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An IoT Based System for Water Quality Monitoring

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ABSTRACT*:* In today's world, Internet of Things (IoT) and Remote Sensing (RS) techniques are being used in different areas of research for monitoring, collecting and analysing data from remote locations. Drinking water is a very precious commodity for all human beings as drinking water utilities face a lot of new challenges in real-time operation. These challenges originate because of limited water resources, growing population, ageing infrastructure etc. therefore there is a need for better methodologies to monitor the water quality. In order to ensure the safe supply of drinking water the quality needs to be monitored in real-time. In this paper we intend to present the design and development of a low cost system for real monitoring of water quality in an IoT environment. The system consists of several sensors which are used for measuring physical and chemical parameters of water. The parameters such as temperature, pH, turbidity, conductivity, dissolved oxygen of the water can be measured. Using this system a person can detect pollutants from a water body from anywhere in the world.

KEYWORDS: IoT, Cloud, Microcontroller, Sensors, Water parameters.

I. INTRODUCTION

Water is used in various activities, such as consumption, agriculture and travel, which may affect water quality. Therefore, the water quality monitoring is necessary which includes several chemical parameters. Some of these are: pH, redox potential, conductivity, dissolved oxygen, ammonium and chloride ion amount. There is need to improve existing system for monitoring water bodies, given that laboratory methods are too slow to develop an operational response and does not provide a level of public health protection in real time. Due to the vast increase in global industrial output, rural to urban drift and the over-utilization of land and sea resources, the quality of water available to people has deteriorated greatly. The high use of fertilizers in farms and other chemicals in sectors such as mining and construction have contributed immensely to the overall reduction of water quality globally[1-2].

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 is made available for drinking in town and city articulated supplies as well as the rivers, creeks and shoreline that surround our towns and cities. The availability of good quality water is paramount in preventing outbreaks of water-borne diseases as well as improving the quality of life.The development of a surface water monitoring network is a critical element in the assessment and protection of water quality.

We developed a prototype of easy to install technology by which the different surface water (e.g. rivers, lakes) quality indicators can be measured. This paper presents a smart water quality monitoring system.

II. RELATED WORK

Many systems have already been developed based on the topics of remote monitoring.
Various researches have been performed to monitor the quality of water:

- **Autonomous water quality monitoring system using GSM** [4].
  This system was developed jointly as an element of the Autonomous Live Animal Response Monitor (ALARM) toxicity biosensor, designed to be deployed in-stream for continuous observation.The objective of their work is to develop a low cost, wireless water quality monitoring system that aids in continuous mensuration of water conditions. Their contribution

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during this is that the system-level integration of biosensors, sensing element signal processing and sensing element information management. Their system was designed to measure a suite of biologically relevant physiochemical parameters in fresh water. They measured temperature, intensity level, pH, electrical conduction, total dissolved solids, salinity, dissolved oxygen and redox potential. These parameters provide insights into the current status of changing water conditions and assist in identifying pollution sources.

- **Using image processing technology for water quality monitoring system** [1].
 The fish responding behavior has been taken one of the methods in monitoring water quality in recent years. This study has successfully in building a water quality monitoring system by utilizing the image processing and fuzzy inference in auto-recognizing the gesture of fish. It was our first time in setting up the image background model by using W4 method, and then adopted deduction of background in recognizing the fish profile.After finding the center-of-gravity position of fish profile, we can obtain the real time characteristic information of fish in position, speed and moving track. Finally put these information the input of fuzzy inference system, via appropriate rules bank in analyzing, the output value can be obtained. In this study, Zebra fish and Common Goldfish were adopted to be the study objects by using different into water and out of water device as well as different concentration of agent in observing the fish in response.

- **Design of Smart Sensors for Real-Time Water Quality Monitoring using ZigBee** [5].
 The system is able to measure physiochemical parameters of water quality, such as flow, temperature, pH, conduction and also the redox 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 analyses the data. In this design, ZigBee receiver and transmitter modules are used for communication between the measuring and notification node. The notification node presents the reading of the sensors and outputs an audio alert when water quality parameters reach unsafe levels. Numerous qualification tests are run to validate each aspect of the monitoring system. The sensors are shown to work within their intended accuracy ranges. The mensuration node is in a position to transmit information via 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.

III. SYSTEM ARCHITECTURE

This section explains the block diagram of the proposed water quality monitoring system. It explains the connection between each component used.

