WATER QUALITY MONITORING SYSTEM USING IOT

A REPORT

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Title

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The UROP Committee certifies that this report complies with the regulations and meets the standard required for completion of
UROP Project

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Date : 14-05-2021

Head of the Department: *Dr. Siva Sankar Yellampalli*

Dedication

We would like to dedicate this work to our professors who taught us. This work is also dedicated to all aspiring students and future researchers.

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Abstract

In the field of engineering, many communication developments are establishing new foundations for the real time environmental applications using sensors, artificial intelligence, machine learning. In our project we are dealing with IOT(Internet of Things) based systems and sensors that enhances or boost up the connections among different devices for exchanging and storing data. In current field of expansion of digital world economically and globally, sensor based networks and its applications are widely used. Water is one of the basic needs of life for our survival. As we know water is essential in our body for functioning our cells and it allows the body to absorb minerals , vitamins , oxygen and helps our body detoxified, maintains our body healthy and hydrated. The key elements such as temperature, Conductivity, turbidity, flow sensor of the water can be measured. The measured values from the sensors can be processed by the core controller. To keep the water pure and clean. IOT plays a vital role in solving real-time environmental problems so its our responsibility to include some measures to monitor water quality time to time as around 40 to 50% of deaths are being caused by contamination of water and to ensure supply of purified water is reaching to people in cities and villages across country.WQM(water quality monitoring) system is a cost effective system developed to monitor drinking water with the help of IOT.

Fresh and clean water is natural resource, we should keep it clean it also helps us in agriculture. There are several real life examples where water level is decreasing day by day due to climatic change and human destruction. In India we pray to holy river ganga but as days are passing some people are damaging its divinity and purity. To save our holy river ganga our government has initiated GAP(ganga action plan)in which some steps are taken to keep the river clean. Apart from ganga river there are many holy rivers those are damaged by human destruction primarily. Another example is Yamuna river which is surrounded around the symbol of love the famous Taj Mahal(one of the seven wonders of world). The monument is situated on banks of river yamuna . The river plays a significance of purity and holiness around the Taj feels like dramatic backdrop scenic beauty. The water provides mirror and gives the feeling of floating tomb of love. Waters of yamuna drains highly fertile land along its course and the water cultivates the vast areas of fields of states like Punjab, Haryana and UP. High usage of chemicals and pesticides and industrial waste is left in rivers that cause death of aquatic life and pollutes water. Due to polluted water many people surviving around the river are also affected worsly day by day. Like GAP, our govt has initiated YAP(yamuna action plan)to maintain the river's purity and cleans the pollutants time to time.

1.INTRODUCTION

In this project, we present the speculation on real time monitoring of water quality in IoT environment. The overall block diagram of the proposed method will be explained. Several sensors (temperature, Conductivity, turbidity, flow) is connected to core controller. The core controller are accessing the sensor values and processing them to transfer the data through internet. Ardunio is used as a core controller. The sensor data can be viewed on the web wi-fi system.

Monitoring of Turbidity, Conductivity & Temperature of Water makes use of water detection sensor with specific advantage and existing GSM network. The system can monitor water quality automatically, and it is low in cost and does not require man on duty. So the water quality testing would be more economical, convenient and eco-friendly.

Along with advantages of monitoring system we have to undergo some disadvantages in this system like there is no continuos and remote monitoring, no monitoring is accessible at fields and this leads to low frequency testing.

By keeping the embedded devices in the surroundings for monitoring enables self protection (i.e., smart environment) to the environment. For implementing we need to utilize and develop the sensor devices in the environment for collecting the information. By deploying sensor devices within the environment into real life i.e. it can interact with other objects through the network. Then the collected data and analysis results are available to the end user through the Wi-Fi.

1.1Arduino

Arduino is an open-source electronics platform supported easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and switch it into an output - activating a motor, turning on an LED, publishing something online. you'll tell your board what to try and do by sending a collection of instructions to the microcontroller on the board. to try and do so you utilize the Arduino programing language (based on Wiring), and therefore the Arduino Software (IDE), supported Processing.

The Arduino Uno is microcontroller board supports the ATmega328 . it's 14 digital input/output pins (of which 6 will be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, an influence jack, an ICSP header, and a push. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to urge started.

The Uno differs from all preceding boards in this it doesn't use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. The Uno board encompasses a resistor pulling the 8U2 HWB line to ground, making it easier to place into DFU mode.

Here are the components that make up an Arduino board and what each of their functions are.

- Reset Button – This will restart any code that is loaded to the Arduino board
- AREF – Stands for “Analog Reference” and is used to set an external reference voltage
- Ground Pin – There are a few ground pins on the Arduino and they all work the same
- Digital Input/output – Pins 0-13 can be used for digital input or output
- PWM – The pins marked with the (~) symbol can simulate analog output
- USB Connection – Used for powering up your Arduino and uploading sketches

- USB Interface Chip - Think of this as a signal translator. It converts signals in the USB level to a level that an Arduino UNO board understands.
- TX/RX – Transmit and receive data indication LED s
- Power LED Indicator – This LED lights up anytime the board is plugged in a power source
- Voltage Regulator – This controls the amount of voltage going into the Arduino board
- DC Power Barrel Jack – This is used for powering your Arduino with a power supply
- 3.3V Pin – This pin supplies 3.3 volts of power to your projects
- 5V Pin – This pin supplies 5 volts of power to your projects
- Ground Pins – There are a few ground pins on the Arduino and they all work the same
- Analog Pins – These pins can read the signal from an analog sensor and convert it to digital

