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PROTOTYPE OF SOLAR BASED SMART WATER QUALITY MONITORING SYSTEM

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Abstract - *A solar based real time water quality monitoring system with the help of IoT is represented in this paper. The complete system is solar-powered as well as battery powered hence ensuring stable and continuous supply of power. The different qualitative parameters of water namely, the pH, temperature, dissolved oxygen, salinity, conductivity, ORP, turbidity, etc. can be measured by simple modification but for implementation purpose only the pH, temperature and turbidity of water have been measured. The quality of the water is tested with the aid of sensors and the sensed data can be viewed on blynk application with the help of IoT via internet. This paper mainly focuses on reducing the manual efforts in checking the purity of water in water tanks and also ensures the safe supply of water for the mankind.*

Key Words: Water Quality Monitoring, IoT, Solar Power.

1.Introduction

In the 21st century, the world is witnessing lots of inventions but at the same time pollution, global warming and so on is also being formed. Because of this there is no safe water for the world's population. It's been surveyed that water pollution is the leading reason behind deaths and diseases worldwide.

Around 70% of India's surface water is unsafe for huma n consumption, per the estimates. Out of the whole Indian population, experts predict that 40% of people may not have a connection to a clean water supply by 2030. In several developing countries, dirty or contaminated water is being employed without any correct former treatment. The main reason for this happening is the unawareness among the public and administration and also the lack of water quality monitoring system.

The most common method to detect the water quality parameters is to collect samples of water manually and then send them to laboratory for detecting and analysing. This method not only wastes too much man power but also consumes a lot of time for monitoring the parameters. The problem of monitoring water quality manually could be overcome if a system embedded with various sensors is used which will automatically monitor the water quality in real time. The purpose of this project is to supply safe water for the mankind by monitoring the water quality and also to reduce human intervention while doing so. Quality checking process is simplified with the implementation of this project as compared to manual process.

2.Related study

All living species on the planet require water to survive. The major sources of water include rain, rivers, and lakes. The rain water that runs over the land includes a variety of hazardous substances that, if ingested, can affect people's health. To guarantee that people have a safe supply of water, the quality of the water must be checked in real time, therefore many methods and technologies are employed to monitor the water quality in the water tank.

To overcome the challenges associated with manual water quality monitoring, researchers developed a new approach termed as WQM system which reduce the actual time consuming in conventional method [2]. The improved version which is GSM Based Water Quality Monitoring System with Arduino, that sends an alarm to a remote user if any water quality parameters change [6]. The overview on Internet of Things and its application which provides brief information about IoT application and challenges in various fields [5]. The study provided information about the transfer of measured data from sensors to the Cloud. Here the live feed is monitored using smart water quality assessment system [4]. Established a supply of sanitised drinking water that is cost effective and efficient to monitor drinking water quality using IoT [3].

Various attempts have been undertaken to establish an efficient water quality monitoring system to solve water quality concerns, according to a literature review. The drawback of the previously observed technique is that it powers the Arduino and sensors with a regular energy supplied from the K.E.B. No notice will be issued to the officials of the municipality corporation if the water quality falls below the threshold. The suggested project solves the previously mentioned issue. The project's major goal is to maintain a safe water supply for humanity while also reducing the amount of manpower required to monitor the water's cleanliness.

3.Requirements

A. Solar Panel

Solar panels are used for the harnessing of solar energy. Solar panels are made up of numerous solar cells that are linked in a series of parallel lines. P-type and n-type silicon are the two types of semiconductors used in solar cells.

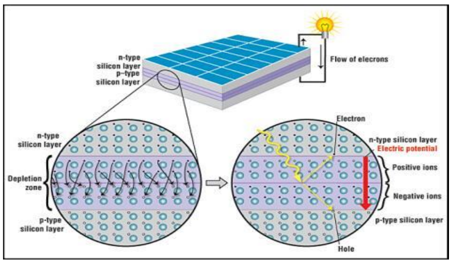

Fig. 1. Solar Panel

Electrons in the silicon are ejected when sunlight strikes a solar cell. If this happens in the electric field, then the electrons will travel from the n-type layer to the p-type layer through the external wire creating a flow of electricity. The solar power then generated can be stored for future use. The solar panel used in our prototype model charges a battery of 9V 2000 mAh for energy storage.

