MONITORING OF URBAN WASTE WATER FOR AGRICULTURE USING IoT

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***Abstract*:** The monitoring of urban waste water for agriculture using IoT provides a smart solution for water quality monitoring for testing water samples and the data uploaded over the internet are analyzed in an LCD and these data's are sent to the cloud and gives an alert to the users mobile server using GSM.Major objective of this project includes measurement of critical water quality parameters such as Turbidity, pH, BOD, TDS and Temperature to identify deviations in parameters and also provides an alert to a remote user, when there is an abnormal level of specified parameters from the pre-defined set of standard values i.e., the threshold value set in the controller. Extreme pH values may indicate chemical spills, treatment plant issues, or problems in supply pipes which can be of severe problem in terms of soil quality and the crop cultivation. Using IoT we are monitoring the parameters and provide an alert message whenever there is a deviation in their values using cloud storage

KEYWORDS: Water, Arduino mega 2560 , Cloud, IoT,GSM

I. INTRODUCTION

Water is used in various activities, like 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. The water quality problems of surface water bodies are predominately caused by organic and nutrient material loads. More than 90% of the River Basin Management Plans (RBMP) assessed indicated that agriculture is a significant pressure in the basin, including diffuse or point source pollution by organic matter, nutrients, pesticides and hydro-morphological impacts.The Plan gives the diffuse Nitrogen and Phosphorous load of each surface water body identifying the load from agricultural waste water body identifying the load from agricultural, waste water treatment plan, urban and other areas to the water body. 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. Improve and expand monitoring and assessment tools to ensure a statistically robust and comprehensive picture of the status of the aquatic environment for the purpose of further planning.

II.HARDWARE DESIGN

The key parameters monitored in the proposed system are conductivity, turbidity, water level and pH. The block diagram of the proposed system is shown in Fig. 2. A controller forms the central part of the IoT enabled water quality monitoring system. As seen from Table 4, it is observed that most of the IoT based solutions use a controller with external Wi-Fi. Such designs are not cost effective, power efficient and also result in complex circuitry. In this work, ESP8266 is a single chip microcontroller with in-built Wi-Fi module and ARM Cortex M4 core, which can be connected to the nearest Wi-Fi hot spot for internet connectivity. Sensors are directly interfaced to the controller since the proposed system is to monitor domestic water quality. The sensor parameters such as conductivity, turbidity, water level and pH are measured by placing the sensor into different solutions of water.

The measured parameters can be viewed by using LCD. The data from the sensors are sent to the cloud using the controller. Threshold is set in the cloud based on the standards provided by WHO. Message is sent from cloud to the users mobile if the value exceeds the threshold. A mobile application has been developed in which values obtained by each sensor in the cloud can be viewed. This can be used by both the water quality monitoring authorities as well as users.In the proposed smart water quality monitoring system, a reconfigurable smart water sensor interface device that integrates data storage, data processing, and wireless transmission is designed. The hardware experimental set-up of smart water quality monitoring system is implemented . The hardware's of water quality monitoring system comprises the following components:

- pH Sensor
- Temperature sensor
- Turbidity Sensor
- Water flow sensor
- Conductivity
- Wi-Fi module
- Arduino board

Conductivity is the measure of solutions ability to carry current. This parameter is used to determine the salt content in the water. In the proposed design, YL-69 is used to measure the conductivity of the water. It consists of two electrodes, when placed in water a potential is generated which is proportional to conductivity. It is measured in seimens per cm. Acceptable range of conductivity is from 300 to 800 µ seimens per cm. pH measures amount of acid or base in the solution. Three in 1 ph meter with inverting operating amplifier is used to measure pH. Inverting Op-amp is used to boost the voltage from mV to voltage range. pH sensor consists of two electrodes which is reference electrode and pH electrode also known as measuring electrode. When placed in the solution pH electrode develops a potential that is proportional to pH. The value ranges from 0 to 14. The acceptable range of pH for drinking water is 6.5 to 8.5.Turbidity is a measure of cloudiness in the water. Opto electronic devices such as LDR and LED are used to measure the turbidity. Light is transmitted and reflected by suspended solids and reflected light is received by the sensors. An LDR is high resistance semiconductor. If light falling on the device is of high frequency, photons absorbed by the semiconductor gives the bound electrons enough energy to jump into the conduction band. In the proposed system distance between the LED and LDR is 9 cm. The resulting free electrons conduct electricity thereby lowering resistance. Water level is sensed to determine the depth of the water in the tank. This is done using probe method. Three probes are used to indicate the level of the water such as high, low and medium.

