). The detecting sensor may be hard wired, or use wireless signals to a central reporting station. Most will come with an auditory alarm system. The type of sensor used will be defined by the system, as well as the gas or gases to be detected. Fixed gas detection can be used indoors, as well as having outdoor use as a perimeter monitor with chemical manufacturing and petrochemical sites.

Portable Gas Detection refers to gas detectors which are worn or carried by an individual. Typically battery operated, portable monitors are used for toxic or combustible gas detection, as well as for oxygen deficiency monitoring in confined spaces.

Area Monitoring Detection offers the benefits of a multi-gas fixed system in a transportable unit. These units are designed for team protection or area surveillance for short-term work where fixed gas systems are not suitable.

Review of Recent Atmospheric Monitoring Systems Technologies

Madhuri Patiletal, (2016) in a study titled Recent Literature on Weather Monitoring Systems classified monitoring systems based on technology to include the following: wireless sensor network based system (WSN) , Satellite based system, Microcontroller Based system, Arduino based system, GSM based system, Radar based system, Zigbee based system, Prediction based system, Sensor Based System, and Camera Based System.

Wireless Sensor Network Based System

According to Ashenafi & Haghani (2014), Wireless Sensor Networks (WSNs) includes various sensors distributed spatially with the capacity of communication, processing and computing. The data is sensed and transmitted to the base-station regularly. Here, in real time manner, data is processed and managed. One proposed framework conquers the above restriction by organization of WSN base for different climate advance utilizing virtual sensor and overlay idea. Checking climate information and giving SaaS and interpersonal organization cataclysm cautions in light of choice ID3 system and give cloud validation utilizing secure shell. Similar work gives a conditional summary on WSN with Internet of bothers based on PARASENSE plan. A good arrangement is made for sending continuous applications and for conveying it.

Satellite Based System

According to Kalsi (2008), Satellite information is progressively being utilized as a part of conjunction with routine meteorological perceptions in the concise investigation and traditional climate gauge to concentrate data. CanSat is a scale reproduction of the outline, creation and dispatch of a genuine satellite. It is described by minimal effort of usage. Climate observing is the utilization of science and innovation to foresee the condition of the climate for a given area. The CanSat assembled can be dispatched and used to monitor neighborhood climate for a range, in a sparing way. Authors have explained on our work on this paper. In this study, the climate satellite is a kind of satellite that is basically used to screen the climate and atmosphere of the Earth. Weather satellite pictures are always helpful in checking the volcanic powder cloud.

Microcontroller Based System

Susmithan and Sowmyabala (2014), in their study, clams that the basic point of a work based on microcontroller is to manufacture an implanted framework to plan an air checking framework which empowers the saw of climate parameters in an industry. This type of work includes different sensors like Gas sensors, temperature sensors, and dampness sensors which were observed with the use of ARM 9 LPC1768 microcontrollers. The following framework utilizes a complex circuit developed with ARM 9 processor. Embedded C programming is used. Scheduling is done with the use of JTAG in association with ARM 9 processor.

Arduino Based System

Through a specific framework it can naturally gather the data about stickiness and temperature. Through this framework authors can naturally gather the data about stickiness and temperature. The points of interest are put away in a database and as per present and past information authors can deliver the outcomes in graphical way in the framework. (Karthik and SurajThapa, 2015).

GSM Based System

In GSM based systems, a gadget for ongoing climate observing is displayed to screen the constant temperature, environmental weight, relative dampness and air's dew point temperature through such system which is utilizing simple and advanced parts. Digital signals are obtained from analog signals and database is altered according to the program designed for displaying user-friendly outcomes in terms of pressure on a display. (Lo Conti, *et. al*. 2014).

Radar Based System

In Radar based systems like, the creators introduced a technique that coordinates both of the information sources to give strategic and arranged climate radar. (Kelly, Kronfeld and Rand, 2000).

ZIGBEE Based System

To create sensor networking and weather station monitoring system without human mediation, utilizing Wireless ZigBee Technology, Zigbee is the most recent remote climate checking method. The previous checking frameworks of Weather Monitoring System are manual that time. (Nisha et. al, 2015).

