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Monitoring and Control of Water Quality System Using Internet of Things and Geographical Information System

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Abstract— **the monitoring of water quality is very much essential to maintain good health and provide support for making decision in environmental issues. The main properties of the water are a natural solvent that dissolves everything it touches. Nowadays, modern sensors are playing vital role to continuously monitor quality and to provide high resolution, quantitative and validated measurements. In this paper, a new model is proposed to monitor water quality parameters based on high level communication technology Internet of Things (IoT) and integrated with Geographical Information system (GIS). The measured water quality parameters were stored in a cloud in IoT for controlling purpose. Based on the contamination and variation of water quality parameters the embedded controller automatically provides control signal to normalize the drinking water level by delivering chemical compound to the pipeline water. The entire system utilizes solar power for their functioning. The proposed system is very useful to monitor and control water quality of pipeline water. The proposed system is useful for water distribution system of government. They can monitor and control the water quality parameter variation using mobile phone or computer with internet facility. The integration of Geographical Information System(GIS) with sensors is able to detect the quality of water status.**

***Index Terms*— Sensors, Internet of Things, Embedded Controller and GIS**

1. INTRODUCTION

The statistical data from world water assessment inform that each and every day approximately 2 million tons of entity waste is inclined with water courses. It keeps tabs on water quality is critical one and the results have been pinpointing any changes or trends which that appear in water bodies of certain period of time. The continuous monitoring of water quality is a vital part, which is used to identify several on hand problems and addresses many issue. Over the past years, the real time example reveals that fertilizers are used for production of food. It had been increased 20% of global nitrogen pollution in rivers. While designing and budding toxic waste anticipation and administration strategies statistics together from water excellence monitoring efforts is enormously obliging. Among seventy percent of unprocessed manufacturing dissipate deserted directly into water systems, toxic waste administration mandatory one. Today, Indian government focusing on achieving goals to provide better quality of water to people and industrial business oriented concern. The citations [1][2] proposed a model to determine the pollution regulations affected radiation leaks to floods, oil spills and mass erosion.

The majority of consumers interpret low drinking water temperatures (especially in the summer months) as an indication of high quality and freshness of the drinking

water. In contrast, an increased temperature and an unusual odor and taste are more likely to be perceived as a quality problem. Even a slight increase in temperature can lead to general changes in the microbiological processes in the drinking water supply. These changes can be noticed by a change in the microbiological stability of the distributed water or the tendency of re-infection. Depending on the chemical-physical and microbiological raw and pure water quality and specific operational boundary conditions, undesirable reductions of the "usual" drinking water quality can occur. A more precise and meaningful investigation of the above-mentioned changes and their possible interactions with the safety and quality of drinking water supply has increasingly become the focus of attention in the water industry in the past years. At the same time, innovative, highly sensitive and efficient analytical methods have been developed that can be used for a more in-depth investigation of these issues, such as online monitoring of chemical and physical properties (e.g. organics, turbidity, electrical conductivity, temperature) [4].

Consumption of water is a main alimentative. Thus, not only convey in the consumption water system, but also the outstanding superiority for the customers have to be ensured. At present, the excellence of consumption water is confirmed by laboratory samples, which are accepted according to the system and law through water companies at particular interval. The real consumption water guideline for intend in improvements by touching away from usual example to a danger assessment of example preparation. Or otherwise, this approach was expensive, since diagonally great part of the consumption water system samples require being in use, transported and analyzed broadsheet to monthly. However, due to their leisurely dynamics, troubles such as contagion proceedings can frequently hardly to detect. The order of arranged occurrence of examinations and to enlarge clearness, a lot of water suppliers expecting real time sensors to respond these issues linked with respect of water excellence in their consumption and delivery [5]

The aforementioned challenges build the physical way of measuring water excellence fairly superfluous. Elegant water excellence monitoring structure by means of IoT, are therefore obligatory to routinely monitor a variety of parameters so as to resolve the excellence of water. Internet of Things has enabled the growth of routine water excellence monitoring systems that alleviate the aforementioned challenges. By means of using devices comparable to sensors and probes, supplementary than a small number of parameters, water can be premeditated in instantaneous from distant locations. These approach hole exist statistics concerning the excellence of a water remains to a display place. Through this stage, an individual or a corporation can obtain helpful measures to make certain best water superiority [1][4]. In this research work, a real time water samples are collected nearby Kavery river and industries to analyze and monitor the quality based on IoT and GIS.

