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# IOT BASED WATER QUALITY MONITORING AND WATER LEVEL CONTROL IN DAMS

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**ABSTRACT** Dams play a very important role to hold and conserve water for optimal usage based on seasonal needs. Water Management plays a very important role in mitigating the current issues of water distribution and utilization. As there are lot of hazards related with the existence of the dams, it has become a necessity to develop a proper monitoring system regarding the opening of the dam gate to retain a safe water level in dams. Exploring usage of IoT for improving the safe utilization of dams, water flow and prevention of dam gate corrosion. Safe water is becoming a scarce resource, due to the combined effects of increased population, pollution, and climate changes. Water quality monitoring is thus paramount, especially for domestic water. Traditionally used laboratory-based testing approaches are manual, costly, time consuming, and lack real-time feedback. Recently developed systems utilizing wireless sensor network (WSN) technology have reported weaknesses in energy management. The parameters such as temperature, PH, flow , moisture, co2, and level of the water can be measured. The measured values from the sensors can be processed by the core controller. The Arduino model can be used as a core controller. Finally, the sensor data can be viewed on internet using WI-FI system.

*Keywords: wireless sensor network, Inter net of things, Water quality, water management, DAM.*

**INTRODUCTION** Water is essential for life on earth. Yet, numerous countries are facing shortages of freshwater [1,2,3]. This alarming issue strongly motivated them to utilize other available resources instead. For example, Gulf countries are acquiring freshwater from the sea through a tedious desalination process [4,5]. Increased costal industrialization and resulting water pollution, however, is making this process even more challenging. Other countries are processing rainwater to obtain freshwater [6]. However, lately climate change is affecting rainfalls, which is putting into jeopardy this option [7,8,9]. Countries where freshwater is more accessible are unfortunately not safe from water related issues [10,11,12]. Water pollution has been reported for years as a growing concern [13]. For example, the America Clean Water Foundation established the water monitoring day (called the EarthEcho Water Challenge) in 2003 [13,14]. Its main agenda is to spread public awareness regarding water pollution. Both the United States Environmental Protection Agency (USEPA) and World Health

Organization (WHO) are constantly providing updates and recommendations on how to cope with the newly detected water contaminants and disea.. On the top of pollution and studies pointing out to global-warming's impact on water resources [19,20,21], the World Water Council (WWC) is predicting a global population increase by 40% to 50% over the next 50 years [22]. This significant growth, in conjunction with urbanization and industrialization, may greatly increase the overall water demand. All aforementioned pointers are indicating a potential global water crisis coming. In the eve of such a water crisis, freshwater is commonly turning into an industrial product. Under the municipality control in urban areas, it is often stored in overhead/underground tanks, sometimes for extended period prior to consumption [23]. Continuous monitoring of water quality is thus necessary, to classify water for its suitable application and prevent waste. For example, water that is not good for drinking can be used for cleaning purposes. Recently, motivated by the progress in Internet-of-Things (IoT), several IoT-based solutions have been devised to water monitoring. Most commercial systems (e.g., Hach guardian blue, Canary, optiEDS, Libelium Inc., Biz4Intellia, and Bluebox) have reported enhanced efficiency as opposed to previous systems centered around older technologies [19]. However, these systems are either very costly or their architectures are closed for public usage. Therefore, the usage of such commercial systems has been limited to developed countries only. This act led to a plethora of studies to devise cheap and reliable IoT-based smart solution to water monitoring, aiming to benefit from the communication infrastructure already existing for smart applications. In the 21st century, there were lots of inventions, but at the same time were pollutions, global warming and so on are being formed, because of this there is no safe drinking water for the world's pollution. Nowadays, water quality monitoring in real time faces challenges because of global warming limited water resources, growing population, etc. Hence there is need of developing better methodologies to monitor the water quality parameters in real time[1]. The water quality parameters pH measures the concentration of hydrogen ions. It shows the water is acidic or alkaline. Pure water has 7pH value, less than 7pH has acidic, more than 7pH has alkaline. The range of Ph is 0-14 pH. For drinking purpose it should be 6.5-8.5pH.