Prediction Based systems

In a prediction based system, Mettlach et. al, (2008) proposed a methodology for monitoring transient climate conditions based on semantic and geospatial coherent cross-disciplinary. In this, demonstration of individuals driven detecting system is given to improve the accuracy of the system and the legitimacy of information collected using regular sensor is affirmed. Similarly, Mattlach et. al. assessed the conventional climate armada as an asset for atmosphere monitoring. The wave soul range, which all NDBC climates floats routinely report hourly. It contains a lot of data with respect to the starting point, quality and term of sea tempests. Such estimations are delivered from basic accelerometers originating from an adult, settled innovation. SWAP is another one method which will execute as an operational sun based observing instrument for space climate forecasting. The LYRA information will make profitable sun powered checking data, for agent space climate now throwing and testing. Similarly in another prediction based system, the control outfit figure with starting condition instability, is handy yet under dispersive. To enhance the unwavering quality of the outfit gauges, the control group is supplemented with 1) annoyed side perspective limit conditions; or, representation blunder representation utilizing either 2) stochastic active soul backscatter or 3) stochastically bothered parameterization propensities. Multi-physics and a stochastic active fundamental backscatter arrangement are utilized in a similar system to speak to model instability in a meso-scale troupe conjecture framework utilizing the Weather Investigation and Forecasting model.

Sensor Based System

In a recent work, Mittal *et. al*. planed to distinguish the topographical ranges for sun based and wind vitality eras with ease. There framework depends on remotely worked framework with sensors, which accumulates climate data and transmits measured qualities to the ground. The framework is worked by battery, and is required to keep running with an expanded life period. Static sensor hubs and submerged sensor web are connected in ecological verification in a novel study. By consolidating adding a sensor system and a technique of distributed computing, the submerged sensor bid can be improved. The climate station is designed recently which has a gathering of sensors for measuring wind pace and bearing, air temperature, relative dampness and precipitation. A snowfall connector can be continuing the precipitation gage that permits estimation of the water fulfilled of snow amid winter months. DCOMP is a novel system having a set up to keep running on sensors with comparative channel settings and has been effectively practiced on most current meteorological imagers. This standard makes DCOMP especially profitable for air research. Correlations with the Moderate Resolution Imaging Spectro-radiometer (MODIS) gathering 5 dataset are utilized to figuring the execution of DCOMP.

Thakur *et.al.,* (2016), in their recent work ,wind sensor, wind direction sensor, humidity and temperature sensor are used for sending the real time data on Thing Speak cloud Which can be easily observed and analyzed to authorized person or may be publically open. It uses Raspberry Pi development board used earlier by many authors for user-friendly works .Arm 7 is an efficient processor which is generally used for real time operation in many applications.

Camera Based System

With a unique sort of camera and computerized multi-image photogrammetric framework, it's currently conceivable to takeout Digital Elevation Models (DEM) with capturing an image by the camera.Using such strategy; the plane is may not be limited to flight way straightly. And it may go straightforwardly along objective region. That postulation presented the work hypothesis of computerized photographic visibility framework (for short is DPVS), edge of framework, structure of equipment and programming stream, at last correspondence amongst host and open air cell.(Shital et. al., 2016)

Review of Recent Embedded Design

This system utilizes the embedded design technique and the Arduino platform. According to the definition of IEEE, an embedded system is a single-purpose computer built into a larger system for the purposes of controlling and monitoring the system. A microcontroller can be considered a self-contained system with a processor, memory and peripherals and can be used with an embedded system. (Only the software needs be added). The majority of microcontrollers in use today are embedded in other machinery, such as automobiles, telephones, appliances, and peripherals for computer systems. These are called embedded systems. While some embedded systems are very sophisticated, many have minimal requirements for memory and program length, with no operating system, and low software complexity. Typical input and output devices include switches, relays, solenoids, LEDs, small or custom LCD displays, radio frequency devices, and sensors for data such as temperature, humidity, light level etc. (GuylèneProulx, 2000.). Embedded systems usually have no keyboard, screen, disks, printers, or other recognizable I/O devices of a personal computer, and may lack human interaction device (A Practical Guide to Fire Alarm Systems, 2011). The amount and type of detectors that one chooses for property protection will depend on the owner’s property protection goals, the value of the property and the requirements of the owner’s insurance company.