2. PROPOSED SYSTEM STRUCTURE

The system composed of solar photovoltaic cell to generate electricity from solar radiation. Solar Photovoltaic Cells are made up of semiconducting material. These materials have been used to absorb sunlight and designing of cells to handle that sunlight when it reaches to the earth surface. The generated electrical power is stored in battery and used for the operation of water quality monitoring sensors such as pH sensor, turbidity sensor, conductivity sensor, pressure sensor, temperature sensor and flow rate sensor. The water quality monitoring sensors are used to measure various water quality parameters. The measured parameters are transferred to cloud storage through Wi-Fi transceiver module. Wi-Fi is wireless network protocol. The persons from anywhere if they know the user authentication Id they can visit the parameter variation through mobile phone or computer. Based on the measured water quality parameter variation, the embedded controller used in the mobile can automatically transfer control signal to the pipe line to add compensative chemical composition to the pipeline water. The overall structure of projected self power-driven Internet of Things used water superiority monitoring and control arrangement is prearranged in the following Fig. 1.

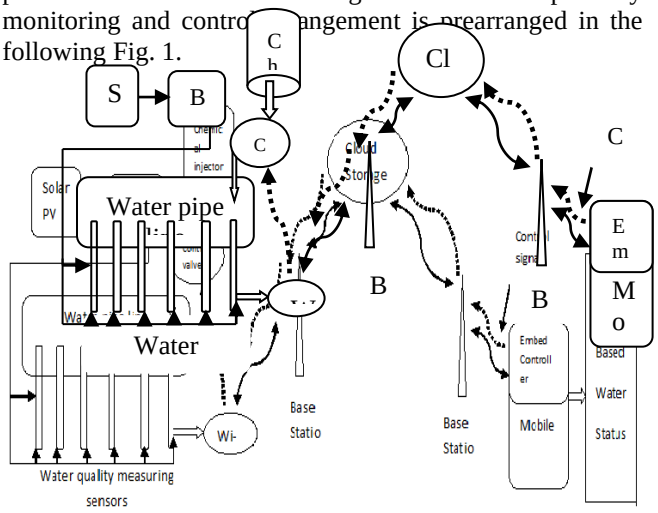

Fig. 1 Structure of Self Powered IoT based Water Quality Monitoring and Control System

The set point values of pH, temperature, turbidity, conductivity, pressure and water flow sensors are programmed into the embedded controller using embedded C programming. The controller makes a comparison between set point and measured value of quality water parameters. Based on the variation between them, the embedded controller issues a control signal to open or close the control valve of chemical injector. The chemical injector injects water purifying chemicals such as chlorine, chlorine

dioxide and ozone into the pipe-line to control the water quality with appropriate level. Depending upon the measured parameter the embedded controller provides control signal to inject proper water purifying chemicals into the pipe-line water.

3. IMPLEMENTATION OF SENSORS

The purpose of using pH sensor is to compute hydrogen ion concentrations of water. The pH is significant pointer of irrigate that is altering chemically.

Fig 3.1 Three-way pH detector

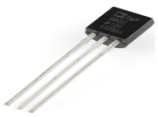

Fig 3.2 LM35 Temperature Sensor

Fig. 3.3 TSD 10 Turbidity sensor

The pH is used to compute the acidity of an aqueous liquid. The solution is acid; the pH value is in the choice of 0 to 6.9. The solution is alkaline, pH choice of 7 to 14. The uncontaminated water is unbiased at pH 7.0. The pH is significant restriction that is calculated in almost each water excellence. The pH detector is a three-way ideal instrument to experiment the pH value of irrigate. This instrument is used to compute pH value of several fluid and also to observe the moisture in earth. It is an accurate instrument. The Fig 3.1 shows the structure of three-way pH detector.

The LM 35 sensor is shown in Fig 3.2 which also gives output as analog signals and gives continuous monitoring. It is an integrated sensor gives very good accuracy and the obtained output is proportional to the temperature in Celsius. Due to sealed nature of sensor circuit, it prevents from oxidation or another process. It additionally has self-heating and will not cause a temperature rise above 0.1° C in the stationary atmospheric conditions. The range of working temperature lies between -55°C and 150°C. Every productivity voltage fluctuates with the value of 10mV with respect to every ambient temperature.

The TSD 10 Turbidity sensor is shown in Fig. 3.3. which gives the measurement of turbidity i.e an amount of suspended particles in the wash water from dishwashers and washing machines. In general, an optical sensor is used in washing machine to measure product for density of turbid water. By using ratio between refraction of wavelength and photo transistor, an extraneous matter concentration can be determined. The optical diodes detect the quantity of luminosity of the light receiver for computing irrigate turbidity.

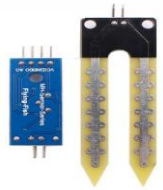

Fig 3.4 Conductivity sensor

Fig 3.5 OEM Pressure transducer

Fig 3.6 Arduino water flow sensor

The Conductivity sensor is shown if Fig 3.4 is providing a measurement of water ability to allow flow of electricity. It has capability in a straight line related to the attentiveness of ions in irrigate. The measure conductive ions come up from dissolved salts and non-living materials. The non-living materials alkalis, sulphides, chlorides, and Carbonate compound. The sensor is able to compute either conductivity solution or whole concentration ion of aqueous samples.

