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SURVEY ON MULTI SENSOR BASED AIR AND WATER QUALITY MONITORING USING IOT

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Abstract **-** The degradation of water resources and air pollution has become a common problem. The conventional methods of monitoring involve the manual collection of water and air sample from different locations. These samples are tested in the laboratory using the rigorous skills. Such approaches are time consuming and are no longer to be considered to be efficient. Moreover, the current methodologies include analyzing various kinds of parameters of quality such as physical and chemical. The old method of quality detection and communication is time consuming, low precision and costly. Therefore, there is a need for continuous monitoring of water and air quality parameters in real time. By focusing on the above issues, a low cost monitoring system is using that can monitor air and water quality in real time using IoT. Each device has a unique identification and must be able to capture real-time data autonomously. Basic building blocks of IoT consist of sensors, processors, gateways, and applications. In the system, water quality parameters are measured by different sensors such as pH, turbidity, dissolved oxygen, temperature, CO2 level and Air quality for communicating data onto a platform via microcontroller based system.

Keywords*:* IoT (Internet of Things), WSN (Wireless Sensor Network), pH (power of Hydrogen), GPRS (General Packet Radio Service), Water Quality, ADC (Analog to Digital Converter), LoRa (Low Range)**.**

I. Introduction

With growing industry advancement and world population industry advancement, environmental pollution became big concern. Systems for air and water quality monitoring are required for activity analysis and their impact on nature of the power plants, mining sector, oil and gas industry, etc. Basically, determination of air and water quality relies on estimation of values of some important and indicative parameters. For example, the water quality monitoring demands the determination of parameters like PH, dissolved oxygen, content of ammonia, conductivity, turbidity, temperature, dissolved metal ions, etc. The air quality depends of the air temperature, humidity, radiation, activity level, air flow and presence of volatile organic compounds. Although there are well known and widely used methods for measurement of these parameters with appropriate Sensors, design of electronic systems for environmental monitoring is not often straightforward. The engineering challenges are various: (a) sensor nodes are usually deployed in remote places, (b) long-term deployments require sensor nodes to be robust and systems to be easily reconfigurable, (c) sensor nodes have to be able to operate autonomously in the required environment, etc. Moreover, such applications require highly reliable and accurate sensors with the reduced level of maintenance, long lifetime, fast response times, high sensitivity and high selectivity.

With the introduction of IoT in the modern world, many problem have been solved. With the use of IoT in monitoring water and air quality, various issues such as data collection, communication, data analysis and early warnings are worked on .But in order to get this into picture, technologies and protocols are combined to get the desired output.

The IoT can be used in practically all scenarios for public services by governments. Sensor-enabled devices can help monitor the environmental impact of cities, collect details about sewers, air quality, and garbage. Such devices can also help monitor woods, rivers, lakes, and oceans. Many environmental trends are so complex, that they are difficult to conceptualize. The Internet of Things (IoT) is a recent communication paradigm that envisions a near future, in which the objects of everyday life will be equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks that will make them able to communicate with one another and with the users, becoming an integral part of the Internet. An urban IoT can provide means to monitor the quality of the air in crowded areas, parks, or fitness trails. The realization of such a service requires that air quality and pollution sensors be deployed across the city and that the sensor data be made publicly available to citizens.

The Wireless Sensor Network (WSN) and wireless communication technologies have been increasingly developed for assisting human's personal and professional daily tasks. The applications of wireless technologies have been developed for the data acquisition, building control, environmental monitoring systems and automation of manufacturing processes in recent years. Today's state-of-the-art WSNs have more advantages such as low costs for both installation and maintenance, and longer operating time. The remote sensor network can be used for stationary or mobile sensor networks. The remote sensor network is commonly used for different purposes such as surveying the development of city infrastructure, environmental

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monitoring, telemedicine or remote health care, research in agriculture, fishing surveillance, farming, border security, traffic management, forestry management, and disaster prevention. A WSN consists of compactly dispersed sensor nodes for sensing, signal processing, embedded computing, and connectivity. This system enables the interaction between persons or computers and the surrounding environment through wireless link. Although the WSNs were used in military and heavy industrial applications originally, today's WSN applications are used for different purposes from the light industrial to heavy industrial systems.