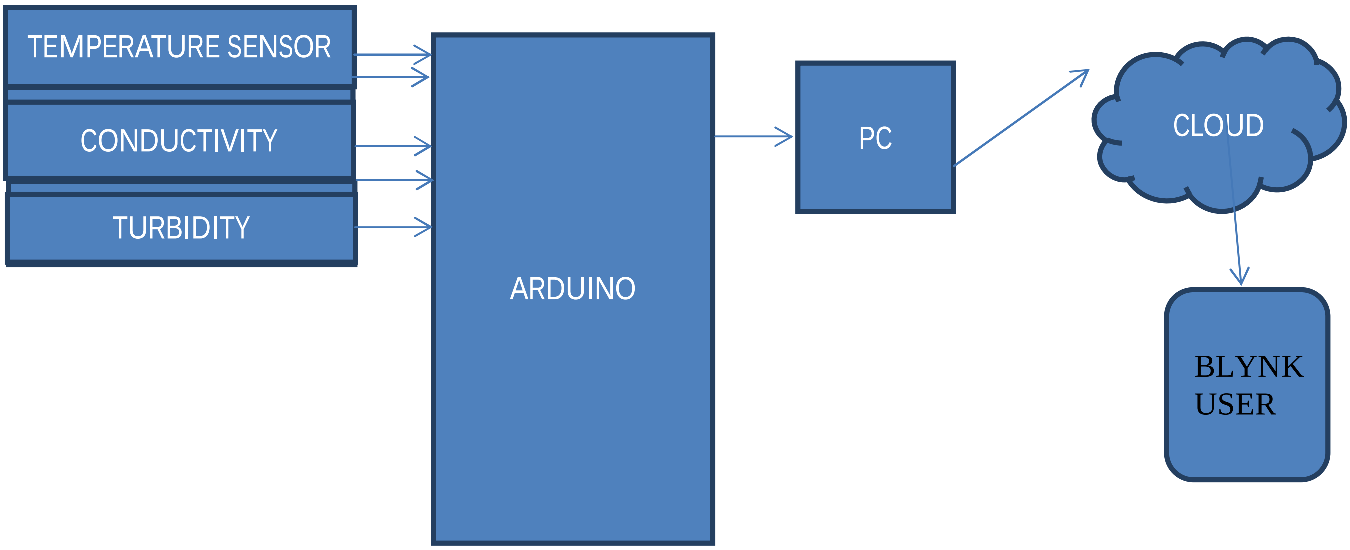

Fig 1: Overall System Architecture

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This figure consists of several sensors like pH, temperature, conductivity, turbidity and water level sensors; these are connected to the Arduino microcontroller. This module is used to access the sensor data and process it. After processing, the data will be uploaded to the cloud using Internet. The uploaded data can be viewed by the Blynk user.

IV. PROPOSED SYSTEM

Here we get water quality conditions through various sensors like pH level sensor, water level sensor, turbidity, and conductivity and Arduino board. The information will be uploaded continuously from the WSN through Microcontroller and Wi-Fi. We control and upload this data to cloud and users can access this data through Blynk application by installing it into their phones. From this system a person from anywhere can monitor the information at any time.
The hardware consists of the following components:

A. ARDUINO MICROCONTROLLER

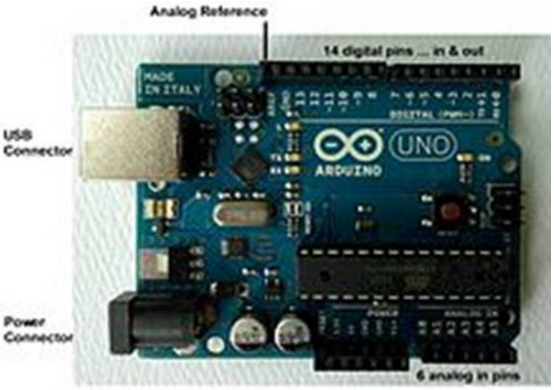

Fig2: Arduino microcontroller

An Arduino board consists of associate Atmel 8-, 16- or 32-bit AVR microcontroller with supportive parts that supports programming and affiliation into completely different circuits. An important aspect of the Arduino is its standard connectors that allow the users to connect the CPU board to a variety of interchangeable add-on modules termed *shields*. Some shields communicate with the Arduino board directly over varied pins, however several shields are individually addressable via an I²Cserial bus—so several shields can be stacked and used in parallel. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillator, though some designs such as the LilyPad run at 8 MHz and dispense with the on-board voltage regulator due to specific form-factor restrictions [1-3]. An Arduino's microcontroller is additionally pre-programmed with a boot loader that simplifies uploading of programs to the on-chip non-volatile storage, compared with other devices that typically need an external chip programmer. This makes using an Arduino more straightforward by allowing the employment of an ordinary computer as the programmer. Currently, opti boot loader is the default boot loader installed on Arduino UNO.

