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A Review on Smart Water Quality Monitoring System

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Abstract: Wireless communication developments are creating new sensor capabilities. The current developments in the field of sensor networks are critical for environmental applications. Internet of Things (IoT) allows connections among various devices with the ability to exchange and gather data. IoT also extends its capability to environmental issues in addition to automation industry by using industry 4.0. As water is one of the basic needs of human survival, it is required to incorporate some mechanism to monitor water quality time to time. Around 40% of deaths are caused due to contaminated water in the world. Hence, there is a necessity to ensure supply of purified drinking water for the people both in cities and villages. Water Quality Monitoring (WQM) is a cost-effective and efficient system designed to monitor drinking water quality which makes use of Internet of Things (IoT) technology.

Keywords: pH sensor, Turbidity sensor, Temperature sensor, Flow sensor, Arduino model, WI-FI module.

I. INTRODUCTION

In the 21st century, there were lots of inventions, but at the same time were pollutions, global warming and so on are being formed, because of this there is no safe drinking water for the world's pollution. Nowadays, water quality monitoring in real time faces challenges because of global warming limited water resources, growing population, etc. Hence there is need of developing better methodologies to monitor the water quality parameters in real time. The water quality parameters pH measures the concentration of hydrogen ions. It shows the water is acidic or alkaline. Pure water has 7pH value, less than 7pH has acidic, more than 7pH has alkaline. The range of pH is 0-14 pH. For drinking purpose it should be 6.5-8.5pH. Turbidity measures the large number of suspended particles in water that is invisible. Higher the turbidity higher the risk of diarrhoea, cholera. Lower the turbidity then the water is clean. Temperature sensor measures how the water is, hot or cold. Flow sensor measures the flow of water through flow sensor. The traditional methods of water quality monitor involves the manual collection of water samples from different locations.

The consequences of water pollution or poor water quality are:

1) *Destruction of Biodiversity:* Pollution of water reduces aquatic ecosystems and initiates unrestrained increase of phytoplankton in water resources.
2) *Food Chain Contamination:* Fishing carried out in polluted water resources and utilization of waste water for agriculture and livestock husbandry may lead to addition of toxins or contaminants into foods that are injurious to the health after consumption.
3) *Scarcity of Drinkable Water:* If pollution of water increases or quality of drinking water is not maintained, then there will be no clean water for drinking or public health or sanitization, in rural as well as urban areas.
4) *Disease:* According to WHO (World Health Organization) information, roughly 2 billion people across the world do not have any option for pure water resources, but they have to drink water polluted by excrement, which exposes them to many ailments.
5) *Infant Mortality:* As per WHO, diarrhoeal diseases associated with lacking of hygiene results in death of nearly 1,000 children per day across the world.

Water quality monitoring is demarcated as the assortment of data at set or desired places and at periodic intervals for providing information that might be accustomed to describe Water Quality Monitoring System

In general water quality monitoring system consists of various sensors such a pH sensor, turbidity sensor, temperature sensors, conductivity sensors, humidity sensors and many other sensors. All the sensors are connected a core controller and this controller controls the operation, gets data from sensors, compares it with that of the standard values and sends the values to the concerned end user or authorities through wireless modules. With the advances in IoT technology, the water quality monitoring system is becoming more smarter with reduced power consumption and ease of operation. Figure shows the operating flow chart of smart water quality monitoring system.

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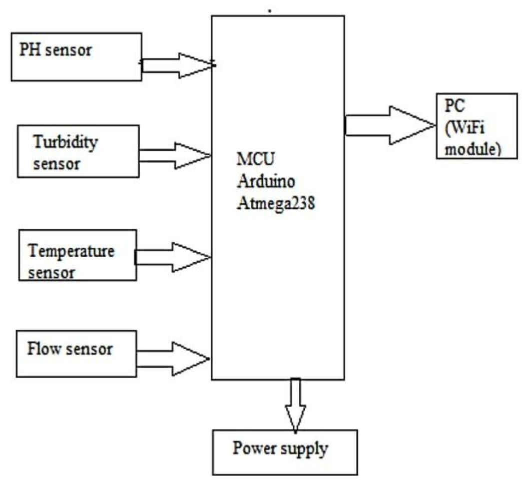

Fig: Block diagram of our project

II. LITERATURE REVIEW

A. Nikhil Kedia entitled "Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project."

Published in 2015 1st International Conference on Next Generation Computing Technologies (NGCT-2015) Dehradun, India. This paper highlights the entire water quality monitoring methods, sensors, embedded design, and information dissipation procedure, role of government, network operator and villagers in ensuring proper information dissipation. It also explores the Sensor Cloud domain. While automatically improving the water quality is not feasible at this point, efficient use of technology and economic practices can help improve water quality and awareness among people.