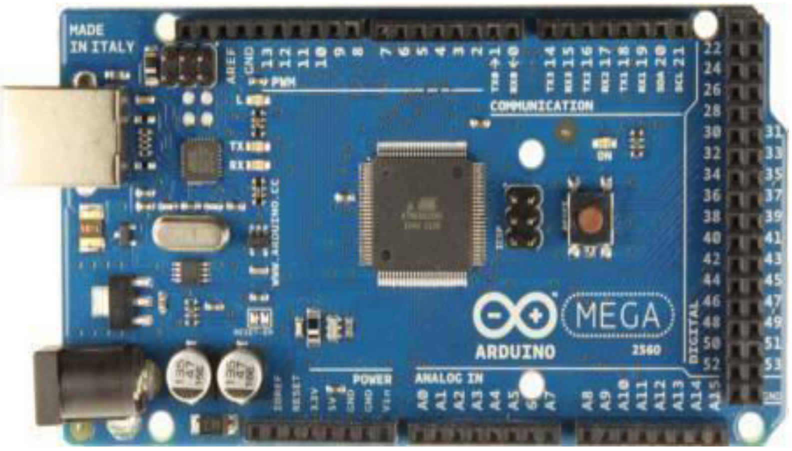
III.SOFTWARE DESIGN

The sensor is constantly updated in the cloud and also displayed in the LCD connected.The programming is done using ENERGIA IDE. Table 10 Parameters measured with different water samples Parameters Drinking water (filter) Pipe water Sample 1 Sample 2 ph 6.5 7.9 8.4 conductivity 448 577 580 turbidity Values stored in the Ubidots cloud Data sent from the controller are stored in "Ubidots" cloud. "Ubidots" offers a platform for developers to capture data and turn it into useful information. The features include a real-time dashboard to analyze data or control devices and share the data through public links. Data stored in the cloud can be used for detailed analysis. The cloud is programmed to send alert SMS messages whenever the monitored parameter exceeds the threshold limit.The system is connected to the Ubidots cloud.

IV.COMPONENTS

a) Arduino mega 2560

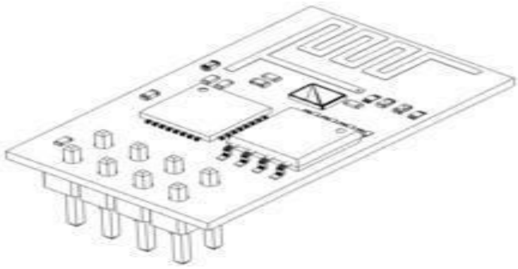
The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power



with a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

b) ESP8266 WIFI module

ESP8266 is an impressive, low cost WiFi module suitable for adding WiFi functionality to an existing



microcontroller project via a UART serial connection. The module can even be reprogrammed to act as a standalone WiFi connected device–just add power! The feature list is impressive and includes: 802.11 b/g/n protocol Wi-Fi Direct (P2P), soft-AP Integrated TCP/IP protocol stack.

c) LCD display

Liquid crystal cell displays (LCDs) are used in similar applications where LEDs are used. These applications are display of display of numeric and alphanumeric characters in dot matrix and segmental displays.The liquid crystal material may be one of the several components, which exhibit optical properties of a crystal though they remain in liquid form. Liquid crystal is layered between glass sheets with transparent electrodes deposited on the inside faces.When a potential is applied across the cell, charge carriers flowing through the liquid disrupt the molecular alignment and produce turbulence. When the liquid is not activated, it is transparent. When the liquid is activated the molecular turbulence causes light to be scattered in all directions and the cell appear to be bright.This phenomenon is called dynamic scattering.The construction of a field effect liquid crystal display is similar to that of the dynamic scattering type, with the exception that two thin polarizing optical filters are placed at the inside of each glass sheet. The liquid crystal material in the field effect cell is also of different type from employed in the dynamic scattering cell. The material used is twisted numeric type and actually twists the light passing through the cell when the latter is not energised.A liquid crystal display (LCD) is an electronically-modulated optical device shaped into a thin, flat panel made up of any number of color or monochrome pixels filled with liquid crystals and arrayed in front of a light source (backlight) or reflector. It is often utilized in battery-powered electronic devices because it uses very small amounts of electric power. LCD has material, which continues the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are