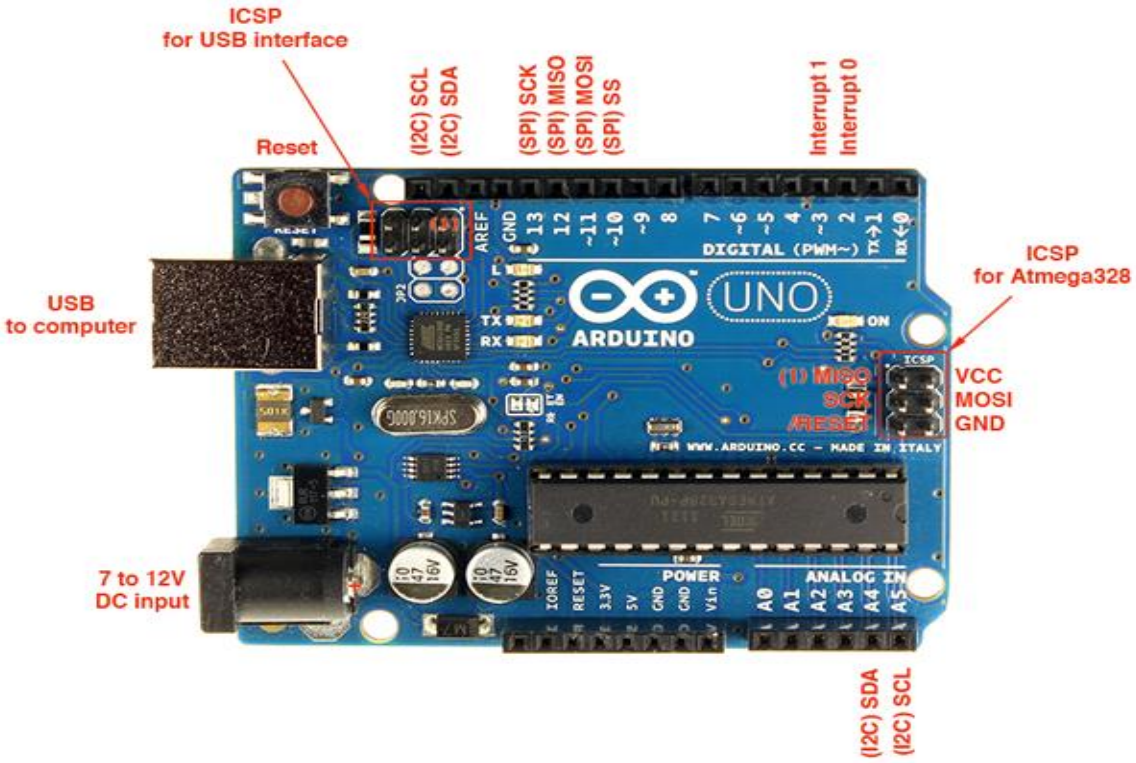


Figure 1. 1 Arduino UNO Board

1.2 Pcb layout description

One of the most discouraging things about designing a hardware project is building the printed circuit board-PCB, it is sometimes possible to use strip board or some other pre-fabricated board but more often than not the circuit complexity and performance requires a proper PCB to be made .The advantage is that due to improvements in printing and processing technologies it is now relatively easy to make inexpensive high quality PCB's at home.

Making of PCB's requires the usage of Ferric Chloride(FeCi3) which is corrosive. So, use of glasses, gloves are recommended.

The first step is to transfer the circuit layout from the PC to the special Press-n-Peel film. Then put the film in the laser printer so that the print will appear on it. This will create a contact print where the black image will end up as copper on the final PCB. Now to transfer the artwork to the Copper board by following the instructions with the Press-n-Peel film:

- Clean the copper board very well with the PCB cleaning rubber.
- Heat the cloths iron to 300 deg F.
- Hole the film with the print in contact to the copper and smoothly iron the film down until the print appears black through the film (about 1min).
- Allow 5min to cool down (or speed up this with water) then peel the film off.

This produces a clean black print on to the copper. If we let the film move or overheat then we will find that the tracks and writing will be smeared and out of focus also the film may be wrinkled up. If we don't use sufficient heat or heat unevenly then the film may not stick or to be dark enough

1.3 Power supply

The Arduino Uno is powered via the USB connection or with an external power supply. the power source is chosen automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter are often connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from battery could also be inserted within the Gnd and Vin pin headers of the flexibility connector.

The board can operate an external supply of 6 to twenty volts. If supplied with but 7V, however, the 5V pin could provide but five volts and so the board is additionally unstable. If using quite 12V, the transformer may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

• VIN. The input voltage to the Arduino board when it's using an external power source (as opposition 5 volts from the USB connection or other regulated power source). you will be able to supply voltage through this pin, or, if supplying voltage via the flexibility jack, access it through this pin.

• 5V.This pin outputs a regulated 5V from the regulator on the board. The board are often supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and might damage your board. we don't advise it.

• 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.

• GND. Ground pins.

• IOREF. This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and choose the acceptable power source or enable voltage translators on the outputs for working with the 5V or 3.3V.

Memory:

The ATmega328 has 32 KB (with 0.5 KB used for the bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which is read and written with the EEPROM library).

Input and Output:

Each of the 14 digital pins on the Uno are used as an input or output, using pinmode,digitalwrite , and digitalread functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an enclosed pull-up resistor (disconnected by default) of 20-50 kOhms. additionally, some pins have specialized functions:

• Serial: 0 (RX) and 1 (TX). accustomed receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

• External Interrupts: 2 and three. These pins is configured to trigger an interrupt on a coffee value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

• PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.

• SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

• LED: 13. there is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

The Uno has 6 analog inputs, labeled A0 through A5, each of which supply 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and so the analog Reference function. Additionally, some pins have specialized functionality:

• TWI: A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

There are a pair of other pins on the board:

• AREF. Reference voltage for the analog inputs. Used with analogReference.

• Reset. Bring this line LOW to reset the microcontroller. Typically accustomed add a push to shields which block the one on the board.

See also the mapping between Arduino pins and ATmega328 ports. The mapping for the Atmega8, 168, and 328 is identical.

Communication:

The Arduino Uno incorporates variety of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is on the market on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the pc. The '16U2 firmware uses the standard USB COM drivers, and no external driver is required. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the pc (but not for serial communication on pins 0 and 1).

