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Design and Implementation of a Smart Water Monitoring System (IoT) Using Arduino Microcontroller

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Abstract- The internet and related technologies, has created an opportunity to improve the remote monitoring of water quality while reducing the cost of measuring parameters such as: pH, temperature, ammonium levels, oxygen levels, water visibility. Internet of Things (IoT) is the mode by which this remote monitoring can be accomplished. IoT is a system where devices and machines within a network share data. The data from the tanks is available to the user wherever he or she may be in the world because the sensors send data to a cloud service on the internet. The cloud service used in this project is Cayenne. Users can easily access the data obtained by the sensors through the IoT dashboard making it a very convenient approach for tank monitoring.

Keywords- Internet of things (IoT), Wireless Sensor networks, Sensor, Water Quality, Wi-Fi module

I. INTRODUCTION

Internet of Things (IoT) is a rapidly expanding computer trend that enables objects or gadgets linked to the internet to have the ability to gather, process, and share information [1]. The internet of things is known as a technology that has demonstrated its existence as a network of machines or gadgets that can communicate with one another [2]. A variety of devices are now available to consumers, businesses, and individuals, such as smart wristwatches that track your health and fitness, voice activated speakers that function as virtual assistants, or the use of IoT to serve as a home automation system that helps to minimize energy consumption. This smart device are configured to interpret data and respond automatically to various conditions; it has sensors that collect data from the physical environment, and it sends and receives data via a network connection to a database, app, and other devices. The fundamental benefit of IoT is a cloud-based data storage system that allows multiple users to connect in any location and at any time as long as they have access to the internet. Water is the most essential and limited resources available all over the world which is used for different purposes which includes agricultural, industrial and all creature existences on the surface of the earth, including humans. It is one of the most important things required for the sake of the sustainability of life and the preservation of the ecosystem [3]. Each year, the United States Geological survey predicts 1.7 trillion gallons of water thrown away, with 70% of this waste occurring indoors, we typically use 27% for showering, flushing toilets, and bathing [4]. In the twenty-first century, many inventions have been made, however pollution, global warming, and other issues have arisen, resulting in a lack of safe drinking water [5], water is a natural resource that is consumed by all living things on the planet, and water accounts for over 60% of the human body, demonstrating how important water is to humans. Water spans around 70% of the surface of the earth, but the quantity of water for human use and utilization account for as little as 2% of total volume. The International Standard Organization defines water quality monitoring to be a process for the collection, measurement and further documenting or signage of the different water features, with the objective of evaluating compliance with the specified water quality objective [6]. Water quality describes the overall biological, physical and chemical composition of the water; thus, evaluating the drinking water quality requires that the numerous physical, chemical, and biological parameters are monitored.

II. RELATED WORKS

Thinagaran Perumal proposed a water control system based on IoT in 2015 that measured water levels in actual time. They established a model with a parameter of water level that can be used in regions prone to crisis. In this project, a sensor for measuring water level was used to detect water levels, when a certain level of water is reached, a signal is sent to a social media platform such as Twitter, the data of the water level was displayed through a remote dashboard [7]. This paper, titled "Analysis of the Water Quality Monitoring System," recommends the creation of a water quality monitoring system that provides information about the nature of water on a website. The researchers use an Arduino microcontroller, a pH sensor, and a turbidity sensor that is each linked to a GSM module and data is sent via a Wi-Fi module that is used to transmit data to a webpage via the net, and is being controlled by the micro-controller with an embedded programming language [8].

N. Vijayakumar and R. Ramya recommended a much system that is less economical to analyze quality of the water in real time in 2015 using the Internet of Things.

(IOT). A variety of sensors used to measures the temperature, PH, turbidity, conductivity and dissolved water oxygen in their model. The information obtained via the sensors, the main controller Raspberry Pi B+ was used to analyze the data. The data was processed and then transferred over the Internet using cloud computing [9].

Steven Silva devised a way for developing a web-based wireless sensor network. In 2011 that combined

ZigBee and Wi-Max technologies. The technique was developed by the researchers and included a ZigBee network that can be used locally which is capable \of acquiring numerous water quality variables, a Wi-Max network and web-based monitoring computer system. The method was developed to collect data and make conclusions with a remote web server in real time. The information was deployed via Wi-Max network from web server through the sensor nodes with the use of the ZigBee gateway. Users were able to monitor the quality of water from the comfort of their residences without having to collect data from scientists using this technique [10].