grouped together in an ordered from similar to a crystal. LCD consists of two glass panels, with the liquid crystal materials sandwiched in between them. The inner surface of the glass plates is coated with transparent electrodes which define in between the electrodes and the crystal, which makes the liquid crystal molecules to maintain a defined orientation angle. When a potential is applied across the cell, charge carriers flowing through the liquid will disrupt the molecular alignment and produce turbulence.When the liquid is not activated, it is transparent. When the liquid is activated the molecular turbulence causes light to be scattered in all directions and the cell appears to be bright. Thus the required message is displayed. When the LCD is in the off state, the two polarizer's and the liquid crystal rotate the light rays, such that they come out of the LCD without any orientation, and hence the LCD appears transparent.

d) SENSORS :

Several sensors are commercially available for water quality monitoring. Some of the works published in literature include fabricated sensors for improved usability. The fabricated sensor includes a solar cell, Li-ion battery, a power module and transmission module.The sensor module output can be directly connected to the microcontroller without additional signal processing electronics. Some authors have developed low cost, easy to use and accurate turbidity sensor for continuous in-pipe turbidity monitoring and have presented a sea water probe for monitoring multiple parameters intended for sea water quality monitoring.

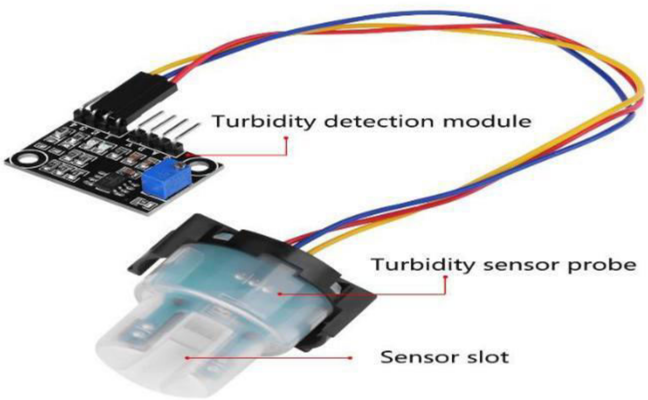
1. pH SENSOR :

PH sensors measure the level of PH in sample solutions by measuring the activity of the hydrogen ions in the solutions. This activity is compared to pure water (a neutral solution) using a pH scale of 0 to 14 to determine the

acidity or alkalinity of the sample solutions.Additionally added Light intensity sensor, Temperature sensor and Water Level sensor. This module can measure the amount of water level and temperature range and light intensity.

2. TURBIDITY SENSOR:

The Arduino Turbidity Sensor is an electronic monitoring module specially developed to work with microcontroller platforms Arduino, Raspberry Pi, PIC, ARM, AVR, among others.Very efficient, the Arduino Turbidity Sensor is able to detect and verify the quality of the water, making the turbidity measurement, where it is possible to verify the results by means of digital or analog signal next to the corresponding pins in the accompanying electronic module.



The Arduino Turbidity Sensor emits at its end an infrared light, imperceptible to human vision, capable of detecting particles that are suspended in water, measuring the light transmittance and the dispersion rate, which changes according to the Amount of TSS (Total Suspended Solids), increasing the turbidity of the liquid whenever levels increase. In general, the Arduino Turbidity Sensor is applied in projects involving the monitoring of water turbidity in rivers, streams, lakes, water bodies, catchment and research sites, laboratories, tanks with liquids and so on.The Arduino Turbidity Sensor has an end specially prepared for direct contact, having an electronic module to amplify and send the received data to the microcontroller of the project.

3. TEMPERATURE SENSOR

The DS18B20 digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with non-volatile user-programmable upper and lower trigger points. The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply. Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1-Wire bus. Thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.

4. TDS SENSOR

TDS (Total Dissolved Solids) indicates that how many milligrams of soluble solids dissolved in one litre of water. In general, the higher the TDS value, the more soluble solids dissolved in water, and the less clean the water is. Therefore, the TDS value can be used as one of the references for reflecting the cleanliness of water. TDS pen is a widely used equipment to measure TDS value. The price is affordable, and it is easy to use, but it is not able to transmit data to the control system for online monitoring to do some water quality analysis. The professional instrument has high accuracy and can send data to the control system, but the price is expensive for the ordinary people.To this end, we have launched an analog TDS sensor kit which is compatible with Arduino, plug and play, easy to use. Matching with Arduino controller, you can build a TDS detector easily to measure the TDS value of liquid. This product supports 3.3 ~ 5.5V wide voltage input, and 0 ~ 2.3V analog voltage output, which makes it compatible with 5V or 3.3V control system or board. The excitation source is AC signal, which can effectively prevent the probe from polarization and prolong the life of the probe, meanwhile, increase the stability of the output signal. The TDS probe is waterproof, it can be immersed in water for long time measurement. This product can be used in water quality application, such as domestic water, hydroponics. With this product, you can easily DIY a TDS detector to reflect the cleanliness of water to protect your health.