The WSN system allows users to monitor and control the connected devices from the base station through different wireless communication standards such as Wi-Fi, General Packet Radio Service (GPRS), Bluetooth, ZigBee, Radio Frequency Identification (RFID), and cellular technologies. The users can monitor the data through a wireless network which can be designed based on one of those wireless communication standards. The advantages of WSN are low power consumption, redundant data acquisition, remote monitoring, fast network establishment, wide coverage area, and high monitoring precision and low duty cycle. Thus, the WSN to the real world is practically unlimited from physical security, environmental monitoring and climate changes. Positioning and tracking and health care to logistic, localization, and so on. The Internet of Things (IoT) was developed in parallel to WSNs and is a physical network which connects all things in order to exchange the data and information through the data sensing devices such as sensors, actuators and computers in line with relevant protocols. In other word, many things are connected into networks in one form or another. The aims of intelligent, identifying, monitoring, locating, tracking and controlling things are achieved by IoTs. There is a variety of IoT applications such as RFID tags, sensor technology, mobile technology and other smart technologies.

II. Objectives

The objectives of this project are given below:

- To design the wireless water and air quality monitoring system.
- To measure PH, dissolved oxygen, content of ammonia, conductivity, turbidity, temperature, dissolved metal ions, etc.
- To collect and transmit data from remote place to the receiver section using the IoT communication.

A. Motivation

In present generation, water in rivers and ponds are getting polluted due to effluents from industries which results in increase of turbidity and variation in pH of water resulting in formation of acidic and/or basic of water, if there is an increase in temperature then the eco system in water will vary resulting in mass killing of fish. Due to air pollution the atmosphere will not be suitable for habitation and will lead to several health disorders. The Air and Water quality monitoring will be useful to determine the pollution level of the air and water and can thus help the government agencies to take necessary actions.

B. Problem Statement

The degradation of water resources and air pollution has become a common problem. The conventional methods of monitoring involve the manual collection of water and air sample from different locations. These samples are tested in the laboratory using the rigorous skills. Such approaches are time consuming and are no longer to be considered to be efficient. Moreover, the current methodologies include analyzing various kinds of parameters of quality such as physical and chemical. The old method of quality detection and communication is time consuming, low precision and costly. Therefore, there is a need for continuous monitoring of water and air quality parameters in real time.

C. Solution To The Problem

By using this project the pollution level of the air and water can be determined by comparing the values obtained from the system with threshold values of normal water if there is a deviation in the values then the government agencies can take necessary actions.

III. Methodology

1. The first task is to determine which water parameters would provide a close indication for water pollution. Through extensive research the parameters are chosen to be composed of pH, turbidity, temperature CO, Air quality.
2. The next step is to transmit the data from the sensors onto the microcontroller kit for further processing.
3. The most of the sensor used will give the analog output the ADC present in the controller will those to digital and transmit the measured data using GPRS module connected to the microcontroller using UART protocol, the information obtained is passed onto the server through GPRS and the end user.

IV. Literature Survey

Shruti Sridharan,et al.,[1] addressed about developing an efficient wireless sensor network (WSN) based water quality monitoring system, that examines water quality, an important factor as far as, irrigation, domestic purposes, industries, etc are concerned.

R.Karthik Kumar et al.,[2] investigated Underwater wireless sensor network to monitor the quality of water using wireless sensor network (WSN) technology powered by solar panel. Through WSN various data collected by various sensors at the node side such as pH, Turbidity and oxygen level are sent to base station. At the base station collected data is displayed as visual and is analyzed using different simulation tools.

Marco Zennaro, Athanasios FloroSs, Gokhan Doga et al., [3] proposed the design of a water quality monitoring system and, building upon the Sunspot technology, a prototype implementation of a water quality wireless sensor network(WQWSN) as a solution to the water quality monitoring problem.

Kirankumar G.Sutar, Prof.Ramesh T.Patil [5] presented the fish farm monitoring system based on wireless sensor network. The system is constituted by a base station and sensor nodes. The sensed parameters with their exact precision values are transmitted to the observing station through wireless communication and details are monitored by the administrator. When any of the parameter is found to be above a threshold value an indicator will indicate it. The system has advantages such as low power consumption, more flexible to deploy.