USB Overcurrent Protection:

The Arduino Uno features a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If quite 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Automatic (Software) Reset:

Rather than requiring a physical press of the push before an upload, the Arduino Uno is meant during the simplest way that allows it to be reset by software running on a connected computer. one in every of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this

line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button within the Arduino environment. this suggests that the bootloader can have a shorter timeout, because the lowering of DTR are going to be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets whenever a connection is made thereto from software (via USB). For the next half-second nearly, the bootloader is running on the Uno. While it's programmed to ignore malformed data (i.e. anything besides an upload of recent code), it'll intercept the first few bytes of knowledge sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, confirm that the software with which it communicates waits a second after opening the connection and before sending this data.

The Uno contains a trace which is able to be move disable the auto-reset. The pads on either side of the trace are soldered together to re-enable it. It's labeled "RESET-EN". you may even be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

Physical Characteristics

The maximum length and width of the Uno PCB are 2.7 and 2.1 inches respectively, with the USB connector and power jack extending beyond the previous dimension. Four screw holes allow the board to be attached to a surface or case. Note that the gap between digital pins 7 and eight is 160 mil (0.16"), not a superb multiple of the 100 mil spacing of the alternative pins.

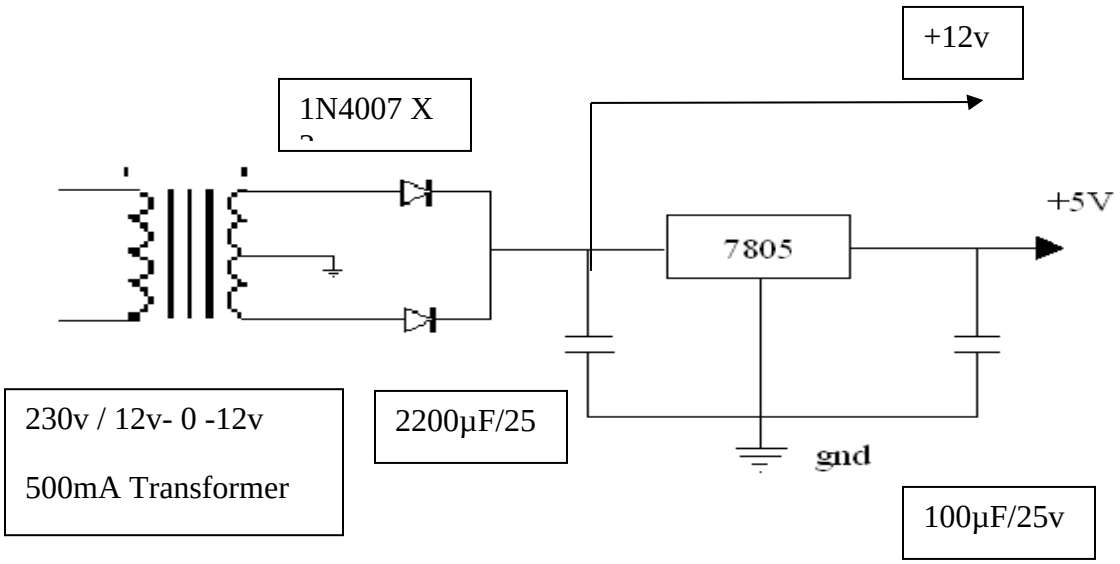


Figure 1. 2 Circuit Diagram for Power Supply

Rectification is a process of rendering an alternating current or voltage into a unidirectional one. The component used for rectification is called 'Rectifier'. A rectifier permits current to flow only during positive half cycles of the applied AC voltage. Thus, pulsating DC is obtained. To obtain smooth DC power additional filter circuits required.

A diode can be used as rectifier. There are various types of diodes. However, semiconductor diodes are very popularly used as rectifiers. A semiconductor diode is a solid-state device consisting of two elements is being an electron emitter or cathode, the other an electron collector or anode. Since electrons in a semiconductor diode can flow in one direction only-form emitter to collector-the diode provides the unilateral conduction necessary for rectification.

The rectified Output is filtered for smoothening the DC, for this purpose capacitor is used in the filter circuit. The filter capacitors are usually connected in parallel with the rectifier output and the load. The AC can pass through a capacitor but DC cannot, the ripples are thus limited and the output becomes smoothed. When the voltage across the

capacitor plates tends to rise, it stores up energy back into voltage and current. Thus, the fluctuation in the output voltage is reduced considerable.

The name 7805 signifies two meaning, “78” means that it is a positive voltage regulator and “05” means that it provides 5V as output. So our 7805 will provide a +5V output voltage.

The output current of this IC can go up to 1.5A. But, the IC suffers from heavy heat loss hence a Heat sink is recommended for projects that consume more current. For example if the input voltage is 12V and you are consuming 1A, then (12-5) * 1 = 7W. This 7 Watts will be dissipated as heat. The input capacitor 2200µF is a ceramic capacitor that deals with input inductance problem and the output capacitor 100µF is also a ceramic capacitor that adds to the stability of the circuit.

1.4 Components Required

- Arduino ATMEGA328
- ESP8266 Serial Esp-01 WIFI Wireless
- Turbidity sensor
- Conductivity Sensor
- Temperature Sensor
- 16X2 LCD Display
- IR sensor and photodiode sensor
- Step down Transformer(230v/12v-0-12v 500mA)
- Analog to Digital Converter
- Voltage Regulator (7805)
- Relay or Mechanical switch
- Buzzer
- Crystal Oscillator

- PCB Boards
- 2 Diodes(1N4007)
- Resistors(1k, 10k)
- LEDs, Buzzer driver
- POWER USB
- POWER JACK

1.1.2 ATMEGA328p

Description:

Parameter	Value
CPU type	8-bit AVR
Performance	20 MIPS at 20 MHz
Flash memory	32 KB
SRAM	2 KB
EEPROM	1 KB
Pin count	28 or 32 pins
Maximum operating frequency	20 MHz

Number of touch channels	16
Maximum I/O pins	23
External interrupts	2
USB Interface	No

Table 1. 1 Pin Configuration of ATMEGA328p micro-controller

1.1.3 16x2 Liquid Crystal Display

16×2 LCD is named so because; it has 16 Columns and 2 Rows. it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots. each character has (5×8=40) 40 Pixels and for 32 Characters we will have (32×40) 1280 Pixels.