Generally, heat detection will be used in all areas that are not considered high value. Here again, one of the most common mistakes in fire alarm system application is to provide partial protection of a building and expect high performance from the installed systems of any kind. (Fullwikipedia, 2014).

Xie Tan (2006) developed a system to counter the problems of gas accidents in coal mines and family safety from gas usage through the use of a new infrared detection optics principle. The

infrared optics gas detection was high in detection accuracy, long range service life. It the system allowed the passage of infrared signal to the gas intended for measurement while its molecules will absorb the light energy. The absorption relationship followed Lamber-Beer law.

In the year 2014, Soundarya, *et al,* stated that an efficient and smooth working controller is needed to continuously sense both leakage and level of the gas. And also fast response is required when leakage is found and the monitoring system must provide additional leakage information which can be used in further processing. The detection system includes Arduino duemilanove, microcontroller board compatible with ATmega328p coupled with the system is the weight sensor, LCD display, GSM and DC motor.

Chen and Jiang, (2008) designed and implemented a GSM-Based Remote Monitoring System. The paper focused on wireless monitoring because the wireless remote monitoring system has a wider application. The hardware and software architecture of the system was designed where the remote signal is transmitted through GSM network. The system has two parts: the monitoring centerand the remote monitoring station. The monitoring centerconsists of a computer and a TC35 communication module for GSM. The computer and the TC35 are connected by RS232. The remote monitoring station consist of a TC35 communication module for GSM, an MSP430F149 MCU, a display unit, sensors and a data gathering and processing unit. The software for the monitoring center and the remote monitoring station were designed using VB.

A review of gas leak detection techniques was done by (Puran G. et. al. 2014) with a classification of leak detection methods in a gas pipeline to monitor the integrity of a pipeline. In terms of mode of operation, (Soundarya ., *et al*, 2014) settled for the use an Arduino board, which is quite expensive and bulky. used microcontroller (PIC16F877), which in turn is a soft real time system. It is said that "A hard real time system should always respond to an event within the deadline or else the system fails and endangers human lives but in soft real time system, failing to meet the deadline produces false output and does endanger the human lives.

Devahema *et al*., (2018) in their survey noted that the level of pollution has increased with times by lot of factors like the increase in population, increased vehicle use, industrialization and urbanization which results in harmful effects on human wellbeing by directly affecting health of population exposed to it. In IOT Based Air Pollution Monitoring System the Air Quality is measured over a web server using internet and will trigger a alarm when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gases are present in the air like CO2, smoke , alcohol, benzene and NH3. It will show the air quality in PPM on the LCD and as well as on webpage so that we can monitor it very easily.MQ135 sensor which is the best choice for monitoring Air Quality as it can detects most harmful gases and can measure their amount accurately .The pollution level can be

monitored anywhere using computer or mobile. Install this system anywhere and can also trigger some device when pollution goes beyond some level, like it can switch on the Exhaust fan or can send alert

According to Pan and Zhu (2018), Dust, known as “airborne particles”, refers to solid particles that are suspended in air (diameter ≤ 100 μm). Among them, dust with diameter < 2.5 μm, known as “fine particulate matter”, is referred to as PM2.5. After being inhaled by the human body, PM2.5 can directly enter the blood through the bronchi and alveoli, which are phagocytized by macrophage. Their long-term stay in the alveoli exerts a negative impact on the human cardiovascular, nervous system, and other organs, posing a threat to people’s health. Consequently, indoor air quality has become a great concern.

Al Ahasan et al., (2018) stated that now-a-days air pollution is one of the most important concern of the world. Air pollution may evolve from anthropogenic or natural sources. Air pollutants of atmospheric substances like CO, CO2, SO2, NO2, and O3 suspended particulate matter (SPM), repairable suspended particulate matter (RSPM), and volatile organic compounds (VOCs) have a great effect on the people health. Most of the major cities in developing countries and most cities of the developed countries are suffering from it. Thus to develop a real time air quality and pollution monitoring system is critical. We have developed an Arduino based air pollution detector which combined a small-sized, minimum-cost sensor to an Arduino microcontroller unit. The advantages of the detector, have a reliable stability, rapid response recovery and long life features. It is affordable, user-friendly, low-cost and minimum-power requirement hardware which is appropriate for mobile measurement, as well as comprehensible data collection. It has a processing software able to analyze, collected quality data with high precision.