A.C.Khetre, Prof.S.G.Hate [6] investigated and defined a wireless sensor network for water environment monitoring system. It provides a useful features such as large monitoring ranges, low cost, low power consumption, flexible configuration and very small damage to the natural environment. The system successfully provides on-line auto monitoring of the temperature, turbidity, water level, and salinity.

Brinda Das, P.C. Jain [7] proposed the "Real-Time Water Quality Monitoring System using Internet of Things" The conventional method of testing water quality is to gather samples of water manually and send to the lab to test and analyze. This method is time consuming, wastage of man power, and not economical. The water quality measuring system that has been implemented checks the quality of water in real time through various sensors (one for each parameter: pH, conductivity, temperature) to measure the quality of water. The ZigBee module in the system transfers data collected by the sensors to the microcontroller wirelessly, and a GSM module transfers wirelessly the data further from the microcontroller to the smart phone/PC. The system also has proximity sensors to alert the officials by sending a message to them via the GSM module in case someone tries to pollute the water body. This system can keep a strict check on the pollution of the water resources and be able to provide an environment for safe drinking water.

M Saravanan, Arindam Das and Vishakh Iyer[8] proposed "Smart Water Grid Management using LPWAN IoT Technology". A new Low Power Wide Area Network(LPWAN) technology called LoRa is explored in their study for the communication of these IoT devices. The LoRa devices can communicate within a range of 2-4 KMs while running on batteries that last for years. As a pilot project, implemented a smart water grid management system in Mori, a village in the eastern Godavari district in Andhra Pradesh situated near to Bay of Bengal. The water grid management system proposed and involves different sensors deployed at various strategically chosen locations to measure the quality of water by generating real time data. The system also provides an alert mechanism which notifies the different level of authorities through email and SMS in case of any issues. Furthermore, it provides a solution for handling the locks that have been employed in and around the village to control the flow of water in a timely manner. The sensors attached with a micro controller in the LoRa module will communicate to the cloud environment through the LoRa gateway. A web page provides the interface to the residents and to the authorities to gauge the water quality after analyzing the data using the prediction algorithm.

Himadri Nath Saha, Supratim Auddy, Avimita et al., [9] presented "Pollution Control using Internet of Things (IoT)".The main objective is to find the pollutants in nature

with the help of the Internet of Things (IoT). The UV sensor is an ultraviolet light sensor. The UV Sensor outputs an analog signal of the amount of UV light it detects. The two in one Temperature and PH sensor is used to monitor the Quality of water, interns of monitoring the level of water, the temperature of the water and its surrounding, the turbidity of the water (how clean the water is) as well as the PH levels of the Water. Therefore, this system monitors all of these result and finally when all data are collected, it sends the information or data to the cloud.

Cesar Encinasn, Erica Ruizy et al., [10] presented "IoT system for the monitoring of water quality in aquaculture" The system proposed in this work monitors the water quality based on wireless sensor networks and on the Internet of Things (IoT).This information is important for the development of this area, since it allows sharing the different conditions in the breeding of aquatic organisms between different breeders and organizations. This information is useful to know the conditions in which there is a better development of a product, worse development, what conditions can mean a possible disaster in the environment and how to optimize resources for the care of the pond.

Jozsef Konyha[11] proposed "Grid-based wide area water quality measurement system for surface water" The development of a surface water monitoring network is a critical element in the assessment and protection of water quality. Prototype of easy to install technology by which the different surface water (e.g. rivers, lakes) quality indicators can be measured. Modular design of the sensor-tube, the equipment can measure from 1 to 7 indicators. The wide area measurement system(WAMS) communicate via the GPRS network.

Pradeep Kumar, Somasundaram and Dharon Joseph[12] proposed "Monitoring Water Quality using RF Module". Here water is constantly monitor the water available through the taps through various sensors. The sensors which are pH sensor, temperature sensor and a turbidity sensor (LED-LDR assembly).It has been implemented the project in real time and this has been found to be very reliable, and efficient in a long run. Transmit the data available to a remote base station using a 2.4 GHz RF module which makes it convenient to monitor at a remote location and requires less man power.

