A SURVEY ON SMART WATER MONITORING AND CONTROL USING INTERNET OF THINGS

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***Abstract*: Nowadays, water scarcity has become an important crisis. Water scarcity is defined as the lack of sufficient available water in all the water resources particularly to meet the demands of water usage all over the world .The usage of water has been increasing more than twice the rate of population increase in the last century, and increasing number of regions are reaching the limit at which water services can be sustainably delivered, especially in dry regions. Water should be treated as a scarce resource. The effects of water scarcity can be categorized into four broad areas education, health, hunger, and poverty. Therefore, it is necessary to monitor and control the usage of water from remote area through internet of things. The objective of this paper is to provide an extensive survey of methods developed over the past decade regarding the smart monitoring of water flow in pipes, leakage detection, and purity of drinking water. A comparative study of pros and cons of these approaches have been perceived and the performance metrics of purity, leakage in water pipes and time of responses have been discussed in this survey paper.**

***Keywords*: Water scarcity, monitoring and control, leakage detection, purity, Internet of Things (IoT).**

INTRODUCTION

Water management is managing of water resources under some certain rules and regulations. Once water was an abundant natural resource, is now becoming a more valuable commodity due to overuse and droughts. Water resource management is the activity of planning, developing, distributing and managing the optimum use of water in the water resources. Water resource management is a sub-set of water cycle management. Ideally, water resource management planning has regard to all the competing demands for water and seeks to allocate water on an equitable basis to satisfy all uses and demands. In present scenario, only about 0.08 percent of all the world's fresh water is exploited by mankind in ever increasing demand for drinking, manufacturing, leisure, sanitation, and agriculture.

LITERATURE SURVEY

M.Jaya Lakshmi et.al., proffered a paper on an enhanced underground pipeline water leakage detection and monitoring system using wireless sensor network. This paper describes about the design and implementation of a water leakage monitoring and detection system to monitor and detect leak with the help of wireless networked sensors. The main objective of this enhanced system is to detect possible underground water leakage for residential water pipes that are monitored from a PC.
The possible communication within the network is provided by ZigBee technology that is built on top of IEEE 802.15.4 communication standard. The benifits of using ZigBee technology is a low power consumption, low data rate, and low cost wireless networking protocol targeted towards automation and remote control applications.

The approximate location of the leakage can be calculated by different cross correlation methods. Cross correlation is defined as a measurement that tracks the movements of two variables or sets of data relative to each other. It can be described as of an independent variable, X, and two dependent variables, Y and Z. If independent variable X influences variable Y and the two are positively correlated, then as the value of X rises so will the value of Y. If the same is true of the relationship between X and Z, then as the value of X rises, so will the value of Z. Variables Y and Z can be said to be cross correlated because their behavior is positively correlated as a result of each of their individual relationships to variable X. Cross correlation can also occur with sets and time series of data. Even though the cross correlation method looks good they have some disadvantages, which make them currently not suitable to be deployed as a buried wireless sensor network system. A major fundamental disadvantage of these systems is the potential for redundancy, which currently makes them unsuitable for general adaptation in pipeline monitoring.[1]

Thinagaran Perumalet.al., propounded a paper on internet of things (IoT) enabled water monitoring system. This paper deals with an IoT based water monitoring system that measures water level in real-time. The desired parameter is measured using water level sensor and if the water level reaches the parameter, the signal will be feed in real-time to social network like Twitter. The proposed solution has integrated sensory system that allows inner monitoring of water quality and is low cost. Alerts and relevant data are transmitted over the Internet to a cloud server and can be received by user terminal owned by consumers. The result of the water measurement is displayed in web based remote dashboard using internet of things.

Water monitoring data are analyzed based on IoT, to measure their performance metric in terms of accuracy as well as response time. The total response time taken to complete one cycle of sensor feed is 126ms. For benchmark and indicators, three levels of indicators are classified which are Safe level (distance greater than 45.0cm), Not Safe level (distance between 35.0cm and 45.0cm) and Danger level (distance less than 35.0cm). Both Not Safe level and Danger level will trigger the LED and subsequently update the results on web-based dashboard. If water level reaches higher, then it will indicate as danger level and trigger the buzzer alarm alert.

The IoT based water monitoring and controlling system is deployed using 2 different IoT sensors (i.e. ultrasonic, water sensor) by applying IEEE802.11 communication standards. The datas from the sensors are transmitted by integrating a wireless gateway within the consumer network. The downside of using IEEE802.11 is it has traffic disruptions ,network security and maintenance needed to stay secured and requires periodic maintenance.[2]

Goib Wirantoet.al., trotted out a paper on design of online data measurement and automatic sampling system for continuous water quality monitoring. The prototype system used here is automated sample collection unit based on an online water quality measurement. The automatic sampling unit was constructed from PVC holder, a 12V motor stepper, a 12V DC pump, and 8 glass tube sample storages. The results after experimenting showed that when the measured the pH values below 4 or above 9 ,or DO value dropped below 5 mg/l, the sample collection unit worked by filling up 20 ml sample in just under 650 ms.