Husain *et al.,* (2016) In their paper a cost efficient, portable, easily manageable Arduino based device has been presented to monitor air quality. The device works by collecting data of quantity of specific harmful gases and the amount of dust present in the air. This device can be located at any place and the data can be transferred to an Android phone via Bluetooth or simply by connecting the device to a PC/laptop. Data collected by the device from different places can be later examined to make further decisions and analysis about the state of air quality; furthermore, it can also help concerned individuals to act upon it.

According to Karami *et a*l., (2018) building performance monitoring could be limited due to the cost and inflexibility of hardware and software platforms for data acquisition. This paper describes a portable continuous measurement toolbox which provides a robust, easily extendable, and low-cost

setup for indoor environmental quality (IEQ) monitoring and performance assessment. Various sensors—temperature, relative humidity, illuminance, CO2, VOC, PM2.5, and occupancy—for IEQ performance measurement are included in this toolbox. Arduino Uno boards were connected to the sensors for data acquisition. ZigBee communication protocol was established between an XBee device for each Arduino board and an XBee receiver connected to a computer. The toolbox utilized the open source, agent-based software platform for data communication and analysis. The data collection system was calibrated against an accurate data acquisition card. Experiments have been conducted using the toolbox for assessing IEQ performance in an open computer lab within a commercial building. Thermal comfort, indoor air quality, and lighting performance have been analyzed based on collected data. The study demonstrated reliability and robustness of the toolbox for continuous monitoring of indoor environmental quality.

Alvea *et al*., (2018) stated that Evidence shows that Smart Cities are starting to materialize in our lives through the gradual introduction of the Internet of Things (IoT) paradigm. In this scope, crowd sensing emerges as a powerful solution to address environmental monitoring, allowing to control air pollution levels in crowded urban areas in a distributed, collaborative, inexpensive and accurate manner. However, even though technology is already available, such environmental sensing devices have not yet reached consumers. In this paper, we present an analysis of candidate technologies for crowd sensing architectures, along with the requirements for empowering users with air monitoring capabilities. Specifically, we start by providing an overview of the most relevant IoT architectures and protocols. Then, we present the general design of an off-the-shelf mobile environmental sensor able to cope with air quality monitoring requirements; we explore different hardware options to develop the desired sensing unit using readily available devices, discussing the main technical issues associated with each option, thereby opening new opportunities in terms of environmental monitoring programs.
Vijayalakshimi *et al.* (2016) are of the opinion that “Real Time Weather Monitoring from Remote Location Using Raspberry pi” proposed a system for Real time weather monitoring using Raspberry pi, it measure various weather parameters like temperature, light intensity, atmospheric pressure, Gas/smoke level using appropriate sensors interfaced with Raspberry Pi, it uses wireless technology to provide real time data transfer. The project deals with designing a simple, highly efficient, cost effective and easy to operate Real time weather monitoring system. Using a database to raspberry pi this project can access from anywhere.

Rasal and Jaideep, (2016) in their research “Raspberry Pi Based Weather Monitoring System” proposed a system that visualizes the parameters of weather variables. To know the current weather condition at remote location this system is design for. Proposed System will visualize and store various weather

parameters as given above with the help of sensors interfaced to Raspberry will get all data, SD card on Pi stores the collected data as like memory card (Rasal, and Rana, 2010).

Gonçalo et al. (2015) in a work titled "An Intelligent Weather Station" presented an intelligent weather station for forecasting different variables of weather. To predict and analysis weather variables from anywhere. The hardware and software design of the implemented prototype are described the forecasting performance related to the three atmospheric variables, atmospheric pressure, humidity, temperature.