The OEM Pressure sensor is shown in Figure 3.5. The OEM pressure sensor is a battery powered water pressure data-logger which works with a 3.7-volt supply. The measuring range is 0 to 20 bar and we prefer to have the quick coupling male nipple for the connector. The stripped down OEM version of the IMP pressure transducer is specifically designed for use inside freshwater pressure loggers to measure pressure by means of a quick release pressure fitting at a full scale pressure rating of 20 bar sealed gauge. It has a four wire mV output which can be powered by a low voltage supply such as 3.7V.

In qualitative aspects and financial point of view, precise flow measurement is consideration as a vital step together in the stipulations. The flow meters had been proven excellent devices to measure water flow and very easy to build a water management system. The water flow sensor YF-S201 sits in line with water line and contains a pinwheel to measure continuous flow of water removed from the source. It is an integrated sensor that has magnetic Hall-Effect and hence outputs an electrical pulse with every revolution. It comes with three wire technology for calculating the flow rate of water from the output terminal.

4. INTERNET OF THINGS (IoT)

In industry 4.0 revolution, Internet of Things (IoT) playing vital role and explains the system of substantial matter “belongings” that are entrenched through sensors and software. This enhanced technologies concerning and exchanging information with additional devices over the internet.

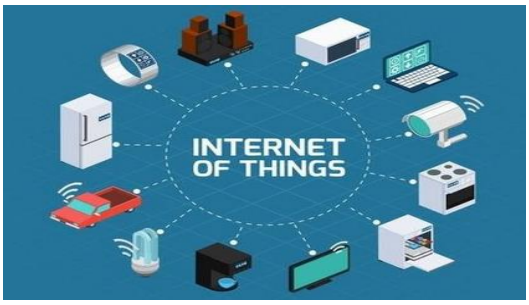

Fig 4.1 Internet of Things (IoT)

Nowadays an IoT is very much contributing to collecting and sharing the data from one system to another system over internet. Getting approval from Microsoft Azure separate location is reserved in cloud to store water quality parameters. In this system IoT is used to store the water quality parameters pH, temperature, conductivity, turbidity, pressure and water flow rate. These stored data can be automatically retrieved by an embedded controller for further process.

5. EMBEDDED CONTROLLER

An embedded controller with 32-bit microcontroller shown in Fig. 5. 1 handles various system tasks. The entire set point values are loaded into the 32-bit embedded controller. The embedded controller is used to receive data from sensor nodes through cloud and process the data. The embedded controllers formulate an assessment among set point data and calculated data

Fig 5.1 32-bit Embedded Controller

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According to the difference among them the embedded controller delivers control signal to the control valve. In this system actuator is used as a control valve. It is used for opening and closing the flow of water purifying chemicals. In this system chlorine is used as water purifying chemical.

6. PROTOTYPE AND OUTPUT

The various water quality monitoring sensors such as pH sensor, temperature sensor, turbidity sensor, pressure sensor, conductivity sensor and flow sensor are inserted into the pipe line to measure water quality parameters. The water purifying chemical injector is also connected to the pipe line through actuator. The prototype model is shown in Fig. 6.1.

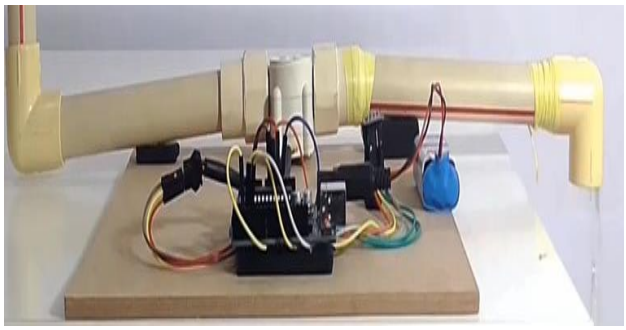

Fig 5.1 Prototype model of Self Powered IoT based Water Quality monitoring and Control system

The entire measuring sensor output is applied to the Wi-Fi transceiver module. It is wireless communication protocol. It can transfer measured parameters to the cloud through base station (BS). Based on Time Division Multiplexing (TDM) each parameter can be measured and stored in Cloud. Separate storage space is already reserved in Microsoft Azure cloud. It can be used as a public cloud. Once the persons know the user authentication ID, the person can visit the water quality parameter variation from anywhere in the world and also they can send control signal to control water quality parameter variation.