B. Arduino Mega

The ATmega2560 microprocessor is used in the Arduino Mega 2560 microcontroller board. It's an 8-bit board with 54 digital pins (including 15 PWM outputs), 16 analog inputs, and four serial connections. It contains everything required to aid the microcontroller. With a 9V power supple, the Arduino Mega has a power consumption of 73.19mA and has 256 kB flash memory, giving it more memory space. Arduino Mega 2560 has the most SRAM space with 8 kB. When the Arduino is running, it has additional SRAM space to create and can manipulate variables.

Fig.2.Arduino Mega

C. pH sensor

A pH sensor is a device which is used to detect the acidity and alkalinity of a solution. The value of pH can vary from 0 to 14, where 7 is a neutral. Values below the 7 will be acidic in nature where the values above the 7 will be alkaline in nature. It is interfaced with Arduino and operates on 5V power supply. The pH level of a solution should be within 6 to 8.5.

Fig.3.pH sensor

D. Temperature Sensor

The temperature sensor indicates hotness or coldness of the water. It is an electronic device that records, monitors, or signals temperature changes by measuring the temperature of its surroundings and converting the input data into electronic data. The temperature sensor DS18B20 has a temperature range of -55 to 125 °C. The sensor is a digital kind that provides reliable readings.

Fig.4.Temperature Sensor

E. Turbidity Sensor

The turbidity of water is a measurement of its clarity. It denotes the degree to which the water's transparency has deteriorated. The device used to measure the turbidity of the water is called turbidity sensor. It measures the amount of light that is scattered by the suspended solids in water. As the amount of total suspended solids (TSS) in water increases, the water's turbidity level increases. Nephelometric Turbidity Units (NTU) or Formazin Nephelometric Units (FNU) is often used to represent turbidity values. The range of turbidity should be within 0 to 5NTU.

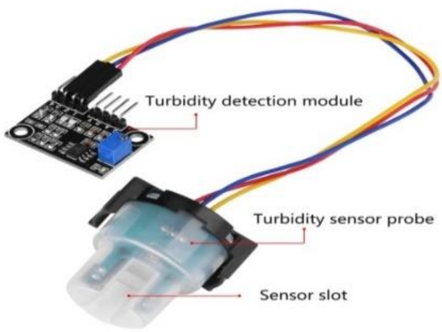

Fig.5.Turbidity Sensor

F. Node MCU

The ESP8266 Wi-Fi Module or node MCU is a low-cost open source IOT platform. It is a self-contained SOC (System on Chip) with integrated TC/IP protocol stack which can provide any microcontroller access to your Wi-Fi network. The ESP-12E module on the NodeMCU ESP8266 development board contains an ESP8266 chip with a Tensilica Xtensa 32-bit LX106 RISC microprocessor. It has interfaces for UART,SPI,and I2C. This microprocessor runs on a configurable clock frequency of 80MHz to 160MHz and supports RTOS. NodeMCU has 128 KB RAM and 4MB of Flash memory to store data and programs and can be powered using Micro USB jack and VIN pin (External Supply Pin).

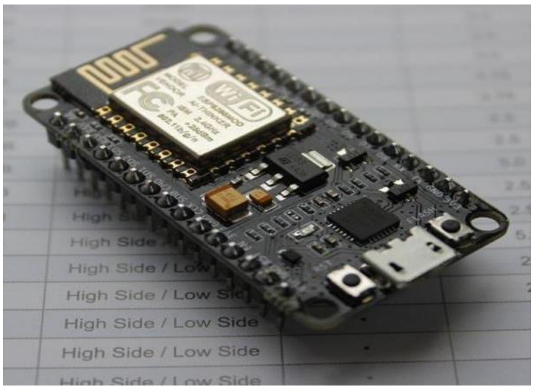

Fig.6.Node MCU

G. Blynk Application

Blynk is an internet-based platform for controlling Arduino or Raspberry Pi. It's a virtual dashboard where we may drag and drop widgets to create a graphic interface for our project. It is possible to control Arduino or ESP32 pins directly from the phone using the Blynk library. The Blynk server has five ports available for various levels of protection. The connection between the app and the server is always encrypted with SSL/TTL, ensuring that it is always safe.