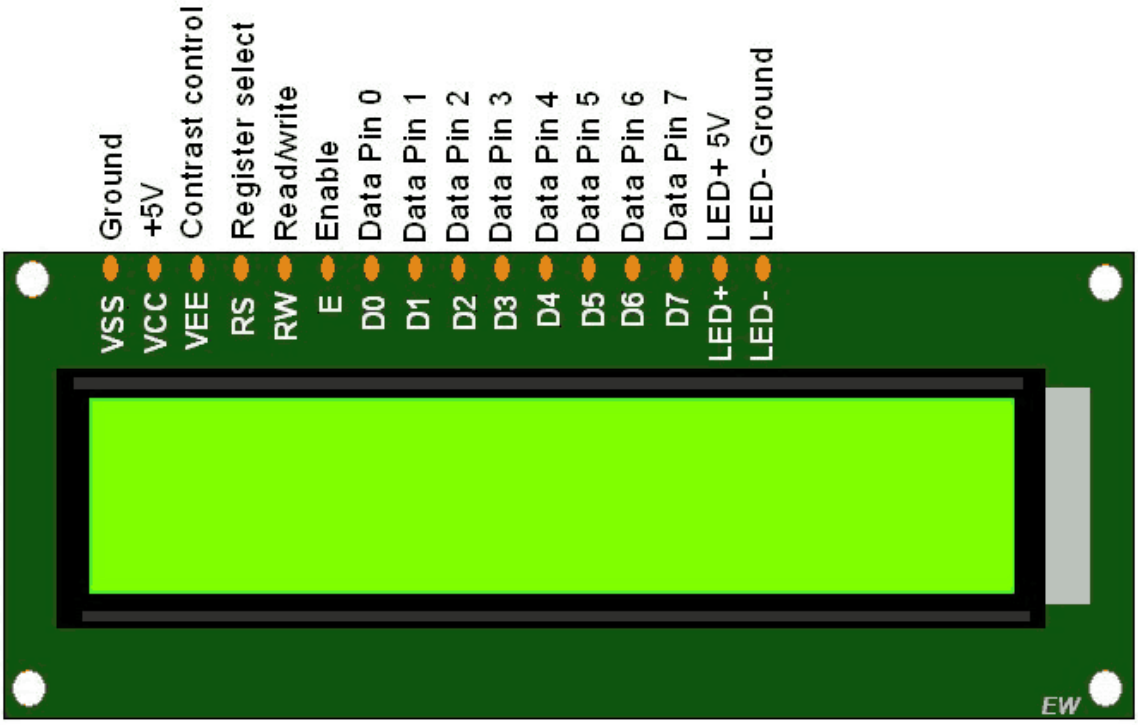


Figure 1. 3 Pin Diagram of 16X2 Liquid Crystal Display

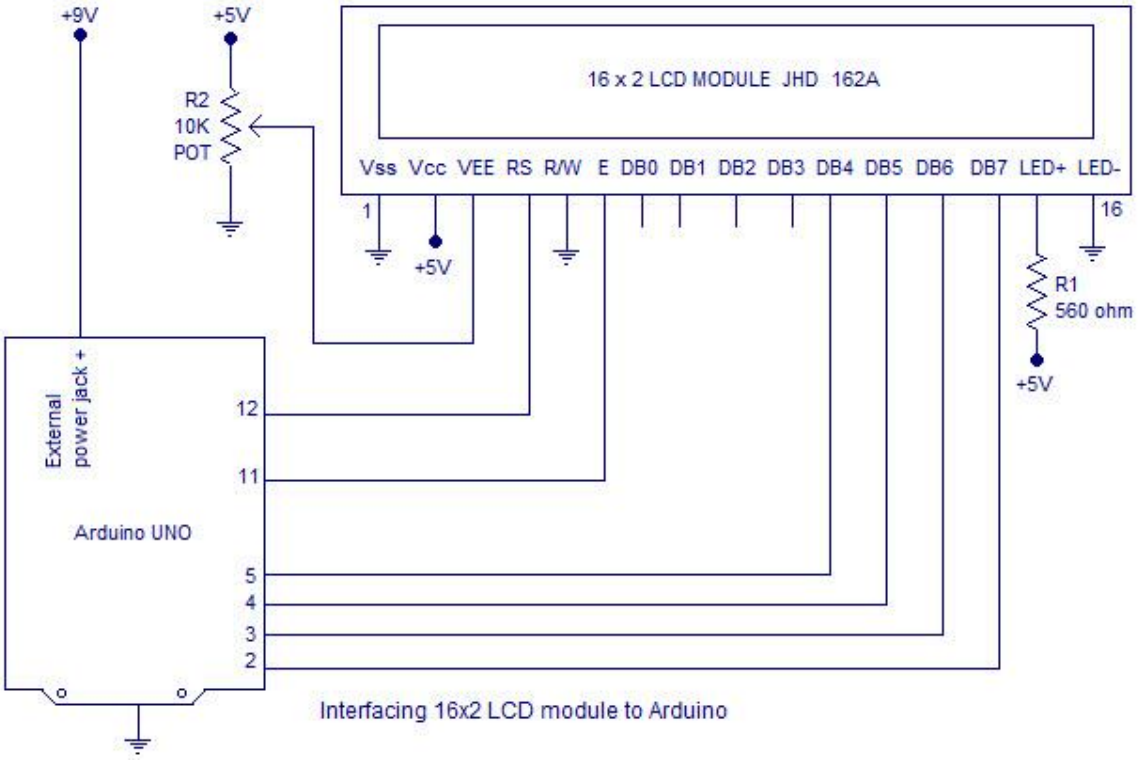


Figure 1. 4 Interfacing 16X2 Liquid Crystal Display with Arduino

TURBIDITY SENSOR:

Turbidity is a measure of the cloudiness of water. Turbidity has indicated the degree at which the water may loses its transparency. It is considered as a good measure of the quality of water. Turbidity blocks out the sunlight needed by submerged aquatic vegetation. It also can raise surface water temperatures above sea level because suspended particles near the surface facilitate the absorption of warmth from sunlight. Warm water holds less dissolved oxygen than cold, so increased water temperatures result in decreased levels of dissolved oxygen.