There are three main blocks used in automatic sampling unit, the sensing block has the main function of performing initial data collection about the water quality parameters from the location of installation. The data logger then processed the data, deciding whether the automatic sampling system should be activated. Otherwise, the data will be stored or transmitted for display. The sampling block only operates under extreme water condition as specified by the data logger. In this case, only when certain threshold values are violated will the water sample be taken. All the measured data will eventually be sent to a Personal Computer (PC) where software has been developed to do the analysis on the water quality parameters. Power consumption is a major constraint. Communication of data is a major source of power consumption. Data communication occurs in two stages for applications such as smart water quality monitoring One is the communication between sensors and the controller and other is the communication between controller and application.[3]

LieGuo Wu et.al., proposed a paper on water environment monitoring system based on ZigBee wireless sensor network. This paper is an introduction to the establishment process of a ZigBee water environment monitoring system. ZigBee standard is a standard that defines a set of communication protocols for short-range, low-data-rate wireless networking. The application of ZigBee wireless sensor networks to the water domain has huge potential for monitoring the health of lake and marine environments.

A ZigBee sensor network deployed on the water could monitor physical variables such as water temperature and pressure as well as variables such as conductivity, pH, dissolved oxygen and certain pollutants. ZigBee networking topologies: star, mesh, tree. And in a ZigBee network , there are three kinds of nodes: Coordinator, Router and End Dev ice. In ZigBee network that too with star topology, every device in the network can communicate only with the coordinator. In a tree topology or a mesh topology, each device can communicate directly with any other device if the devices are placed close enough together to establish a successful communication link. And in a tree topology, ZigBee end devices act as leaves of the tree and don't participate in message routing. A mesh topology didn't have thus restriction. A ZigBee network, regardless of its topology, is always created by the coordinator node. The coordinator controls the network and allocates a unique address to each device in the network. A star topology network is easy to install and to detect faults, and there are no disruptions to the network then connecting or removing devices. The remote monitoring centre consists of two parts: the GPRS gateway and the data base. The GPRS gateway is used to receive the water parameters, and the server will store the data and produce a report that shows the quality of the water environment. They have done two types of data collection experiments the pH data collection and the temperature data collection. We used ten end devices to collect the temperature measurement range is 0-100 ° C, and the accuracy is ±O.S°C; its pH measurement range is 0-14, and the accuracy is ±0.05. The limitations of ZigBee is low complexity, and low data speed. Its high maintenance cost, lack of total solution, and slow materialization, Low transmission, as well as low network stability.[4]

Baoding Zhang et.al., introduced a paper on a kind of design schema of wireless smart water meter reading system based on ZigBee technology. ZigBee is one kind of technology with short distance, low complexity, low power, low data rate, low cost and two-way wireless communication. And it is developed based on the IEEE 802.15.4 wireless standard about the networking, security and application software technology. It supports three main types of self-organizing wireless network, star topology, network topology and cluster topology. In the network, the number of network nodes can reach 65000, the distance between each network node can be expanded from the standard 75m to a few hundred meters, or even several kilometers, and the rate of wireless data transmission can achieve up to 76.8kb/s.

GPRS (General Packet Radio Service) technology is a new type of packet data transmission technology added based on the existing GSM network, with permanent online, fast login, high speed, billing according data volume of transmission, automatic switch, safe and reliable advantages and existing GPRS data transmission speed is about the actual 40 kb/s. In this paper, ZigBee wireless technology is used to solve the problems of communication among water meters, acquisition spots and data concentrators. And the communication between data concentrators and data processing center is via GPRS network. The inconvenience in using this technique is power consumption and the cost. And the power consumption is an important problem to restrict the mass using of the wireless meter reading system.[5]

Peng Cheng et.al., presented a topic on the design and implementation of remote-sensing water quality monitoring system based on spot-5. It deals with the study of RWQMS(Remote-sensing Water Quality Monitoring System V1.0) is designed and implemented based on SPOT-5 remote-sensing image and the system structure. In SPOT-5 image basis, the water quality monitoring system established the model of semi-supervised parameters inversion according to the artificially sampling data and remote-sensing images, which can predict water concentration with providing a new remote-sensing for users. Thus, it evaluate the water level according to GB3838-2002 ,an environmental quality standards for surface water.

Modular principle. The water quality monitoring system design not only includes the remote sensing image processing functions for users, but also includes the functions of predicting and evaluating water quality according to remote-sensing data. Therefore, we must design various modules to complete different function so as to maintain and expand the system changes. Scalability principle, in system design, we need to consider the needs of the future development of demand, it can expand with needs. Under the modularized structure design, only modify a little module function, RWQMS will be improved and be implicated in different fields.