**LITERATURE SURVEY** As an open research area of concern, several related review/survey articles have been published to highlight progress in the sensor and wireless communication technology, cloud services, and computing devices among others. In [3], authors present an excellent review on WSN technology for leak detection, but the article offers no contents on water quality monitoring. While Pule et al. [2] focus their survey on environmental monitoring with emphasis on water, they mainly cover WSN technology missing new IoT based smart systems. Similarly, Ahmed et al. [19] centered their review paper around water quality monitoring, covering all technologies including WSN, but new IoT based systems. Geetha and Gouthami [2] in their review paper also included the real-time dimension of smart water quality monitoring systems but kept a rather generic scope while covering IoT based techniques. Damor and Sharma [24] in their review paper made a first attempt to cover IoT based systems, but a critical analysis, and comparison of methods is missing. In their study, Banna et al. [21]

provide a survey of existing and emerging sensors technologies for water monitoring. However, it also has given very less attention to IoT based systems. Adu-manu et al. [20] published an exclusive review on water quality monitoring using WSN technology. This is a great resource of knowledge, but unfortunately only covers up to WSN-based water monitoring systems and needs to be extended to include the new IoT applications in the same field.

**PROPOSED METHOD:**

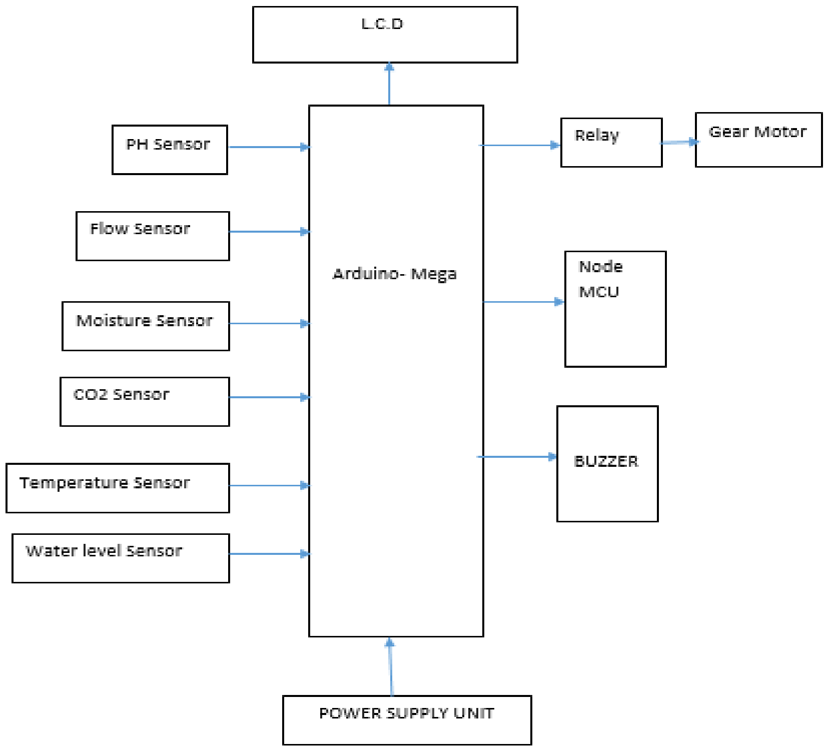



**Fig1: Proposed block diagram**

**ARDUINO MEGA** The Arduino Mega is based on ATmega2560 Microcontroller. The ATmega2560 is an 8-bit microcontroller. We need a simple USB cable to connect to the computer and the AC to DC adapter or battery to get started with it. The Arduino Mega is organized using the Arduino (IDE), which can run on various platforms. Here, IDE stands for **Integrated Development Environment.**

The functioning of the Arduino Mega is similar to other Arduino Boards. We need not require extra components for its working. The ATmega2560 Microcontroller is consistent with most of the shields of Arduino UNO. The Arduino Mega board is shown below:

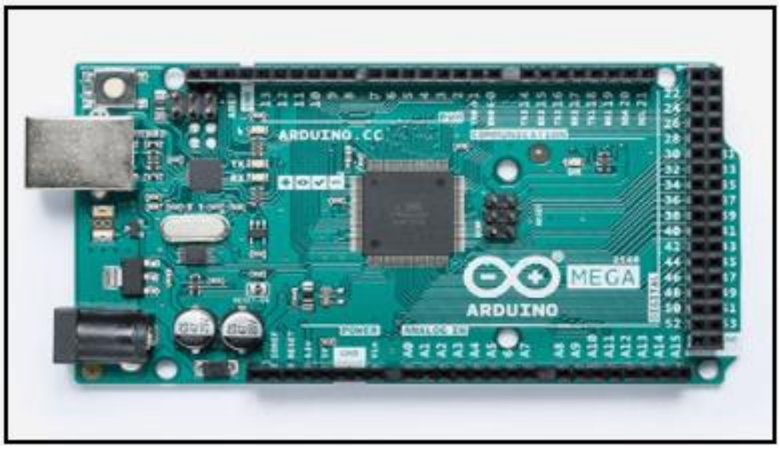



Fig2: Arduino Mega

The advantage of using the Arduino Mega board over other boards is that it gives the advantage of working with more memory space.

It has higher processing power, which can help us to work with the number of sensors at a time.

**LIQUID CRYSTAL DISPLAY** The LCD is used for the purpose of displaying the words which we are given in the program code. This code will be executed on microcontroller chip. By following the instructions in code the LCD display the related words. Fig. shows the LCD display.


**Fig3 : LCD Display**

The LCD display consists of two lines, 20 characters per line that is interfaced with the PIC16F73.The protocol (handshaking) for the display is as shown in Fig. The display contains two internal byte-wide registers, one for commands (RS=0) and the second for characters to be displayed (RS=1). It also contains a user-programmed RAM area (the character RAM) that can be programmed to generate any desired character that can be formed using a dot matrix. To distinguish between these two data areas, the hex command byte 80 will be used to signify that the display RAM address 00h will be chosen Port1 is used to furnish the command or data type, and ports 3.2 to 3.4 furnish register select and read/write levels.

**PH SENSOR:** pH is the numeric representation of gram-equivalent per liter of hydrogen ion concentration in any solution. It varies between 0 to14. It is the logarithmic measurement of moles of hydrogen ions per liter of solution. The solutions having pH value between 0 to 7 are acidic solutions with large concentration of hydrogen ions whereas solutions having pH value between 8 to 14 are basic solutions with small hydrogen concentration. The solutions having pH value of 7 are neutral solutions. Measuring the pH gives the measure of alkalinity or acidity of a solution.

- To monitor pH level of blood, which must be between to 7.35 and 7.45
- To monitor pH level of soil for optimal growth of crops according to the requirements.
- To monitor pH of rain so that we can detect the pollutants in air, if the rain water becomes more acidic.
- To monitor pH of many other daily used products like milk, shampoo etc.

**FLOW RATE SENSOR Flow measurement** is the quantification of bulk fluid movement. Flow can be measured in a variety of ways. The common types of flowmeters that find industrial application can be listed as below:

- a) Obstruction type (differential pressure or variable area)
- b) Inferential (turbine type)
- c) Electromagnetic
- d) Positive-displacement flow meters, which accumulate a fixed volume of fluid and then count the number of times the volume is filled to measure flow.
- e) Fluid dynamic (vortex shedding)
- f) Anemometer
- g) Ultrasonic
- h) Mass flowmeter (Coriolis).

Flow measurement methods other than positive-displacement flowmeters rely on forces produced by the flowing stream as it overcomes a known constriction, to indirectly calculate flow. Flow may be measured by measuring the velocity of fluid over a known area. For very large flows, tracer methods may be used to deduce the flow rate from the change in concentration of a dye or radioisotope.

Both gas and liquid flow can be measured in volumetric or mass flow rates, such as liters per second or kilograms per second, respectively. These measurements are related by the material's density. The density of a liquid is almost independent of conditions. This is not the case for gases, the densities of which depend greatly upon pressure, temperature and to a lesser extent, composition.

When gases or liquids are transferred for their energy content, as in the sale of natural gas, the flow rate may also be expressed in terms of energy flow, such as gigajoule per hour or BTU per day. The energy flow rate is the volumetric flow rate multiplied by the energy content per unit volume or mass flow rate multiplied by the energy content per unit mass. Energy flow rate is usually derived from mass or volumetric flow rate by the use of a flow computer.