III. PROPOSED METHODOLOGY

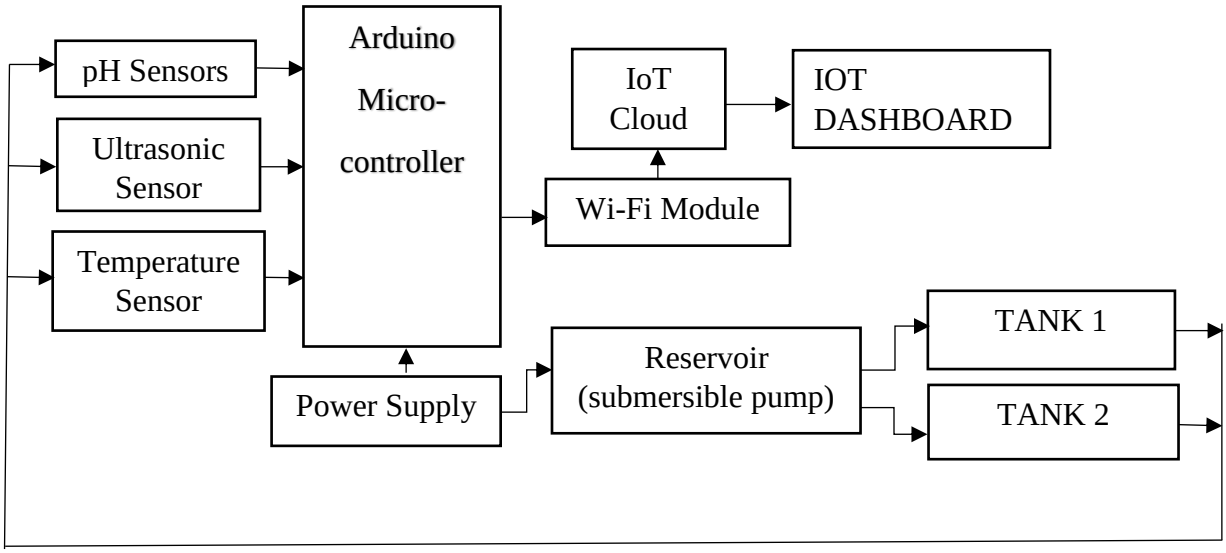


Figure 1 Block diagram of the project

The overall system design of the water monitoring system is as follows:

We have a system of 2 tanks and a reservoir connected together and 2 5v DC water pumping system. Each tank has 1 ultrasonic sensor, placed on top of the tanks, the function of the ultrasonic sensor in each tank is to detect when the water has reached a certain level within the tanks. The sensors sends a message to the Arduino micro-controller, which passes an input signal to the pump that automatically comes on when the water reaches the lowest point of the tanks, the ultrasonic sensors sends a signal to the micro-controller that triggers the pump to go off once it detects the tank is already filled up with water, we can completely prevent overflowing by using this framework. The second one is measuring the quality of the water using pH parameters, the pH sensor is placed inside the reservoir where the water is being pumped from into the two tanks, pH sensors measures the hydrogen value in the water to know if it is healthy for consumption, it displays the pH value on the IoT dashboard after measuring for it, once the pH value is below or above 7 the water needs to be filtered. PH means “potential of hydrogen" the quantity of hydrogen contained in a substance (in water). The pH is weighed on a 0-14 scale. Seven is neutral, which indicates that the equilibrium between acid and alkalinity resides. Estimating below 7 means that acid is present and above 7 is the basic measurement (or alkaline) [11]. A water temperature sensor is also placed inside the tank to know the hotness or coldness of the water coming into the tanks. The values detected by the sensors are transferred to a free IoT platform called Cayenne mydevices where all the analytics and the visualization of the values are seen called Cayenne mydevices with the aid of a Wi-Fi module.

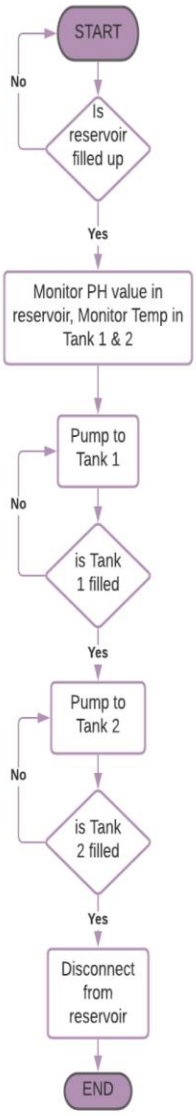


Figure 3 Flow chart diagram of the project

A brief description of some of the materials used include:

A. PH SENSOR

This equipment is used to basically measure how acidic or alkaline a substance is. PH value ranges from 0-14. When the pH value of a particular substance is below seven it is acidic and when it is above seven it is considered basic. The pH sensor is calibrated to get the correct value by simply dipping it into a drinkable water, the pH of a natural water is supposed to be 7, if it is not, the we have to set the values y rotating the pin on the Analog to digital converter of the sensor.