CONDUCTIVITY SENSOR:

A conductivity sensor measures the power of solution to conduct an electrical current. It's the presence of ions in an exceedingly solution that allow the solution to be conductive: the greater the concentration of ions, the greater the conductivity.Water conductivity sensors are employed in water-quality applications to live how well an solution conducts an electrical current. This kind of measurement assesses the concentration of ions within the solution. The more ions that are within the solution, the upper the conductivity.

TEMPERATURE SENSOR:

Water Temperature indicates how water is hot or cold. This temperature sensor is measured in digital type to give precise reading. They are devices to live temperature readings through electrical signals. The sensor is created from two metals, which generate electrical voltage or resistance once it notices a change in temperature. A temperature sensor is an device that measures the temperature of its environment and converts the input file into electronic data to record, monitor, or signal temperature changes.

1.1.4 Buzzer

A buzzer or beeper may be a signalling device, usually electronic, typically employed in automobiles, household appliances like a kitchen appliance, or game shows. It most ordinarily consists of variety of switches or sensors connected to a bearing unit that determines if and which button was pushed or a preset time has lapsed, and typically illuminates a light-weight on the suitable button or electrical device, and sounds a warning in the kind of an eternal or intermittent buzzing or beeping sound. Initially this device was supported an electromechanical system which was a twin of an electrical bell without the metal gong (which makes the ringing noise). Often these units were anchored to a wall or ceiling and used the ceiling or wall as a sounding board. Another implementation with some AC-connected devices was to implement a circuit to form the AC current into a noise loud enough to drive a loudspeaker and hook this circuit up to an inexpensive 8-ohm speaker. Now-a-days, it's more popular to use a ceramic-based piezo-electric sounder sort of a sonalert which makes a high-pitched tone. Usually these were connected to driver" circuits which varied the pitch of the sound or pulsed the sound on and off.