User-friendly interface design principles, the interface design of system operation should consider users needs and should be friendly, intuitive and easy operation. Data input convenient and consistent format, system must provide uniform data input formats, can input batch measured data or single measured data, and can modify and delete. Besides, it can also add or delete the water quality parameters of the system inversion with the change of the national water quality indexes. The obstacle in using SPOT-%5 remote sensing is its high cost.[6]

Kaushikguptaet.al., put forward an idea on smart water management in housing societies using IoT. The paper converges on an idea where the ultrasonic water level sensor would be constantly monitoring the water level and transmitting the data over cloud to residents of the society. Turbidity sensor would be monitoring basic quality features of water which will come handy while choosing the water provider services, as historic data would be present in a form of quality vs quantity graph. The sensed parameters from the sensors will be collected and will be sent to the cloud to update the real time data so that it can be made available on the smart phone app.

As a key controller, we have used raspberry pi. It has built- In WiFi module so that it can easily communicate with other devices and cloud thus allowing its control from any computer such as a smart phone, over the internet. The protocol used for transmitting data is MQTT (Message Queuing Telemetry Transport) which is a Subscribe/Publish service. MQTT is a fast, low bandwidth protocol, SSL security, and is optimized for IoT. Ultrasonic sensor is used to find the distance. Here the purpose of ultrasonic sensor is to get the between water and the ultrasonic sensor. This is used to calculate the water level in percentage and also water quantity in liters in our proposed project. Turbidity sensor provides the information about the extent of suspended physical impurities in water. The drawback of using MQTT protocol is It operates over TCP .TCP requires more handshaking to set up communication links before any messages can be exchanged. This increases wake-up and communication times, which affects the long-term battery consumption. [7]

Michel R. Machado et.al., asserted a paper on smart water management system using the microcontroller zr16s08as IoT solution. The system operates through the smart monitoring of the water flow in pipes of the water distribution network, aiming to ensure quality of the water supply, knowing that water losses characterize one of the great problems in the world, as pipe holes may be open doors to water contaminants. Adopting criteria such as low consumption and low cost, the use the ZR16S08 microcontroller in the design of wireless sensor nodes that will be coupled in the water pipes was adopted. Complementing the system, a central processing unit, composed of a Raspberry Pi microcomputer, manages the traffic of the information collected by the sensor nodes and routes it to a web server.

Considering the size of the sensor nodes, their power consumption, and regulatory issues, a link between the sensor nodes, operating at a frequency of 433 MHz, was defined. The advantages of using this model of communication structure are the low consumption of the sensor nodes when compared to a multi hop topology, since the same ones, after sending data, go into “Standby” mode, deactivating most of their logical functions. The communication between the sensor nodes and the gateway is done through an On-off Keying (OOK) modulation. Setting the microcontroller to an IDLE state during the "zero" logic transmission, in fact, in the logic zero state there is no transmission, conserving battery power. The demerit of using this microcontroller is it offers a great cost to performance ratio.[8]

CONCLUSION

This paper discuss about many different techniques and tools are used for water management and control. In this literature survey, an overview of water monitoring and control of water flow in pipes, leakage detection and purity of the water is monitored from remote area and controlled using Internet of Things (IoT). Motor can be controlled automatically and full smart automation can be achieved. It is a robust, easy-to-install system and small in size. This project will increase the convenience for the residents by enabling them to monitor and control the water management system remotely using smart phone. In this paper, a complete IoT solution for water management was presented including the measurement system and data communication between sensor nodes and central node. Preliminary results have shown a fully operational prototype system capable of measuring the water flow, comparing the data and reproduce it with a minimal error. The summary of all different techniques used till date and the performance metrics of them are mentioned below.

SUMMARY

Sl no	TECHNOLOGY	MICROCONTROLLER	SENSORS	PERFORMANCE METRICS		
				LEAKAGE DETECTION	PURITY	TIME OF RESPONSE
1.	ZigBee technology	Atmel's ATmega1281V Microcontroller and AT86RF212 RF Transceiver	flow sensor	High leakage detection	-	1 sec
2.	IEEE802.11 based IoT	ATmega328P	ultrasonic sensors	Water level detection	-	126ms
3.	Xbee module	PCDuino microcontroller	pH sensor dissolved oxygen(DO) stepper motor	-	4 or 9 for pH. 5 mg/l for DO	650 ms for 25ml sample
4.	ZigBee networking	MCU CC2530 chip	pH sensor Temperature sensor	-	7-8 pH 4 and 20 deg C	-
5.	ZigBee technology	PIC16F946	water meters GPRS module.	-	-	-
6.	Remote-sensing water quality monitoring system V1.0(REMS)	-	GPS	-	High accuracy	-
7.	IoT	RaspBerry Pi zero w	Ultrasonic sensor Turbidity Relay switch	Water level	High accuracy turbidity detection	Real time datas
8.	IoT	ZR16S08 microcontroller RaspBerry Pi	water flow sensor	Every 17s	-	50ms

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