- **Signal Transmitter Board**

  Input Voltage: 3.3 ~ 5.5V

  Output Voltage: 0 ~ 2.3V

  Working Current: 3 ~ 6mA

  TDS Measurement Range: 0 ~ 1000ppm

  TDS Measurement Accuracy: ± 10% F.S. (25)

  Module Size: 42 * 32mm

  Module Interface: PH2.0-3P

  Electrode Interface: XH2.54-2P

- **TDS probe**

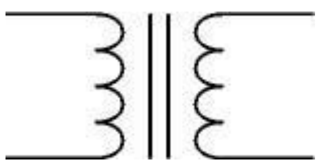
  Number of Needle: 2
  Total Length: 83cm
  Connection Interface: XH2.54-2P
  Colour: Black
  Other: Waterproof Probe

5. Memory:

The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library).

e) TRANSFORMER:

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC.Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage.The input coil is called the primary and the



output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.The ratio of the number of turns on each coil, called the turn's ratio, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

Turns ratio=Vp/Vs=Nn/Ns and Power out=Power in

Vs*Is=Vp * Ip

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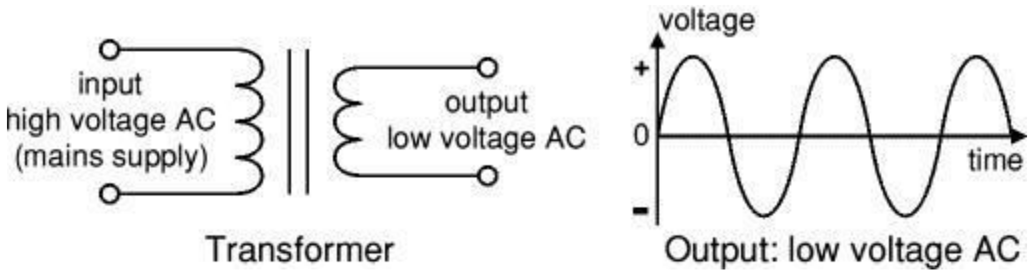
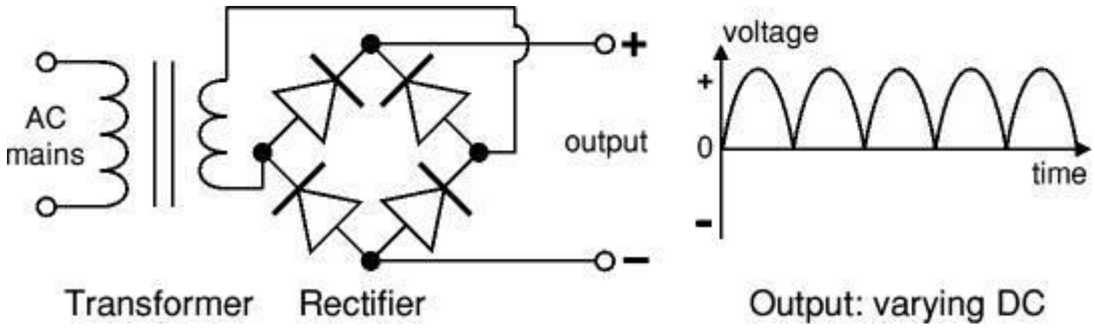
Vp = primary (input) voltage Vs = secondary (output) voltage
Np = number of turns on primary coil Ns = number of turns on secondary coil
Ip = primary (input) current Is = secondary (output) current



The low voltage AC output is suitable for lamps, heaters and special AC motors. It is not suitable for electronic circuits unless they include a rectifier and a smoothing capacitor.