Vasantha and Basha, (2016) in a work titled "Weather Monitoring Using Raspberry Pi Viva Web Application" proposed an environment monitoring system. This system also capable of monitoring and control of environmental parameters like temperature, pressure and humidity. It also focused on low cost. This system uses Wireless sensor Networks for sensing the environment parameters in the area under supervision.

Natanael, *et al*. (2016), developed a low cost automated data acquisition system for urban sites temperature and humidity monitoring based in internet of things. This work produced an automated Data Acquisition system that communicates the interaction and interoperability of temperature and humidity sensors through the internet. Results proved that the use of internet of things improved the effectiveness of automatic decision making for the system.

Fortes and Borba (2017). Design of Low Cost Multi Channel Data Acquisition System for Meteorological Application. A low cost multi-channel Data acquisition system was designed for acquiring temperature, humidity, barometric pressure, altitude and light intensity from the environment and stores the data in a PC for future use. The sensors are interfaced with ATmega328 which performs the acquisition function and data logging.

Ojike1 *et al* (2016). In this work, a low cost six- multipoint temperature data logger was developed. It was designed using LM35 as the sensor, and arduino Uno as the data processing element. The response time of the sensor was observed to be between three and four minutes. The comparative evaluation of the system with other established thermometers show that no two temperature meters gave the same values. However the most important thing is that all the systems recorded the same temperature flow pattern. This indicates that the systems actually senses change in the surrounding effectively. In relation to the alcohol thermometer, the designed system shows an accuracy of +0.4oC at temperatures below 300C and +1.850C at temperatures above 300C. The system gives room for effective and adjustable

Table 3 Summary of Literature Review

S/N	Author	Technology	Key feature	Limitations

temperature data logging procedure. Hence, the system is recommended for use in monitoring low temperature systems.

Najwa (2016) in his paper describes the design of a general data logger for Photovoltaic (PV) monitoring system that can store bulk data from input channels in large memory storage. It utilizes Arduino Mega 2560 board in conjunction with ATmega2560 chip. For monitoring the related parameters, a 240-W PV system is used where electrical parameters are tapped into the input channels of the data logger. The system will convert the acquired raw data to digital input for data acquisition and will store the data onto SD card. The data logger is also equipped with DS1307 Real Time Clock (RTC) chip for data stamping in the SD card every at the occurrence of the logging process. Results and findings are recorded and compared with the data that was taken by one commercial data logger DataTaker DT80 during the testing stage. This is to test the data reliability as well as to examine the performance of the proposed data logger throughout the testing process.

Mabrouki et al (2021) in their paper propose an automatic weather monitoring system that allows having dynamic and real-time climate data of a given area. The proposed system is based on the internet of things technology and embedded system. The system also includes electronic devices, sensors, and wireless technology. The main objective of this system is sensing the climate parameters, such as temperature, humidity, and existence of some gases, based on the sensors. The captured values can then be sent to remote applications or databases. Afterwards, the stored data can be visualized in graphics and tables form.

		Used		
1	Kelly. W, K. Kronfeld & T. Rand, (2000).	Radar	Weather Monitoring Systems that reads climate parameters	• Tremendous initial cost, noise and interference, propagation delay, time delay lessens. • No data logging System • No Gas pollution Detector
2	Xie Z. Tan Q. (2006)	infrared optics gas detection	high in detection accuracy, long range service life.	• It cannot be monitored remotely and requires the physical presence of the human being to take readings. • No weather Station • No logging system
3	Chen and Jiang, (2008)	GSM	a GSM-Based Remote Monitoring System.	• It cannot be monitored remotely and requires the physical presence of the human being to take readings. • No weather Station • No logging system
4	Kalsi S.P, (2008)	Satellite	Weather Monitoring Systems that reads climate parameters	• Tremendous initial cost, noise and interference, propagation delay, time delay lessens efficiency. • No data logging System • No Gas pollution Detector
5	Mettlach et. al, (2008)	Predictions	Weather Monitoring Systems	• Climate prediction correctness has been difficult to address. Fault prediction occurs due to climate changes. • No Logger • No Gas pollution Detector
6	Ashenafi and Haghani, (2014)	Wireless Sensor Network Based System	Weather Monitoring Systems that reads climate parameters	• Lower speed, less secure because programmer can read information like username and password • No data logging System • No Gas pollution Detector
7	Lo Conti, et. al. (2014)	GSM	Weather Monitoring Systems that reads climate parameters	• The limitations of this system are that it cannot be monitored remotely and requires the physical presence of the human being to take readings. • No data logging System • No Gas pollution Detector
8	Puran G. et. al. (2014)	Arduino Base	Gas leak detection System	• it cannot be monitored remotely and requires the physical presence of the human being to take readings. • No weather Station • No logging system
9	Soundarya, et al, (2014)	Arduino Base	Gas Linkage Detector and LCD Display	• it cannot be monitored remotely and requires the physical presence of the human being to take readings. • No weather Station • No logging system
10	Susmithan & Sowmyabala, (2014)	Micro-controller LPC1768	Weather Monitoring Systems	• No Logger • No Gas pollution Detector