Zhu Wang Qi Wang, Xiaoqiang Hao [13] discussed the problem of the manual analytical method adopted in water quality detection with bad real-time character and introduced a novel kind of remote water quality measuring and monitoring system based on WSN.

Raja Vara Prasad Y, Mirza Sami Baig, Rahul K. Mishra et.al.,[14] The system proposed integrates different technologies like frequency hopping communication technology and virtual instrument technology to fulfill wireless data transmission for monitoring of air quality. The carrier frequency is adjusted according to the result and full radio spectrum is used with the use of a spectrum hole detection sample. The wireless transmission of data is performed without interference with this specimen and real time information can be received by a system effectively. Moreover, this system is useful for non-professional staff also as the data is easy to read and shown clearly.

Devarakonda, S., Sevusu, P., Liu, H., Liu, R., Iftode et. al.,[15] Pollution can be effectively monitored with the use of WSN is capable of providing a real time pollution data. The calibration of gas sensors like CO2 gas sensors, NO2 gas sensor is done by using various suitable calibration technologies and then WSN is formed using a multi hop data aggregation algorithm. The pollution data is shown in the form of numbers and charts with the help of web interface and is available on internet as well. Temperature and humidity parameters are measured along with the gases and data is analyzed data fusion.

Cho Zin Myint, Lenin Gopal, and Yan Lin Aung [16] presented "Reconfigurable Smart Water Quality Monitoring System in IoT Environment". Here a reconfigurable smart sensor interface device for water quality monitoring system in an IoT environment is proposed. The smart WQM system consists of Field Programmable Gate Array (FPGA) design board, sensors, ZigBee based wireless communication module and personal computer (PC). The FPGA board is the core component of the proposed system and it is programmed in very high speed integrated circuit hardware description language (VHDL) and C programming language using Quartus II software and Qsys tool. The proposed WQM system collects the five parameters of water data such as water pH, water level, turbidity, carbon dioxide (CO2) on the surface of water and water temperature in parallel and in real time basis with high speed from multiple different sensor nodes.

Shailaja M Gunda Nikkam ,Dr.V R Pawar [17] proposed "Water Parameter Analysis for Industrial Application using IoT". Here implementation for monitoring the contaminated water quality by adapting new technologies such as IoT(Internet of Things), WSN's(Wireless sensor network) and communication standards. IoT and WSN's have been grabbed attention towards it in all real time applications (Manufacturing system, Health care system and Industrial monitoring systems) for providing worldwide network to each interconnected objects for collecting data about physical things by using standard communication protocol. The performance analysis of the proposed systems is carried out by collecting water parameters data from different sensing elements (Turbidity, Density, Temperature and PH) at base station and comparing with its threshold value at the monitoring unit. Hence implemented system makes

awareness and avoids major risk related to spreading of polluted industrial water at a long distance with low cost.

Octavian Postolache, Jose Dias Pereira and Pedro Silva Girao [18] presented "Wireless sensor network-based solution for environmental monitoring". This study presents a wireless sensor network architecture that combines low cost sensing nodes and a low cost multi parameters sensing probe for reliable monitoring of water quality parameters of surface waters (lakes, estuaries and rivers) in urban areas. A particular attention is dedicated to the design of the conductivity, temperature and turbidity signal conditioning circuits, highlighting important issues related to linearization, measuring dynamic range and low-cost implementation by using commercial off-the-shelf components and devices. Several issues related to the wireless sensor network implementation are included in this study, as well as several simulation and experimental results.

A.N.Prasad, K. A. Mamun et al.,[19]proposed "Smart Water Quality Monitoring System". The high use of fertilizers in farms and also other chemicals in sectors such as mining and construction have contributed immensely to the overall reduction of water quality globally. Water is an essential need for human survival and therefore there must be mechanisms put in place to vigorously test the quality of water that made available for drinking in town and city articulated supplies and as well as the rivers and shoreline that surround our towns and cities. Fiji Islands are located in the vast Pacific Ocean which requires a frequent data collecting network for the water quality monitoring and IoT and Remote sensing can improve the existing measurement. It presents a smart water quality monitoring system for Fiji, using IoT and remote sensing technology.