Rectifier:

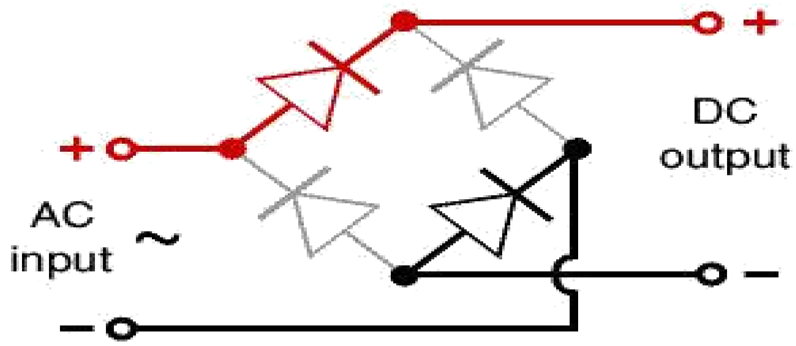
There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC.



The varying DC output is suitable for lamps, heaters and standard motors. It is not suitable for electronic circuits unless they include a smoothing capacitor.

f) BRIDGE RECTIFIER:

A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses the entire AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. Bridge rectifiers are rated by the maximum current they can pass and the maximum reverse voltage they can withstand (this must be at least three times the supply RMS voltage so the rectifier can withstand the peak voltages). Please see the Diodes page for more details, including pictures of ridge rectifiers.Alternate pairs of diodes conduct, changing over the connections so the alternating directions of AC are converted to the one direction of DC.



Output: full-wave varying DC: (using the entire AC wave):

V.PROPOSED SYSTEM:

In this System, the array of sensors collects the data. In proposed System, it displays the deviation of water quality parameters and also sends the measured data to the microcontroller via IoT. It collects the data on real time basis without any human intervention with the help of GSM module.The key parameters monitored in the proposed system are conductivity, turbidity, water level and pH. The block diagram of the proposed system is shown in Fig.
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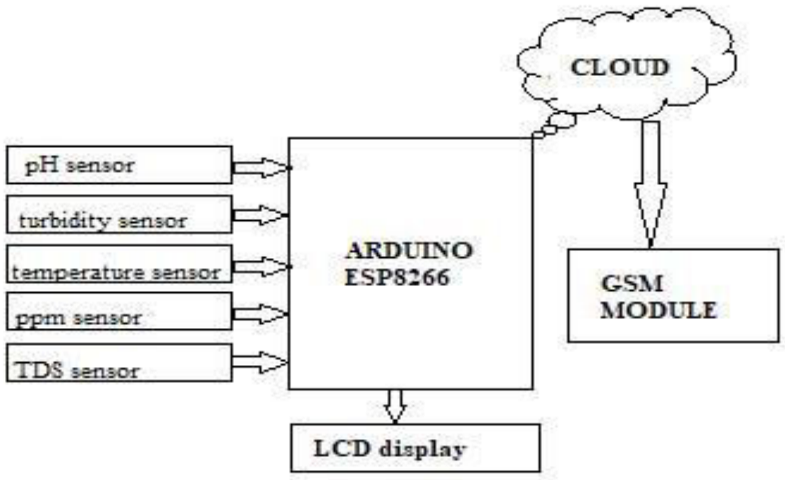

effective, power efficient and also result in complex circuitry. In this work, ESP8266 is a single chip microcontroller with in-built Wi-Fi module and ARM Cortex M4 core, which can be connected to the nearest Wi-Fi hot spot for internet connectivity. Sensors are directly interfaced to the controller since the proposed system is to monitor domestic water quality. The sensor parameters such as conductivity, turbidity, water level and pH are measured by placing the sensor into different solutions of water. The measured parameters can be viewed by using LCD. The data from the sensors are sent to the cloud using the controller. Threshold is set in the cloud based on the standards provided by WHO. Message is sent from cloud to the users mobile if the value exceeds the threshold. A mobile application has been developed in which values obtained by each sensor in the cloud can be viewed. This can be used by both the water quality monitoring authorities as well as users.In the proposed smart water quality monitoring system, a reconfigurable smart water sensor interface device that integrates data storage, data processing, and wireless transmission is designed.