B. Temperature sensor

An analog temperature sensor is easy to explain, it's a chip that tells you what the ambient temperature is. These sensors use a solid-state technique to determine the temperature. That's to mention, they don't use mercury (like previous thermometers), bimetallic strips (like in some home thermometers or stoves), nor do they use thermistors (temperature sensitive resistors). Instead, they use the actual fact as temperature will increase; the voltage across a diode will increase at an acknowledged rate. Technically, this is actually the voltage drop between the base and emitter - the Vbe - of a transistor. By exactly amplifying the voltage change, it is simple to generate an analog signal that is directly proportional to temperature. In this, we are using LM35 sensor.

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LM35 Sensor Specification:

The LM35 series are precision integrated-circuit LM35 temperature sensors, whose output voltage is linearly equivalent to the Celsius (Centigrade) temperature. The LM35 sensor thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. Low cost is assured by trimming and calibration at the water level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package.

C. PH Meter

A **pH Meter**is a scientific instrument that measures the hydrogen-ion concentration in water-based solutions, indicating its acidity or alkalinity expressed as pH. The pH meter measures the distinction in electrical potential between a pH electrode and a reference electrode, and so the pH meter is sometimes referred to as a "potentiometric pH meter". The difference in electrical potential relates to pH of the solution. The pH meter is employed in several applications starting from laboratory experimentation to internal quality control.

Fig3: pH meter

D. Conductivity

Conductivity sensors are compact, fully integrated sensors for measuring the electrical conductivity of seawater. Conductivity is a key parameter for unmoved measurements of many basic fundamental physical properties of seawater.For seawater, the power to conduct electrical current is mostly dependent on temperature and therefore the amount of inorganic dissolved solids. Salinity is defined as the concentration of dissolved solids. This means that, together with temperature and depth information, a good estimate of the salinity may be determined.By using the inductive principle, stable measurement can be obtained without utilizing electrodes that are easily fouled and may wear out in the sector.

E. Water Level Sensor

The sensor used for **mensuration of fluid levels** is termed as level sensor. Obvious from its name, level sensors are used to measure the level of the free-flowingsubstances. Such substances embody liquids like water, oil, slurries, etc. additionally as solids in granular/powder form (solids which can flow). These substances tend to get settled in the container tanks due to gravity and maintain their level in rest state. Level sensors measure their level against a pre-set reference.

F. Turbidity

Turbidity is the quantitative measure of suspended particles in a fluid. It can be soil in water or chocolate flakes in your favourite milk shake. While chocolate is something we *so want* in our drinks, soil particles are totally undesired. Turbidity Sensor along with a micro controller unit takes care of turbidity measurements. Crafted with plastic and some metal-alloy traces, turbidity sensor uses light to convey data concerning turbidity in water.The turbidity sensor appears like an Android bot. Two horn like structure, a top to bottom mono material body. A black colour cap is placed at the bottom of the sensor. Thick alloyed contact legs provide ways for connectors to hold to the sensor. A white plastic slab protects the legs from damage.The plastic used to make outer structure can survive high temperature variations as well

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as mechanical corrosions. Scales are found on the transparent can which enable easy gripping. Between the "horns", a bulge can is seen that holds the thermistor and provides temperature sensing ability to the sensor.

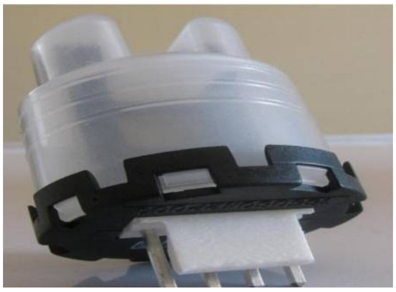

Fig4: Turbidity sensor

V. RESULTS

The result values for different sensors depend on the water samples that it is immersed in. The result can display on the PC or uploaded to the drive.