B. Jayti Bhatt, Jignesh Patoliya, Iot Based Water Quality Monitoring System, IRFIC, 21feb,2016.

Jayti Bhatt, Jignesh Patoliya entitled "Real Time Water Quality Monitoring System". This paper describes to ensure the safe supply of drinking water the quality should be monitored in real time for that purpose new approach IOT (Internet of Things) based water quality monitoring has been proposed. In this paper, we present the design of IOT based water quality monitoring system that monitor the quality of water in real time. This system consists some sensors which measure the water quality parameter such as pH, turbidity, conductivity, dissolved oxygen, temperature. The measured values from the sensors are processed by microcontroller and this processed values are transmitted remotely to the core controller that is raspberry pi using Zigbee protocol. Finally, sensors data can view on internet browser application using cloud computing.

C. Michal lom, ondrej priby & miroslav svitek, Internet 4.0 as a part of smart cities, 978-1-5090-1116-2/16/$31.00 ©2016 IEEE.

Michal Lom, Ondrej Pribyl, Miroslav Svitek entitled "Industry 4.0 as a Part of Smart Cities". This paper describes the conjunction of the Smart City Initiative and the concept of Industry 4.0. The term smart city has been a phenomenon of the last years, which is very inflected especially since 2008 when the world was hit by the financial crisis. The main reasons for the emergence of the Smart City Initiative are to create a sustainable model for cities and preserve quality of life of their citizens. The topic of the smart city cannot be seen only as a technical discipline, but different economic, humanitarian or legal aspects must be involved as well. In the concept of Industry 4.0, the Internet of Things (IoT) shall be used for the development of so–called smart products. Sub components of the product are equipped with their own intelligence. Added intelligence is used both during the manufacturing of a product as well as during subsequent handling, up to continuous monitoring of the product lifecycle (smart processes). Other important aspects of the Industry 4.0 are Internet of Services (IoS), which includes especially intelligent transport and logistics (smart mobility, smart logistics), as well as Internet of Energy (IoE), which determines how the natural resources are used in proper way (electricity, water, oil, etc.). IoT, IoS, IoP and IoE can be considered as an element that can create a connection of the Smart City Initiative and Industry 4.0 – Industry 4.0 can be seen as a part of smart cities.

D. Zhanwei Sun, Chi Harold Liu, Chatschik Bisdikia_, Joel W. Branch and Bo Yang, 2012 9th Annual IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks.

Zhanwei Sun, Chi Harold Li, Chatschik Bisdikian, Joel W.Branch and Bo Yang entitled "QOI-Aware Energy Management in Internet-of-Things Sensory Environments". In this paper an efficient energy management frame work to provide satisfactory QOI experience in IOT sensory environments is studied. Contrary to past efforts, it is transparent and compatible to lower protocols in use, and preserving energy-efficiency in the long run without sacrificing any attained QOI levels. Specifically, the new concept of QOI-aware "sensor-to-task relevancy" to explicitly consider the sensing capabilities offered by an sensor to the IOT sensory environments, and QOI requirements required by a task. A novel concept of the "critical covering set" of any given task in selecting the sensors to service a task over time. Energy management decision is made dynamically at runtime, as the optimum for long-term traffic statistics under the constraint of the service delay. Finally, an extensive case study based on utilizing the sensor networks to perform water level monitoring is given to demonstrate the ideas and algorithms proposed in this paper, and a simulation is made to show the performance of the proposed algorithms.