**YF-S201 Hall Effect Water Flow Meter / Sensor**

This sensor sits in line with your water line and contains a pinwheel sensor to measure how much liquid has moved through it. There's an integrated magnetic hall effect sensor that outputs an electrical pulse with every revolution. The hall effect sensor is sealed from the water pipe and allows the sensor to stay safe and dry. The sensor comes with three wires: red (5-24VDC power), black (ground) and yellow (Hall effect pulse output). By counting the pulses from the output of the sensor, you can easily calculate water flow. Each pulse is approximately 2.25 milliliters. Note this isn't a precision sensor, and the pulse rate does vary a bit depending on the flow rate, fluid pressure and sensor orientation. It will need careful calibration if better than 10% precision is required. However, its great for basic measurement tasks!

We have as example Arduino sketch that can be used to quickly test the sensor, it will calculate the approximate flow of water in liters/hour.

The pulse signal is a simple square wave so its quite easy to log and convert into liters per minute using the following formula.

Pulse frequency (Hz) / 7.5 = flow rate in L/min.

**MOISTURE SENSOR:** The soil Moisture sensor FC-28 has four pins

- VCC: For power
- A0: Analog output
- D0: Digital output
- GND: Ground

The Module also contains a potentiometer which will set the threshold value and then this threshold value will be compared by the LM393 comparator. The output LED will light up and down according to this threshold value.

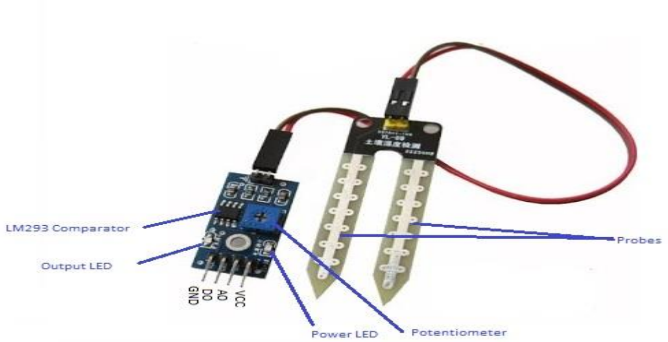



**Fig4: Moisture Sensor**

The **Moisture sensor** is used to measure the water content(moisture) of soil.when the soil is having water shortage,the module output is at high level, else the output is at low level.This sensor reminds the user to water their plants and also monitors the moisture content of soil.It has been widely used in agriculture,land irrigation and botanical gardening.

**WORKING PRINCIPLE OF MOISTURE SENSOR**

The Soil Moisture Sensor uses capacitance to measure dielectric permittivity of the surrounding medium. In soil, dielectric permittivity is a function of the water content. The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the soil. The sensor averages the water content over the entire length of the sensor. There is a 2 cm zone of influence with respect to the flat surface of the sensor, but it has little or no sensitivity at the extreme edges.The Soil Moisture Sensor is used to measure the loss of moisture over time due to evaporation and plant uptake,evaluate optimum soil moisture contents for various species of plants,monitor soil moisture content to control irrigation in greenhouses and enhance bottle biology experiments.

**MQ2 SENSOR:** The MQ series of gas sensors use a small heater inside with an electro-chemical sensor. They are sensitive for a range of gasses and are used indoors at room temperature. The output is an analog signal and can be read with an analog input of the Arduino. The MQ-2 Gas Sensor module is useful for gas leakage detecting in home and industry. It can detect LPG, i-butane, propane, methane ,alcohol, hydrogen and smoke. The sensor is actually enclosed in two layers of fine stainless steel mesh called **Anti-explosion network**. It ensures that heater element inside the sensor will not cause an explosion, as we are sensing flammable gases.


**Fig5: GAS sensor**

It also provides protection for the sensor and filters out suspended particles so that only gaseous elements are able to pass inside the chamber. The mesh is bound to rest of the body via a copper plated clamping ring.

**TEMPERATURE SENSOR (LM35) LM35** is a precision IC **temperature sensor** with its output proportional to the temperature (in ºC). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With **LM35**, temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 ºC temperature rise in still air. The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every ºC rise/fall in ambient temperature, *i.e.*, its scale factor is 0.01V/ºC.