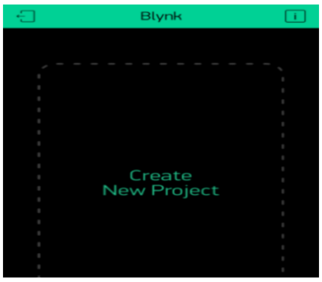

Fig.7.Blynk

4.Design and Implementation

A. DESIGN OF POWER CIRCUIT

The figure 8 shows the power circuit of the system where the output of solar panel i.e., 12V is being regulated to 9V with the help of regulator circuit. The resultant voltage is then utilized to charge the battery.

- Solar Panel- 12V, 20W.
- Diode – 1N4148.
- Capacitor – 0.1uF.
- Resistors – 100 ohm,5K(Pot).
- Voltage regulator – LM317T.
- Battery – 9V, 2000mAh.

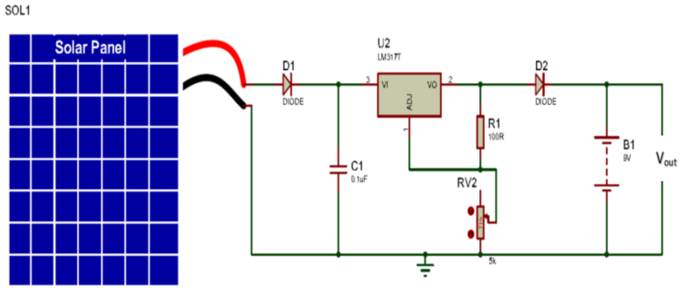

Figure 8: Power Circuit

Calculation of External Resistance

The LM317T regulator requires two external resistors to adjust the output voltage. The output voltage of regulator is controlled by the external resistor values i.e., R1 and R2. If R1 is assumed to be 100Ω and the required output voltage is 9.8V, then the R2 value is calculated as follows

$$Vout = Vref\,(1+ {}^{R2}/_{R1})$$

R1= 100 Ω, Vout = 9.8V, Vref = 0.27V, R2 =?

$$9.8 = 0.27\,(1+ {}^{R2}/_{100})$$

$$R2 \approx 3500\Omega$$

B. Flowchart

Figure 9 represents the flow chart of the system. Initially Arduino reads the data from all sensors, after which the data will be transferred to the Wi-Fi module through serial communication and subsequently to the cloud. Real-time data can be viewed using the blynk application. If the values are not within the limit, an alert about the water quality will pop-up in the blynk application. An email is sent to higher authorities, if the concerned authority does not take any action within a certain period of time after the alert and also an alert will pop-up in the blynk application mentioning about the email.