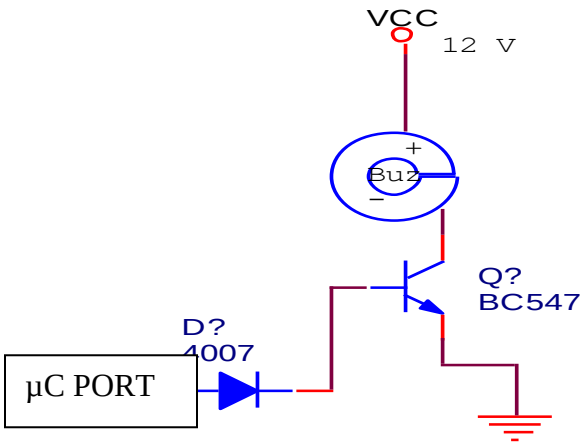


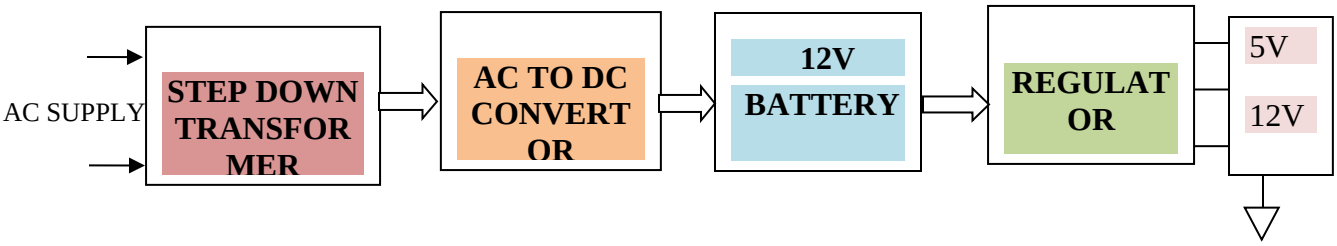
Figure 1. 5 Circuit Diagram of Buzzer

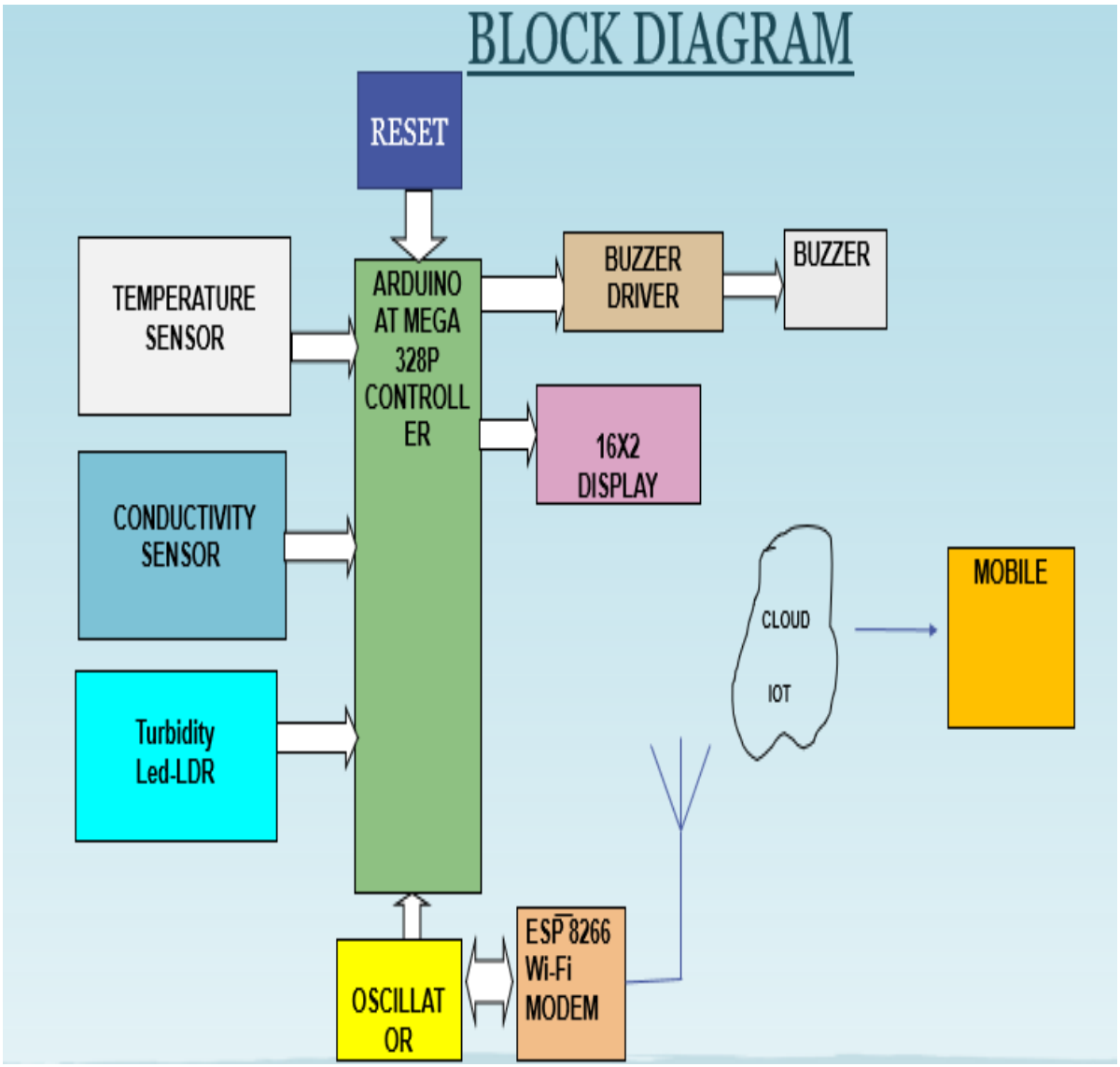
When low pulse is given to base of transistor Q1, the transistor is turned OFF. Now 12V is given to base of Q2 transistor so the transistor is conducting and buzzer is energized and produces the sound signal.

2. Design

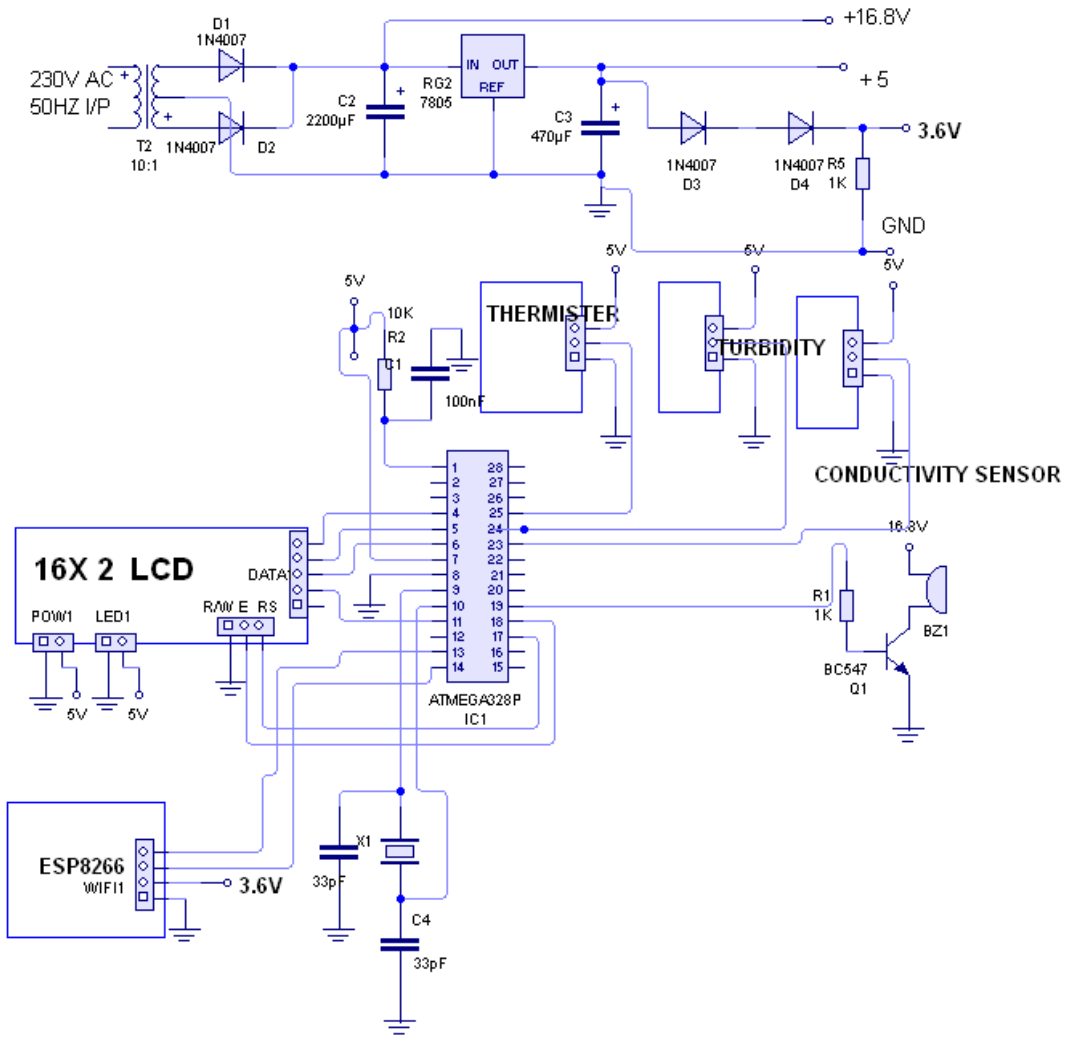
2.1 Block Diagram

Power supply





2.2 Circuit Diagram



APPLICATIONS

In light of accelerating concerns around water scarcity, the price of water, and now, water quality as a results of prolonged facility shutdowns, commercial building owners are being forced to pay closer attention to water management.