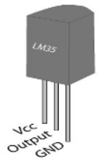



Fig6: LM35

In general,a **temperature sensor** is a device which is designed specifically to measure the hotness or coldness of an object.**LM35** is a precision IC temperature sensor with its output proportional to the temperature (in °C).With LM35,the temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1 °C temperature rise in still air. The operating temperature range is from **-55°C to 150°C**.The LM35's low output impedance,linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy.It has find its applications on power supplies,battery management,appliances,etc.click **here** for datasheet. The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in °C).It can measure temperature more accurately than a using a thermistor. The sensor circuitry is sealed and not subject to oxidation.The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage be amplified.The LM35 has an output voltage that is proportional to the Celsius temperature.The scale factor is .01V/°C.

The LM35 does not require any external calibration or trimming and maintains an accuracy of +/-0.4°C at room temperature and +/-0.8°C over a range of 0°C to +100°C.Another important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low self-heating capability.The LM35 comes in many different packages such as TO-92 plastic transistor-like package,T0-46 metal can transistor-like package,8-lead surface mount SO-8 small outline package.

**WATER LEVEL ULTRASONIC**

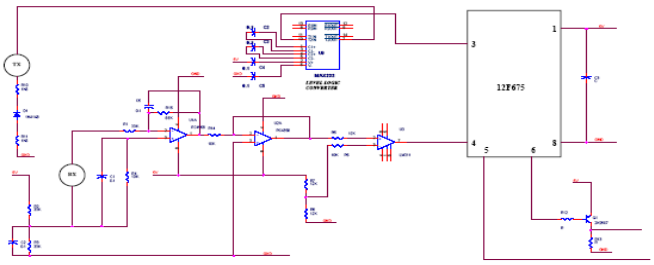



**Fig7: Ultra sonic circuit**

**Circuit Description:** This circuit is designed to measure the distance of the object with the help of ultrasonic waves. The 12F675 microcontroller is used to generate the 40 KHz frequency signal. This signal is given to level logic converter (MAX232) in order to convert to TTL output pulse to +12v and -12v pulse. Then this pulse is transmitted through ultrasonic transmitter. The ultrasonic wave is spread in the air and hit the nearest object and reflected from the object which is received by the ultrasonic receiver. The received wave is given to amplifier in order to amplify the received weak signal. After the amplification the amplified wave is given to zero adjustment amplifier because the amplified wave is in the range of above 6v level. Then the output is given to comparator in which the wave signal is converted into corresponding square wave signal. Then the square wave signal is given to input of the microcontroller. Now the microcontroller compares the time between the transmitted signal and received signal and generates the corresponding pulse output which is equal to distance of the object. Then the pulse signal is given to input of BC547 transistor. It emits an ultrasound at 40 000 Hz which travels through the air and if there is an object or obstacle on its path It will bounce back to the module.

**NODE MCU:** The Node MCU is an open source firmware and development kit that helps you to prototype your IoT product with ArduinoIDE or in few Lau script lines. It includes firmware which runs on the ESP8266 Wi-Fi SoC. And hardware which is based on the ESP-12 module. In this tutorial we explain how to use NodeMCU with Arduino IDE.

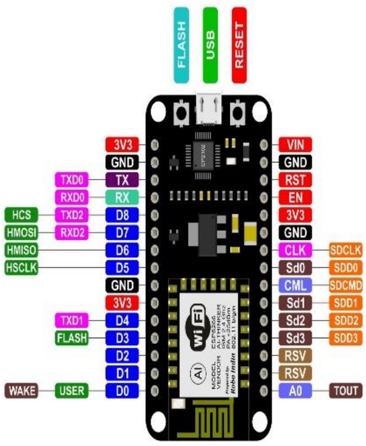



**Fig8. NODE MCU**

**RELAY:** Thus far we have seen a selection of *Input* devices that can be used to detect or "sense" a variety of physical variables and signals and are therefore called **Sensors**. But there are also a variety of electrical and electronic devices which are classed as *Output* devices used to control or operate some external physical process. These output devices are commonly called **Actuators**. Actuators convert an electrical signal into a corresponding physical quantity such as movement, force, sound etc. An actuator is also classed as a transducer because it changes one type of physical quantity into another and is usually activated or operated by a low voltage command signal. Actuators can be classed as either binary or continuous devices based upon the number of stable states their output has.