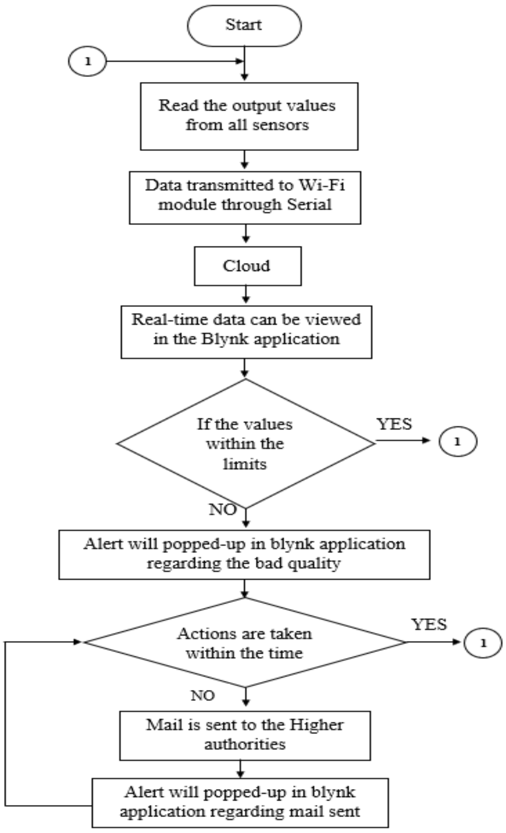

Fig.9.Flowchart of the system

C. Working

The figure 10 shows the block diagram of the system

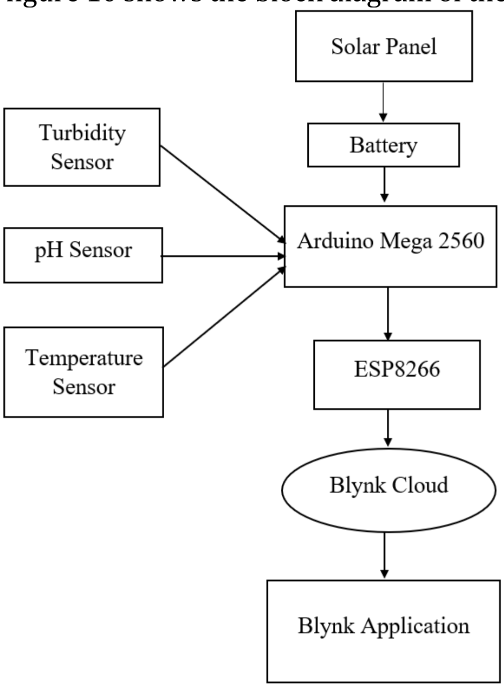

Fig.10.Block diagram of the system

The proposed system consists of two parts, one is hardware and other one is software. The hardware consists of sensors (pH sensor, turbidity sensor and temperature sensor), ESP8266 Wi-Fi module, Arduino Mega 2560 and power supply. The software consists of Arduino Software (IDE) and BLYNK app.

The power is supplied to the system using a combination of both solar panel as well as battery i.e., during the day time or when there is a sufficient voltage, the battery is in both charging and discharging state. But during the night time or when there is no sufficient voltage, the battery is in discharging state.

The data sensed is processed by the Arduino mega to which the sensors are connected. The Arduino mega is programmed using Arduino IDE and it helps to convert analog values to digital one. The processed data is then sent to the ESP8266 through serial communication. The ESP8266 Wi-Fi module is programmed using Arduino IDE and it helps to certify the quality of water good/bad by comparing the data with the range i.e., pH sensor 6.5 to 8.5, temperature sensor 10 to 60 degree Celsius and turbidity 0 to 5 NPT. Finally, this data is uploaded to Blynk cloud with the help of ESP8266 module.

Blynk application is built and connected to the cloud where the data of the sensors are present. This application is then installed in android smartphones to see the output. Thus, by installing this system in all city's supply tanks with Wi-Fi, it is possible to determine the quality of the water and monitor the quality of the entire city from one location.

The system is programmed in such a way that when the sensed data of water exceeds the safety limits, an alert is popped-up in the application. If the concerned authority does not take any action in improving the water quality within the given time limit, then an email is sent to the higher authorities regarding the quality and informing them to take necessary actions regarding water quality.