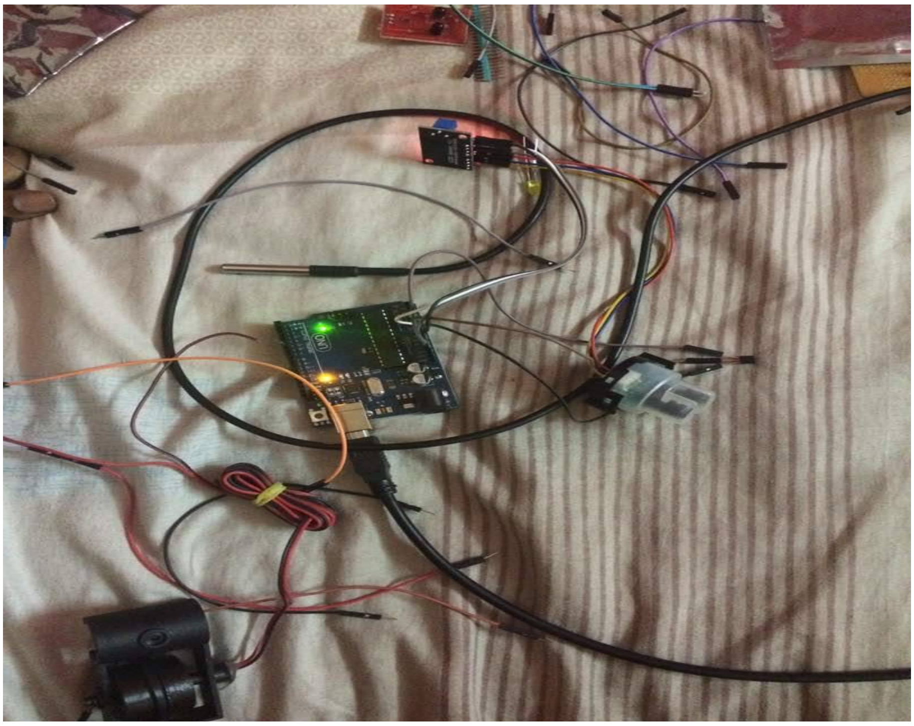

Fig5: Circuitry of Arduino and Sensors

The figure depicts the hardware setup for monitoring the water quality. It consists if a microcontroller and five sensors which includes pH level; sensor, water level, turbidity, conductivity and temperature sensor. All the sensors are connected the microcontroller which consists of an IC. The controller unit is connected to the PC.

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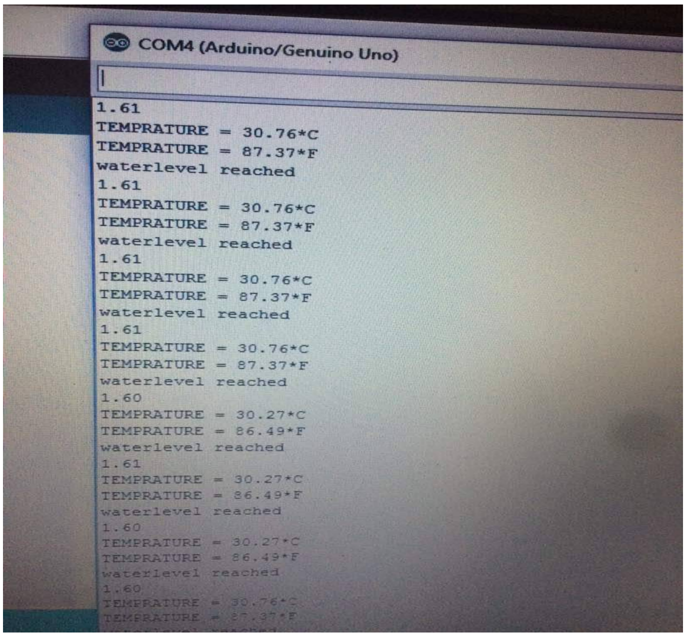

Fig6: Output on Arduino Software

The figure depicts the derived values from each sensor when dipped in water. The output as shown in the figure varies with different water samples.

VI. CONCLUSION

The Project "An IoT based system for water quality monitoring" has been successfully designed and experimented. We have seen the success of sensors in various fields; the same idea has been applied to this water quality monitoring system. In this paper we have analysed different water quality monitoring systems. There are lots of techniques available to do the same. All these techniques are expensive and difficult in terms of analysing and collecting the data.

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