**DC MOTORS**

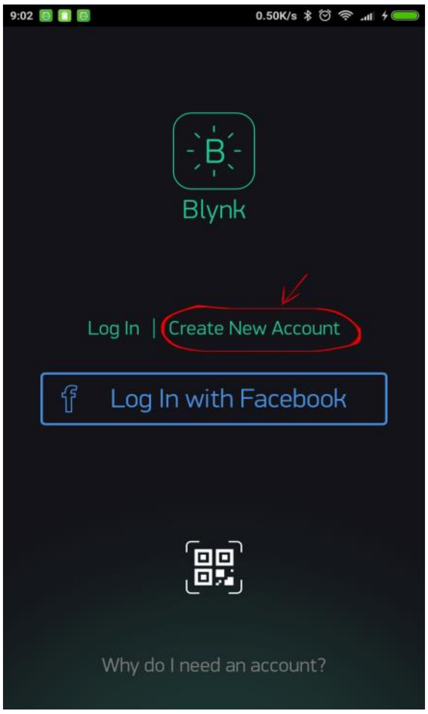
The direct current (DC) motor is one of the first machines devised to convert electrical power into mechanical power. Permanent magnet (PM) direct current converts electrical energy into mechanical energy through the interaction of two magnetic fields. One field is produced by a permanent magnet assembly; the other field is produced by an electrical current flowing in the motor windings. These two fields result in a torque which tends to rotate the rotor. As the rotor turns, the current in the windings is commutated to produce a continuous torque output. The stationary electromagnetic field of the motor can also be wire-wound like the armature (called a wound-field motor) or can be made up of permanent magnets (called a permanent magnet motor).

In either style (wound-field or permanent magnet) the commutator. acts as half of a mechanical switch and rotates with the armature as it turns. The commutator is composed of conductive segments (called bars), usually made of copper, which represent the termination of individual coils of wire distributed around the armature. The second half of the mechanical switch is completed by the brushes. These brushes typically remain stationary with the motor's housing but ride (or brush) on the rotating commutator.

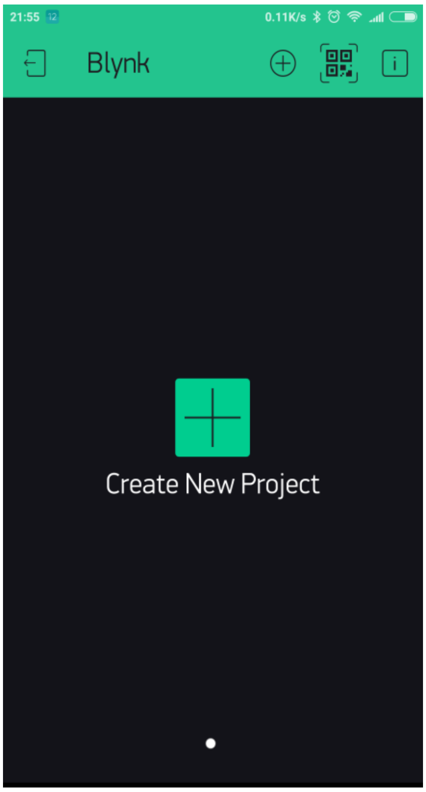
**BUZZER** The piezo buzzer produces sound based on reverse of the piezoelectric effect. The generation of pressure variation or strain by the application of electric potential across a piezoelectric material is the underlying principle. These buzzers can be used alert a user of an event corresponding to a switching action, counter signal or sensor input. They are also used in alarm circuits. The buzzer produces a same noisy sound irrespective of the voltage variation applied to it. It consists of piezo crystals between two conductors.

**BLYNK APP:** Blynk is a Platform with iOS and Android apps to control Arduino, Raspberry Pi and the likes over the Internet. It's a digital dashboard where you can build a graphic interface for your project by simply dragging and dropping widgets. It's really simple to set everything up and you'll start tinkering in less than 5 mins. Blynk is not tied to some specific board or shield. Instead, it's supporting hardware of your choice. Whether your Arduino or Raspberry Pi is linked to the Internet over Wi-Fi, Ethernet or this new ESP8266 chip, Blynk will get you online and ready for the **Internet Of Your Things**.

CREATE A BLYNK ACCOUNT After you download the Blynk App, you'll need to create a New Blynk account. This account is separate from the accounts used for the Blynk Forums, in case you already have one.