		MCU		
11	Karthik & SurajThapa, (2015)	Arduino	Weather Monitoring Systems	• Structure is drawback size should be as small as possible. • No Logger • No Gas pollution Detector
12	Mestre et al. (2015)	Raspberry Pi Based Weather Monitoring System	Raspberry Pi Based Weather Monitoring System for atmospheric pressure, humidity, temperature	• . it cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Gas Detector • 28No logging system
13	Nisha et. al, (2015)	Zigbee	that reads climate parameters	• Shorter range, lesser complexity, less information speed, high cost. • No Logger • No Gas pollution Detector
14	Husain et al., (2016)	Arduino and Android.	Air quality monitoring: with Bluetooth data logging	• It cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Gas Detector • Single logging system
15	Madhuri P. Patiletal (2016)	GSM	Weather classified monitoring systems	• No data logging System • No Gas pollution Detector • it cannot be monitored remotely and requires the physical presence of the human being to take readings.
16	Najwa, Nasuha and Mahzan (2016)	Arduino Based Data Logger for Photovoltaic Monitoring System	Design and Development of an Arduino Based Data Logger for Photovoltaic Monitoring System on onto SD card.	• It cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Gas Detector • Single logging system
17	O. Ojike1, Mbajiorgu, Anoliefo and Okonkwo4 (2016)	Arduino and LM35 sensor, Weather Data Acquisition System	Design and Analysis of A Multipoint Temperature Data logger.	• It cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Gas Detector • Single logging system
18	Rasal and Jaideep (2016)	Raspberry Pi Based Weather Monitoring System	Raspberry Pi Based Weather Monitoring System" proposed a system that visualize the parameters of weather variables.	• it cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Gas Detector • No logging system
19	Shital M. Dharrao,et. al., (2016)	Camera	Weather Monitoring Systems	• For vertical photography which require clear sky, no cloud & is humped by strong thermal activity in the air. • No Logger • No Gas pollution Detector

20	Siddharthan & . Kasiraj, (2016)	Sensors and Arduino	Detection of Toxic Gases using Arduino and GSM Network	• No Logger • Weather Monitoring Systems • Single Sensor • No Logging System
22	Vasantha, and Basha, (2016)	Raspberry Pi Viva Web Application Weather Monitoring System	Monitoring Using Raspberry Pi Viva Web Application. capable of monitoring environmental parameters like temperature, pressure and humidity.	• It cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Gas Detector • No logging system
23	Vasudev Yadav, Akhilesh Shukla et. al., (2016)	GSM,	LPG Gas leakage detector	• The limitations of this system are that it cannot be monitored remotely and requires the physical presence of the human being to take readings. • Single Gass sensor • No Logger • No weather monitoring system • No IoT reporting
24	Vijayalakshimi and Lakshmi (2016)	uses wireless technology Using Raspberry Pi	Real Time Weather Monitoring from Remote Location Using Raspberry Pi. To measure temperature, light intensity, atmospheric pressure, Gas/smoke	• It cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Gas Detector • No logging system
25	Fortes and Borba (2017)	Arduino Weather Data Acquisition System	Design of Low Cost Multi Channel Data Acquisition System for temperature, humidity, barometric pressure	• It cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Gas Detector • No logging system
26	Al Ahasan et al., (2018)	Arduino and volatile organic compounds VOCs sensor	Arduino-Based Real Time Air Quality and Pollution VOCs Monitoring System.	• It cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Weather System • No logging system
27	Alvear (2018)	crowd sensing architectures, IoT architectures and protocols	crowd sensing architectures, IoT architectures and protocols	• Iit cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Gas Detector • Single logging system
28	Devahema et al., (2018)	IoT on Arduino , MQ 135 Senor,	IOT Based Air Pollution Monitoring System the Air Quality is measured over a web server, LCD Display	• Weather Monitoring Systems • Single Sensor
29	Karami, (2018)	Arduino and ZigBee	Real Time monitoring of indoor environmental quality using an Arduino-based and Open source, agent-based software platform for data communication.	• It cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Gas Detector • No logging system