METHODOLOGY:

The hardware experimental set-up of smart water quality monitoring system is implemented . The hardware's of water quality monitoring system comprises the following compon Conductivity is the measure of solutions ability to carry current. This parameter is used to determine the salt content in the water. In the proposed design, YL-69 is used to measure the conductivity of the water. It consists of two electrodes, when placed in water a potential is generated which is proportional to conductivity. It is measured in seimens per cm. Acceptable range of conductivity is from 300 to 800 µ seimens per cm. pH measures amount of acid or base in the solution. Three in

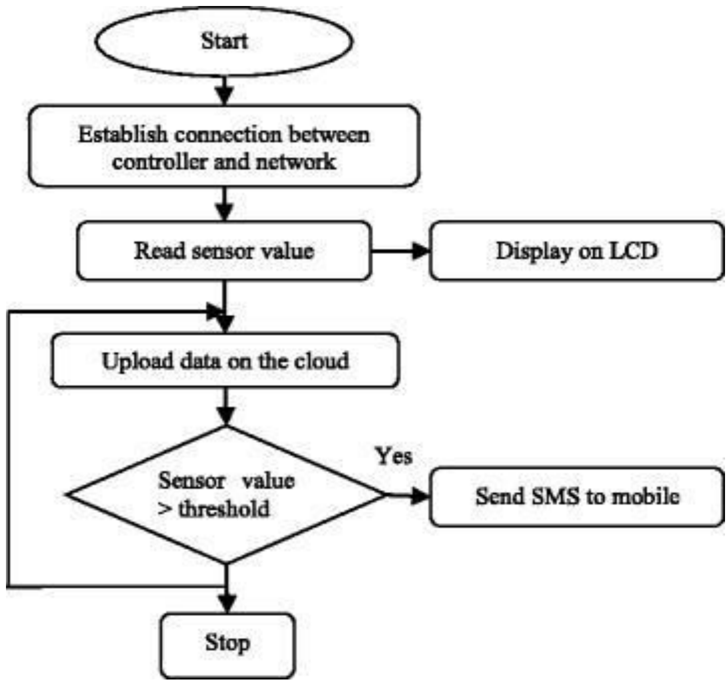

Figure:6

1 ph meter with inverting operating amplifier is used to measure pH. Inverting Op-amp is used to boost the voltage from mV to voltage range. pH sensor consists of two electrodes which is reference electrode and pH electrode also known as measuring electrode. When placed in the solution pH electrode develops a potential that is proportional to pH. The value ranges from 0 to 14. The acceptable range of pH for drinking water is 6.5 to 8.5.Turbidity is a measure of cloudiness in the water. Opto electronic devices such as LDR and LED are used to measure the turbidity. Light is transmitted and reflected by suspended solids and reflected light is received by the sensors. An LDR is high resistance semiconductor. If light falling on the device is of high frequency, photons absorbed by the semiconductor gives the bound electrons enough energy to jump into the conduction band. In the proposed system distance between the LED and LDR is 9 cm. The resulting free electrons conduct electricity thereby lowering resistance. Water level is sensed to determine the depth of the water in the tank. This is done using probe method. Three probes are used to indicate the level of the water such as high, low and medium.The sensor is constantly updated in the cloud and also displayed in the LCD connected.The programming is done using ENERGIA IDE. Table 10 Parameters measured with different water samples Parameters Drinking water (filter) Pipe water Sample 1 Sample 2 ph 6.5 7.9 8.4 conductivity 448 577 580 turbidity Values stored in the Ubidots cloud Data sent from the controller are stored in "Ubidots" cloud. "Ubidots" offers a platform for developers to capture data and turn it into useful information. The features include a real-time dashboard to analyze data or control devices and share the data through public links. Data stored in the cloud can be used for detailed analysis. The cloud is programmed to send alert SMS messages whenever the monitored parameter exceeds the threshold limit.The system is connected to the Ubidots cloud.

CONCLUSION AND FUTURE WORK:

This presents a detailed survey on the tools and techniques employed in existing smart water quality monitoring systems. Also, a low cost, less complex water quality monitoring system is proposed. The implementation enables sensor to provide online data to consumers. The experimental setup can be improved by incorporating algorithms for anomaly detections in water quality using a GSM module and the data are stored in the cloud.The cloud stores the values of all the parameters from the beginning which can be referred for future use.Wi-Fi has made it possible to connect people and machines on land, in the air and at sea. It is critical that both companies and governments keep ethics in mind as we approach the fourth industrial revolution. The Future Works includes converting our prototype into a device by getting access to the data of the respective person and providing the remedial measures for the improvement of the water quality.For eg: The pH of water required for the cultivation of paddy should be acidic if the water is basic the specific remedial measures are to be implemented with the help of the recorded data.When farmers up-to-date information collected, they can understand what situation will be in the future, and they can predict some problems that may arise. Moreover, farmers may use data to improve their sales and change business processes.

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