Water bills and meter readings—once considered sufficient for managing water consumption—have been eclipsed by more sophisticated tools and methods, like Internet of Things (IoT) sensors and advanced data analytics. Whether you're striving to use water

more optimally, maintain a continuously healthy facility, achieve LEED or WELL certification, or anything, today's water management techniques are grounded in data the reasonably data that may only be collected through an IoT water monitoring system. Keep reading to determine the various ways building managers are applying IoT technology to water-related issues in an attempt to alter their operations for the higher.

IoT Water Monitoring Systems:

1. Prevent Legionella with IoT flow monitoring.

The EPA has noted that one amongst the risks related to reopening buildings after a chronic closure (such as during the COVID-19 pandemic) is that the potential presence of Legionella bacteria in building plumbing systems, which might result in illness. Such bacteria is understood to grow when plight temperatures decrease from the recommended temperature of 140 degrees Fahrenheit to lukewarm (usually anywhere from 77 degrees to 108 degrees Fahrenheit), and disinfectants (like chlorine) dissipate because of inactivity within the pipes over an extended period of your time.

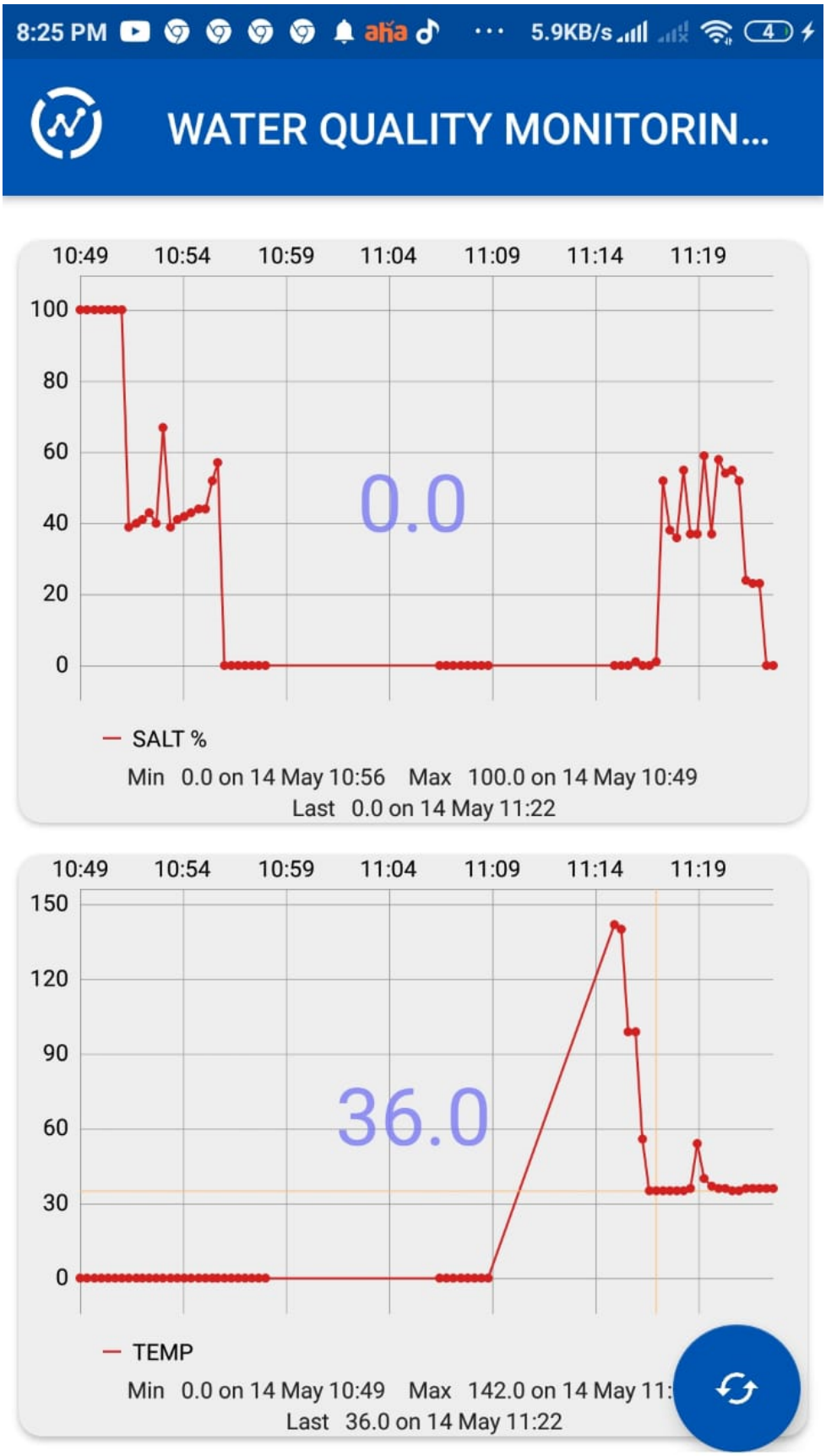
3. METHODOLOGY

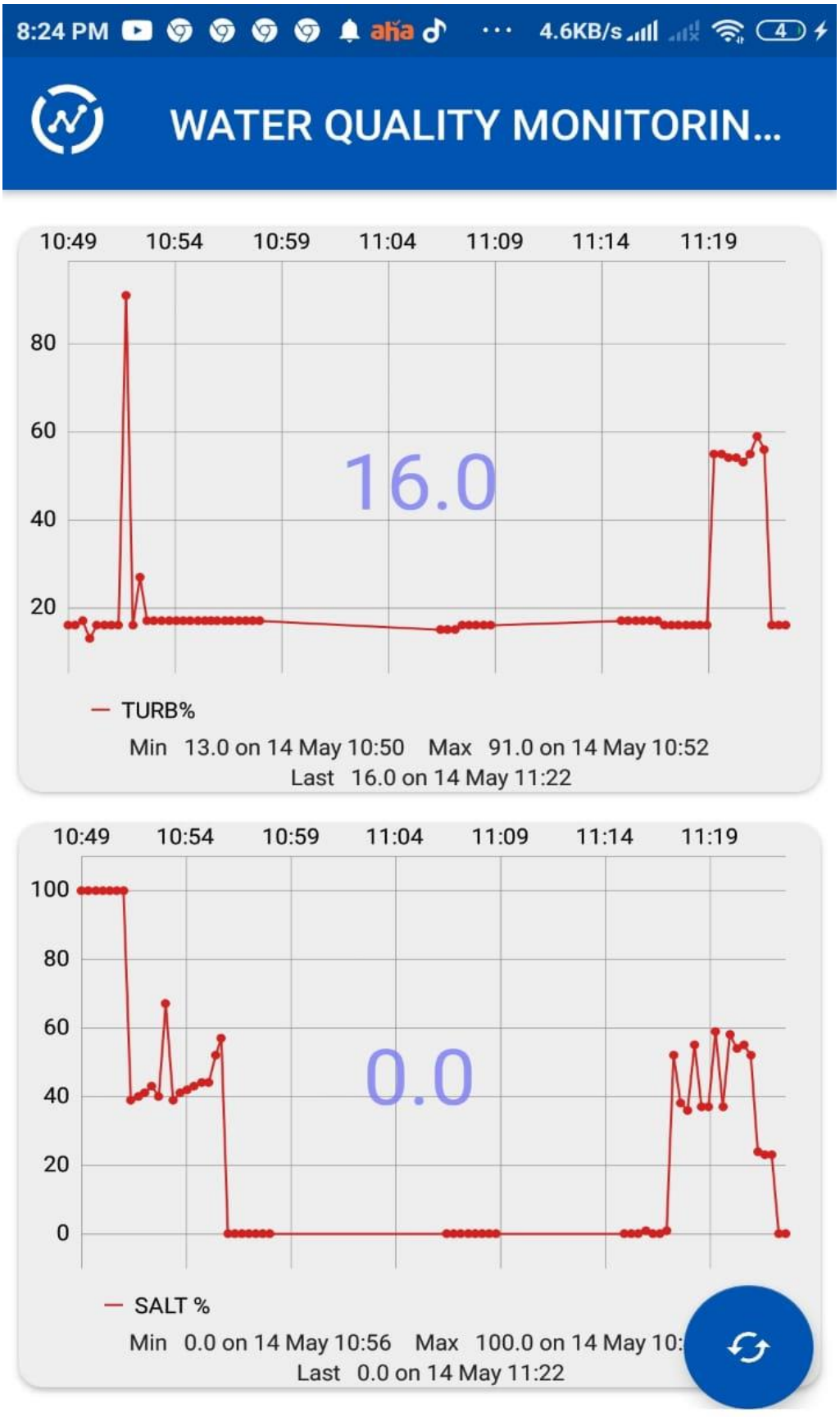
The suggested system uses four sensors which are pH, turbidity, ultrasonic, DHT-11, microcontroller unit as the main processing module and one data transmission module ESP8266 Wi-Fi module (MCU). The microcontroller unit is the vital part of the system deployed for water quality measurement because The Arduino uno consumes low power, and it is a tiny size, where the dimensions could be a good use for a key point-of-sale technology. Among four sensors, two of the sensors collect the data in the form of analog signals of data.WQM system uses technical procedure for assessing and monitoring quality and pollution problems in large scale water distribution networks. for example, in major irrigation system. The strategy utilises low-cost, field-kit instrumentation which will be utilized by non-technical staff, and substantially reduces the requirement for expensive and time-consuming laboratory analysis.