E. Sokratis Kartakis, Weiren Yu, Reza Akhavan, and Julie A. McCann, 2016

IEEE First International Conference on Internet-of-Things Design and Implementation, 978-1-4673-9948-7/16 © 2016IEEE. Sokratis Kartakis, Weiren Yu, Reza Akhavan, and Julie A. McCann entitled "Adaptive Edge Analytics for Distributed Networked Control of Water Systems" This paper presents the burst detection and localization scheme that combines lightweight compression and anomaly detection with graph topology analytics for water distribution networks. We show that our approach not only significantly reduces the amount of communications between sensor devices and the back end servers, but also can effectively localize water burst events by using the difference in the arrival times of the vibration variations detected at sensor locations. Our results can save up to 90% communications compared with traditional periodical reporting situations.

F. .NielAudre Cloete, R.Malekian, Lakshmi Nair Published 19 July 2016 (DOI:10.1109/ACCESS.2016.2592958 Corpus ID: 1814780_)

This paper describes work that has been done on design and development of a water quality monitoring system, with the objective of notifying the user of the real-time water quality parameters. The system is able to measure the physiochemical parameters of water quality, such as flow, temperature, pH, conductivity, and the oxidation reduction potential. These physiochemical parameters are used to detect water contaminants. The sensors, which are designed from first principles and implemented with signal conditioning circuits, are connected to a microcontroller-based measuring node, which processes and analyzes the data. In this design, ZigBee receiver and transmitter modules are used for communication between the measuring and notification nodes. The notification node presents the reading of the sensors and outputs an audio alert when water quality parameters reach unsafe levels. Various qualification tests are run to validate each aspect of the monitoring system. The sensors are shown to work within their intended accuracy ranges. The measurement node is able to transmit data by ZigBee to the notification node for audio and visual display. The results demonstrate that the system is capable of reading physiochemical parameters, and can successfully process, transmit, and display the readings.

G. Water quality analysis of Surface water

A Web approach Poonam Prasad & Meenal Chaurasia & R. A. Sohony & Indrani Gupta & R. Kumar Received: 25 April 2012 /Accepted: 6 November 2012 / Published online: 14 December 2012 # Springer Science Business Media Dordrecht 2012 Abstract The chemical, physical and biological characteristics of water with respect to its suitability de-scribe its quality. Concentration of pesticides or fertilisers degrades the water quality and affects marine life. A comprehensive environmental data information system helps to perform and complete common tasks in less time with less effort for data verification, data calculations, graph generation, and proper monitoring, which helps in the further mitigation step. In this paper, focus is given to a web-based system developed to express the quality of water in the imprecise environment of monitoring data. Water samples were analyzed for eight different surface water parameters, in which four parameters such as pH, dissolved oxygen, biochemical oxygen demand, and fecal coliform were used for the water quality index calculation following MPCB Water Quality Standards of class A-II for best designated use. The analysis showed that river points in a particular year were in very bad category with certainty level of 0–38 % which is unsuitable for drinking purposes; samples in bad category had certainty level that ranged from 38 to 50 %; samples in medium to good category had certainty levels from 50 to 100 %, and the remaining samples were in good to excellent category, suitable for drinking purposes, with certainty levels from 63 to100 %.

H. Journal of Global Biosciences

ISSN 2320-1355 STUDY OF WATER QUALITY PARAMETERS OF CAUVERY RIVER WATER IN ERODE REGION The water samples were analyzed for physicochemical characteristics. The physicochemical parameters were analyzed namely Temperature, pH, EC, TS, TDS, TSS, Total Hardness, DO, COD, BOD5, Chloride, PO4 and SO4 (Table 1) whereas the correlation coefficients (r) among the average ofeach parameters are presented in Table2. Temperature: Temperature of water may not be as important in pure water because of the wide range of temperature tolerance in aquatic life, but in polluted water, temperature can have profound effects on dissolved oxygen (DO) and biological oxygen demand (BOD).The fluctuation in river water temperature usually depends on the season, geographic location, sampling time and temperature of effluents entering the stream (Ahipathy, 2006).The water temperature was found to be maximum 27.5º C East. The temperature of west and north was recorded (Figure 1) as 26º C. The lowest water temperatures were observed in south site 25ºC. The variation is mainly related with the temperature of atmospheric and weather condition (Adebowale et al., 2008).