B. ARDUINO MEGA

The Arduino Mega board is an open-source microcontroller board working based using Atmega2560 chip. It is the brain of the system. All the analog and digital input and output pins are connected to the Arduino. The Arduino board is programmed using Arduino IDE (Integrated Development Environment). This particular board has a total of 54 pins both analog and digital pins with a total of 16 analog to digital converter pins, before uploading the code to the microcontroller, we need to specify the board and port that we are using, in Arduino IDE.

C. ESP8266-01 WIFI MODULE

ESP8266-01 is a low-cost Wi-Fi microchip. It is used to connect the Arduino board to a Wi-Fi network and establish internet connection, when the internet connection is established, the data ca e set from the Arduino to the cloud or ay platform being used to visualize the data.

D. TEMPERATURE SENSOR

This DS18B20 seal type temperature has a 9 to 12-bit temperature readings (adjustable) over a 1-Wire interface, allowing us to use only one wire (and ground) that needs to be connected from a central microcontroller. We used this to measure the temperature of the water to know the degree of hotness or coldness of the water. According to the Canadian guidelines for drinking water the acceptable water temperature for humans to consume is 15 degree Celsius [12].

E. ULTRASONIC SENSOR

The Ultrasonic sensor HC-SR04 uses sound waves to detect distance of object by measuring time spent for the object/body to reflect the ultrasonic sound waves emitted by it. Ultrasonic sensors emit short, high-frequency sound pulses at regular intervals. These propagate in the air at the velocity of sound. If they strike an object, then they are reflected back as echo signals to the sensor, which itself computes the distance to the target based on the time-span between emitting the signal and receiving the echo.

F. IoT Platform

The data being monitored is uploaded into the cloud via the Cayenne IoT platform. Cayenne processes the data and shows the data on the dashboard where the user can view through their mobile phone or a computer.

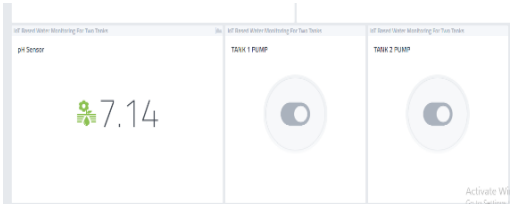
IV. RESULTS and DISCUSSION

The picture below represents the outcome of our smart water monitoring system, consisting of two tanks and a reservoir. The reservoir houses two 5v dc pump which pumps water into the two tanks at the top. The two tanks consist of a waterproof temperature sensors each inside the tanks and one ultrasonic sensors at the top of the tanks which makes use of height to measure the

distance between the water and the top of the container. The white casing consists of the Arduino mega board, the Wi-Fi module and the other components that makes the system to work.

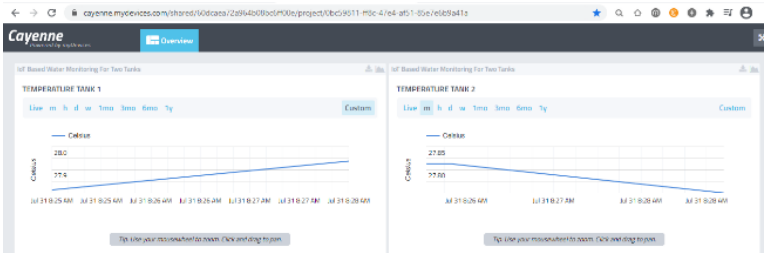
Figure 2 Image of the final project work

- In figure B, it shows the cayenne IoT dashboard which is used for visualizing the values detected by the sensors displaying the pH value measured by the pH sensor, a value of 7.14 was oobtained which implies that the water is neutral and it is safe for human consumption.



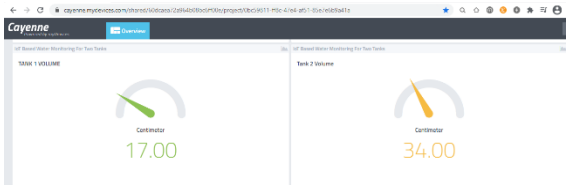
(B)

- In figure A, it shows the IoT dashboard displaying the temperature values, from the result of the water tested that gave a pH value of 7.14, for tank 1 the temperature was in between 27.9 degree Celsius to 28 degree Celsius and tank 2 temperature was between 27.80 and 27.85 degree Celsius.



(A)

- In figure C, The picture above displays the water level for each tanks. This feature simply is used to know the level of water that is available in the tanks.



(C)

CONCLUSION

A low-cost effective system is necessary to monitor the water quality that is being consumed by various individuals as low water quality is dangerous to the human health. We have been able to implement a system that measures water level and also measure water quality. The water quality measures the pH value and the temperature of the water, whereas the water level system measures the level of water in the tanks then the user can view all the values being measured through the IoT platform and the water pumps can be turned on from the IoT dashboard.

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