The entire system is developed in Embedded-C and simulating the written code using Arduino IDE. As to gather data on pH, turbidity, level of water, temperature, and humidity of the surrounding atmosphere, the water quality monitoring system employs sensors. Authorized users can access these data using a user ID and password for accessing data on the Thing Speak server by logging into their accounts. The information is gathered, stored, examined and transmitted in real-time. The ESP8266 is a low-cost Wi-Fi module consists of a full TCP/IP stack Wi-Fi chip and microcontroller chip which is manufactured by M/S Espino. The code boots from external flash directly during the processing. ESP8266 uses Tx and Rx serial transceiver pins for gathering data, for changing wireless module settings, for changing serial query commands. Two pins (Tx/Rx) are needed to interact, but only attached, between a Wi-Fi module and a MC but connected oppositely. It is easy to lineup an IoT application via Wi-Fi Module using SPI and UART board.

3.1 Conclusion

In this project, the quality of water is monitored successfully using modules like PC (wifi module) and IDE for transferring information and tracking techniques respectively. An IR sensor was included to detect water quality.Below attached images are the results of our project. Here we used thingview application as medium for cloud information.


8:25 PM
5.9KB/s
WATER QUALITY MONITORIN...
10:49
10:54
10:59
11:04
11:09
11:14
11:19
100
80
60
40
20
0
0.0
SALT %
Min 0.0 on 14 May 10:56 Max 100.0 on 14 May 10:49
Last 0.0 on 14 May 11:22
150
120
90
60
30
0
36.0
TEMP
Min 0.0 on 14 May 10:49 Max 142.0 on 14 May 11:
Last 36.0 on 14 May 11:22


8:24 PM
4.6KB/s
WATER QUALITY MONITORIN...
10:49
10:54
10:59
11:04
11:09
11:14
11:19
80
60
40
20
16.0
TURB%
Min 13.0 on 14 May 10:50 Max 91.0 on 14 May 10:52
Last 16.0 on 14 May 11:22
10:49
10:54
10:59
11:04
11:09
11:14
11:19
100
80
60
40
20
0
0.0
SALT %
Min 0.0 on 14 May 10:56 Max 100.0 on 14 May 10:
Last 0.0 on 14 May 11:22

FUTURE SCOPE:

In future, we can add pH sensor to our project. It will help to identify if any chemicals mixed in water. Based on pH value, we can find if the water contains any chemicals which are toxic to us.

4. Reference List

- Sathish Pasika, Saiteja Gandla – The author proposed smart water monitoring system based on wireless communication with the help of RF (radio frequency) and transmitter.
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