The paper depicts a brief survey on the technology used in the existing smart water quality monitoring system and describes the technology used for this system. It also includes the international status of the system. Comparative study of the different mode of technologies used for real time monitoring. By employing this recommended system, the related authorities can take measures to boost the water quality which makes it more usable. These measures can diminish the contaminants present in water, which in turn cut off the threats caused due to usage of unclean water for daily life, assuring the acceptable facets of water**.**

I. S.Geetha and S.Gouthami developed a low powered and naiver solution for monitoring quality of in-pipe water based on IoT.

The developed model is used to test samples of water and the data collected from the sensors is uploaded over the internet is analysed. This model is less complex and low cost smart water quality monitoring system with a core controller having built-in Wi-Fi module for monitoring quality parameters like turbidity, conductivity and pH. The developed system comprises of an alerting facility for informing the users on deviance of water quality parameters. The implementation facilitates sensors to provide data over the internet to the end customers. The setup used for experiment can be enhanced by integrating algorithms for incongruity detection in quality of water.

J. Bharathi Sengupta et.al proposed a cost effective technique for monitoring water quality and controlling in real-time using IoT.

The proposed system comprises of different sensors like temperature sensor, turbidity sensor and pH sensor that are interfaced with Rasp-berry Pi via an Analog-to-Digital converter (ADC). Based on the da-ta obtained from various sensors and processing of data by the Raspberry Pi, the solenoid valve will be directed to either continue or stop the flow of water from the overhead tank to houses using relay mechanism. This entire process takes place automatically without human intervention thus saving the time to handle the situation manually. Finally its checks for weather water quality parameters are desired range or not. These all devices are low cost flexible and high efficiency.

K. M. Joseph Vishal Kumar and Krishna Samalla proposed a cost effective system to monitor quality of water in real-time using IoT.

The designed system used various sensors to measure the chemical and physical parameters of the water. This smart water quality system consists of a Raspberry pi controller interfaced with various sensors like CO2 sensor, pH sensor, turbidity sensors, temperature sensor and water level sensors. These sensors control the entire operation and monitoring is done by Cloud based wireless communication devices.

L. Demetillo et.al proposed a cost effective and water quality monitoring system in real-time that can be used in remote lakes, rivers and other water resources.

The major hardware in the system comprises of a microcontroller, standard electrochemical sensors, a customized buoy and a wireless communication system. The developed system is capable of detecting pH, dissolved oxygen and water temperature at pre-programmed periodic intervals. The developed system transmits the collected data in tabular and graphical formats over a personalized web-based portal and registered mobile phones for serving better to the appropriate end-users. The results of the experiment proved that the developed system has higher anticipation and could be employed for monitoring environment practically by giving end-users with pertinent and well-timed information for better action plan. Extension of the coverage range using autonomous surface vehicle is continuing for covering huge areas such as rivers, lakes and other such water resources that needs continuous monitoring owing to its prominence to both nature and humankind. Use of lithium-ion batteries as a source of power and the inclusion of heavy metallic ion as parameters of concern is furthermore deliberated for the extension of the work.

M. Anuradha et.al developed a cost effective system for monitoring the quality of water in real-time using IoT.

The developed method is a sensor based Water Quality Monitoring System that is used to measure chemical and physical parameters of water. The parameters are measured using sensors and are processed by Raspberry Pi controller. Lastly, the measured sensor data is seen on the internet by using ThingSpeak API. The distinctiveness of this work is that the water monitoring system is having many advantages such as high mobility, high frequency and the developed model uses low power. Quality parameters like ammonia, hardness, conductivity, fluoride, iron, chloride content can be also deliberated for measurement of quality of water and the measured values are used for checking the cleanliness of the water for numerous applications like daily requirements for industries and drinking water.

III. CONCLUSION

Water Pollution is a major threat to any country, as it affects health, economy and spoils bio-diversity. In this work, causes and effects of water pollution is presented, as well as a comprehensive review of different methods of water quality monitoring has been discussed. Although there have been many excellent smart water quality monitoring systems, still the research area remains challenging. This work presents a review of the recent works carried out by the researchers in order to make water quality monitoring systems smart, low powered and highly efficient such that monitoring will be continuous and alerts/notifications will be sent to the concerned authorities for further processing. The use of latest sensors for detecting various parameters of quality, use of wireless communication standards for better communication and IoT will definitely make a better system for water quality monitoring and the water resources can be made safe by immediate response.

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