N Vijayakumar R Ramya[20] proposed "The real time monitoring of water quality in IoT environment". Design and development of a low cost system for real time monitoring of the water quality in IOT(internet of things).The system consist of several sensors is used to measuring physical and chemical parameters of the water. The parameters such as temperature, PH, turbidity, conductivity, dissolved oxygen of the water can be measured. The measured values from the sensors can be processed by the core controller. The raspberry PI B+ model can be used as a core controller. Finally, the sensor data can be viewed on internet using cloud computing.

Vinod Raut and Sushama Shelke [21] proposed "Wireless Acquisition System For Water Quality Monitoring" .The proposed system aims to design a wireless acquisition system which is the basic building block of the water quality monitoring system. This work carried out to design the embedded wireless monitoring system that can measure the turbidity and pH of the water remotely. The system is built using the Peripheral Interface Controller (PIC) microcontroller, which gives a low cost and low power water quality monitoring system with the intrinsic use of RISC type controller. The system consists of two sections, namely, Transmitter section, that collects the pH and turbidity readings from remote place, and, Receiver section, that collects transmitted readings using the ZigBee wireless communication protocol. The results are classified into three classes using the different pH and Turbidity levels to get a water quality index. The results are displayed on the LCD as well as on PC over different time periods.

V. System Design

Sensors for measuring air and water quality such as pH, Temperature, Turbidity, CO2 sensors and MQ sensors are connected to Micro Controller Unit for further processing. Serial Communication unit acts as a phase between MCU and GPRS module, GPRS module transmits the data to workstation and later the data is stored in cloud for further use. The system architecture of Air and Water quality monitoring system is as shown in fig 1

1. The first task is to determine which water parameters would provide a close indication for water pollution. Through extensive research the parameters are chosen to be composed of pH, turbidity, temperature CO2, Air quality.

2. The next step is to transmit the data from the sensors onto the microcontroller kit for further processing.

3.The most of the sensor used will give the analog output the ADC present in the controller will those to digital and transmit the measured data using GPRS module connected to the microcontroller using UART protocol, the information obtained is passed onto the server through GPRS and the end user.

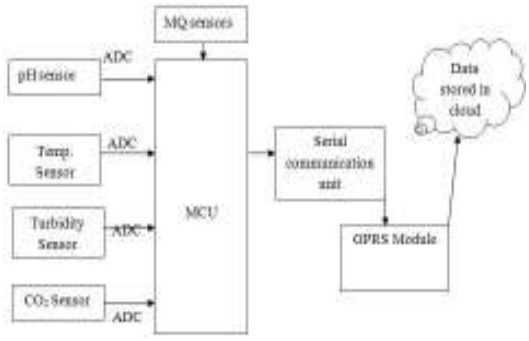

Figure 1: The block diagram of smart water and air quality monitoring system

VI. Advantages

The advantages of Air and Water quality monitoring system are as follows:

 The low cost, efficient, real-time water quality monitoring system has been implemented and tested.

 Through this system, the officials can keep track of the levels of pollutions occurring in the water bodies, environmental air quality and send immediate warnings to the public.

 This can help in preventing diseases caused due to polluted water and presence of metals.

 Quick actions can be taken to curb extreme levels of pollution like in the case of the water bodies and rivers.

 The system can be easily installed with the base station kept close to the target area, and the task of monitoring can be done by less-trained individuals.

VII. Applications

The Applications of water and air quality monitoring system are as follows:

 Industrial water monitoring.

 Waste water management system.

 Water bodies and Rivers.

 Drinking water Plants.

 Air Pollution monitoring system.

VIII. Conclusion

Multi sensor based air and water quality monitoring using IoT is proposed. Literature reveals that manual data computation using the laboratory methods is time consuming and existing system are inefficient at providing accurate results also they do not provide long range communication but since this project uses GPRS module the data can be transmitted over a very long range and the proposed project is also cost effective.

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