30	Pan and Zhu, (2018)	Sensors and Arduino	Air Quality and Dust Monitor Using Arduino	• It cannot be monitored remotely and requires the physical presence of the human being to take readings. • No Gas Detector, No logging system
31	Pritam Ghosh, Palash Kanti Dhar, (2019)	SMS alert	gas leakage detector	• The limitations of this system are that it cannot be monitored remotely and requires the physical presence of the human being to take readings. • Single Gas sensor • No Logger • No Weather Monitoring Systems
32	Chaudhary, Juhi & Mishra, Anurag, (2019)	Arduino Uno, MQ-6 Gas Sensor, LCD, LPG, Stepper Motor Driver, Buzzer, GSM mode	Detection of Gas Leakage and Automatic Alert System using Arduino	• Single Gass sensor • No Logger • Weather Monitoring Systems • No IoT reporting
33	Mabrouki et al., (2021)	Arduino IoT-Based Weather Monitoring	IoT-Based Data Logger for Weather Monitoring Using Arduino-Based Wireless Sensor Networks with Remote Graphical Application and Alerts	• Internet Failure causes system failure • No Gas Detector • No logging system

.Summary and Conclusion

Although there are many advanced systems that might be able to monitor more atmospheric parameters, these systems usually generalize their measurements over a very large area, for instance, monitoring real time parameters for a metropolitan area or large suburbs using a few observation points. Our review also shows that the existing systems have the following lapses: (i) inability to automatically monitor multiple types of air quality parameters (Combustible and Toxic gases) at the same time monitor atmospheric conditions such as, temperature, humidity and heat Index. This makes getting the whole picture in terms of harmful particles, gases, temperature and humidity very difficult. (ii) Most of the existing systems do not have data logging facility, and they are design to be carried by individuals that has to retrieve or read and collect the data by themselves. This requires manual intervention and increases labor costs and the chance for mistakes. (iii) The IOT based wheatear forecasting systems on ground, possesses the ability to access information remotely through internet devices and websites, but connectivity is the major challenge. This is because in a situation of network failure such system becomes useless hence a standalone IOT system is equally prone to fault in data logging.

(iv) Furthermore, most of the atmospheric monitoring system provides only the present condition and readings of a particular field which will not provide past records of this particular environment, hence make it difficult for environmental inspectors to have an historical record of environmental conditions for proper assessment of the exact condition of a particular city or particular place. (v) Another main

problem in most of the existing system is the inability of giving alert signals whenever it encounters divergent issues. This imposes a very big risk of insecurity for users. Another issue with the existing system is that most of the devices have limited power supply. Power requirements are one of many major constraints as these instruments are generally sited far from main power supply. For sensors to work in the field, they must be electrically stable. If instruments are not kept charged, turning it on and using it without allowing the sensors to warm up will cause the instrument to give wrong readings some times. Replacing sensors with new sensors that have not been conditioned correctly will cause the same effect. When you respond to an emergency, you need all of your options immediately available, hence the lack of multiple power sources imitate most of the existing systems. Having done extensive review of the existing atmospheric monitoring systems, it is obvious that although many researches have been done in this area, more needed to be done in order to harmonize and reconcile the vulnerabilities in the existing atmospheric systems. This is because atmospheric pollution is an important issue that has severe effects and the effects of pollution are detrimental to the life and health both human beings and other living things.

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