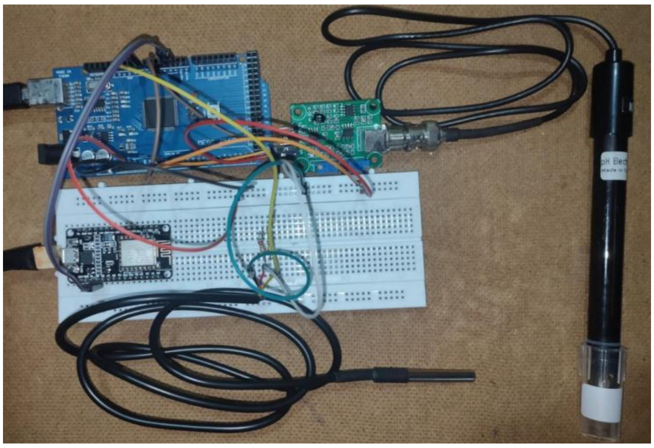

Fig.11. Hardware Design

5. RESULT OF POWER Result

CIRCUIT

A 12V 20W solar panel is used to supply the system and also to charge a battery of 9V for future use. From the figure 4.1 it is observed that the power circuit was producing 9V DC across the battery with the help of the solar panel.

RESULT OF SYSTEM

Using prototype model we measured pH and temperature of different water solution samples and the resulting output is tabulated below.

TABLE: Comparison of pH and temperature sensor

Sl. No.	Solutions	Standard Values of pH	Experimental Results of Ph	Temperature Value
1.	Bore-well Water	7.1 – 8.2	7.78	27.6
2.	Tap Water	6.5 – 8.5	7.30	25.9
3.	Lime Water	12.4	11.85	24.3
4.	Salt Water	7.6 – 8.4	8.37	25.5

Blynk application is used to display the parameters of the water . The figure12 shows that whenever the parameters are within the range then the quality shows good. If the measured value exceeds the limit then the quality shows bad. For pH sensor we have set a limit of 6.5 to 8.5 and for temperature sensor it is 0 to 60°C and for turbidity sensor it is 0 to 5 NPT.The model was so designed that it automatically sends a mail to the concerned authorities about the bad water quality. If the water quality shows bad then an alert message will be displayed on the blynk application is showed in the figure13. If no actions were taken to improve the quality of water within a specified time limit then a mail will be sent to the higher authorities is showed in the figure14.

Fig.12.Water parameters displayed on Blynk application

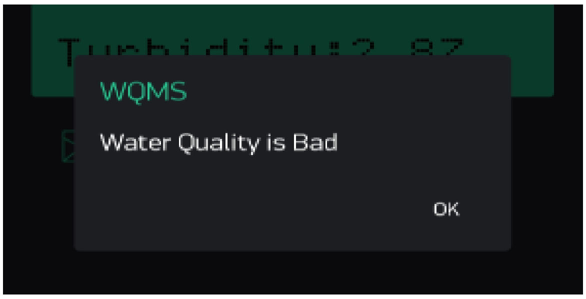

Fig.13. Alert message

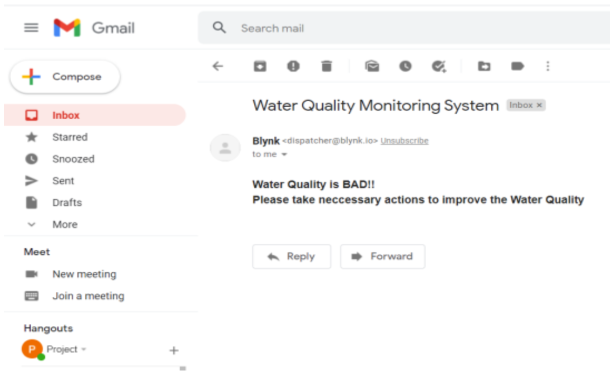

Fig.14.Mail sent to the higher authority

6. Conclusions

The system designed and tested is a low-cost, high-performance, real-time water quality monitoring system. This system uses renewable energy source such as solar energy to deliver uninterrupted transmission of real-time water data. The mechanism certifies water quality faster with less manual effort than traditional methods, and it makes water monitoring easier.

By installing this system in all city's supply tanks, it is possible to determine the quality of the water and monitor the quality of the entire city from one location. By using this system one can determine the quality of water using the Android application.

7. Future scope

With minor improvisation/modification, this technology can be implemented in the following areas such as Fish farming, Monitoring coolant, Chemical manufacturing industry, Drinking water.

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