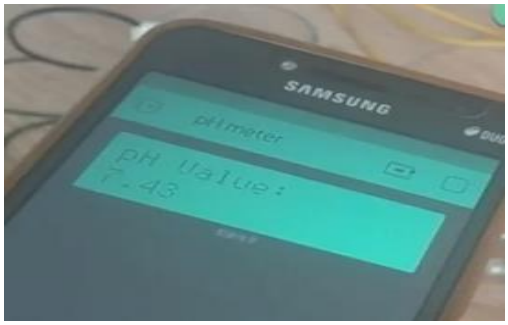

Fig 6.2 Snap shot output

The entire stored data from the cloud automatically transferred to Embedded Controller in a particular destination node such as mobile phone, Laptop or desktop computer. Embedded controller compares measured and set point values. If any deviations obtained by the controller, it will send control signal for further process. This control signal given to the actuator to open or close the tap to inject the water purifying chemical compound to the pipe line water. The snap shot output shown in mobile phone is shown in Fig 6.2. We can view the output through mobile phone, Laptop or desktop computers. The system should have internet facility. From the obtained output pH value is 7.43, so the pipe line water is basic. It is not a pure drinking water. Hence the controller provides control signal to inject minimum amount of chlorine into the water in order to control drinking water quality to a predetermined level.

7. GIS BASED WATER QUALITY MONITORING AND MAPPING

The chemical, physical and biological characteristics of water bodies are the important parameters to monitor the water quality. Various studies have been carried out by different researchers to use remote sensing and GIS as an effective tool to continuously monitor the quality of the water supplied. The Fig. 6.1 shows the GIS based water quality parameters mapping and status system

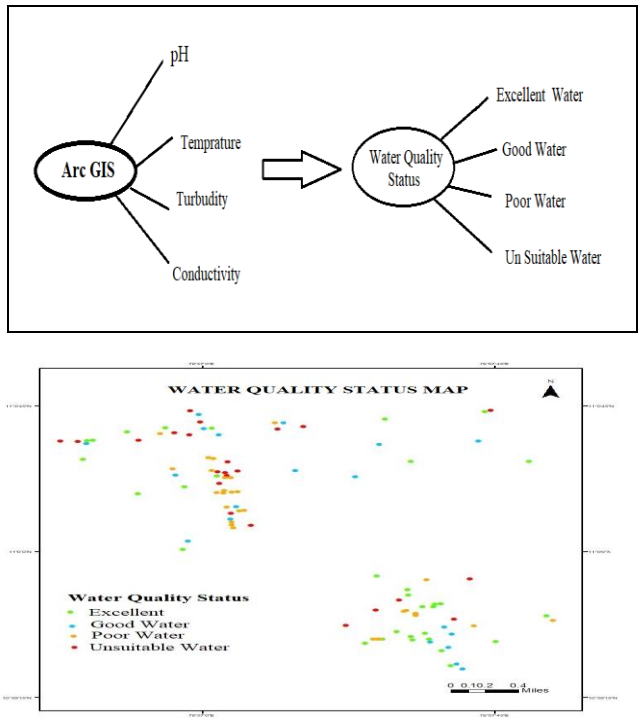

Fig 6.1 GIS Water Status System

In this research work the four main water parameter (pH, temperature, turbidity, conductivity) are measured using the sensors and using GIS as a tool this data is converted in to geo-spatial database. The spatial data base is integrated with the water quality parameter to create a vector layer in Arc GIS. Spatial query and analysis can be done on this vector layer which facilitates the decision maker to take effective controlling measures. By using statistical tools, the locations more vulnerable to poor water quality can be identified and effective measures can be taken.

8. CONCLUSION

The newly proposed self-powered IoT based water superiority monitoring scheme implemented with very less expensive. The arrangement consumes extremely consumption of power for its functioning. The portable arrangement provides effective features such as less weight, preservation and testing time phase of samples is less than in seconds. The projected arrangement in this work also accomplishes protected information broadcast. The testing time phase can further have reduced to nano-seconds and power consumption is also required very smaller amount. The modern computerization control of this water superiority monitoring procedure and control reduces the necessity of physical labor to examine irrigate excellence, hence it saves time. The integration of Geographical Information System (GIS) with sensors is able to detect the quality of water status. The projected arrangement is extremely helpful to preserve citizens from injurious hazards. Since the vaccination of water purifying chemicals the hazards be capable of be avoided. From the analysis of results, the system makes the control and monitoring procedure more competent and successful. The projected arrangement is extremely valuable for protection of community healthiness and as well makes the surroundings free from danger. The projected representation is adopted to experiment the irrigate samples in the drainage panel. This novel thought be able to advance extensive to additional areas like natural gas monitoring, liquid monitoring systems etc.

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