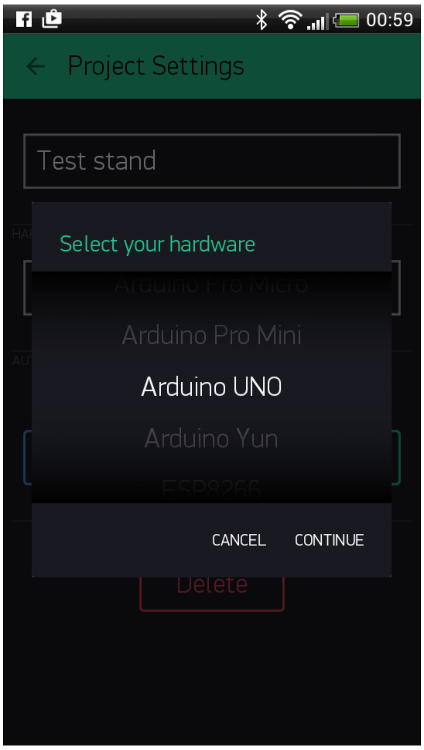



2. Create a New ProjectAfter you've successfully logged into your account, start by creating a new project.




3. Choose Your Hardware

Select the hardware model you will use. Check out the list of supported hardware




**RESULTS:**


**Fig: Proposed result with all safe conditions**


**Fig: Proposed result with high water level , motor on condition**

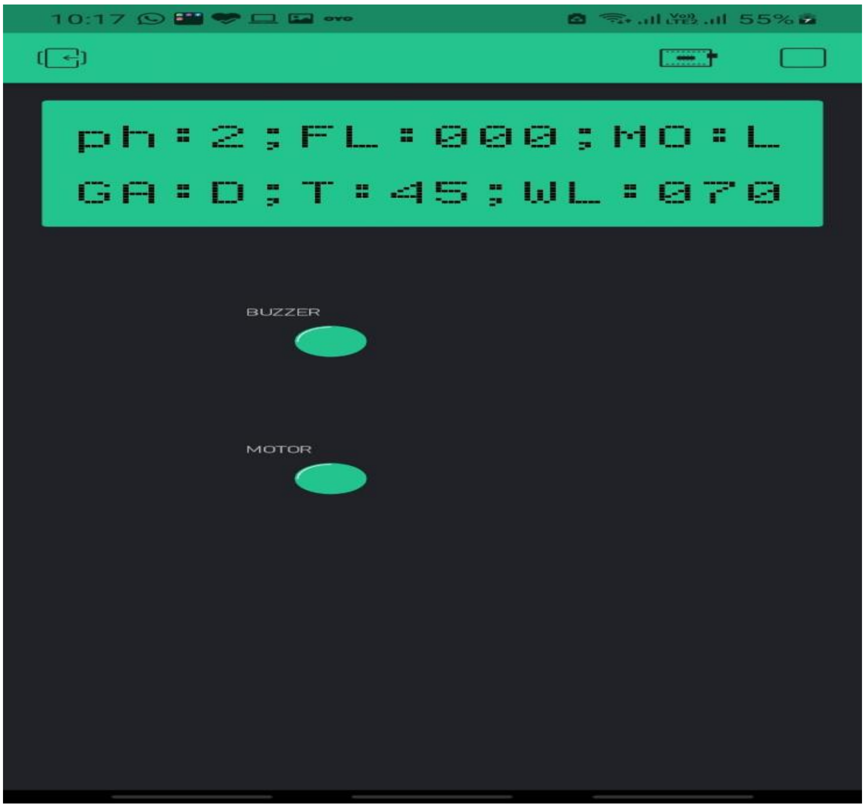



**Fig: Proposed result with high water level, Danger gas, high temperature, motor on condition and buzzer on condition**

**CONCLUSION:**

Finally, this concept identified a suitable implementation model that consists of different sensor devices and other modules, their functionalities are shown in figure. In this implementation model we used ATMEGA 328 with Wi-Fi module. Inbuilt ADC and Wi-Fi module connects the embedded device to internet. Sensors are connected to Arduino UNO board for monitoring, ADC will convert the corresponding sensor reading to its digital value and from that value the corresponding environmental parameter will be evaluated. After sensing the data from different sensor devices, which are placed in particular area of interest. The sensed data will be automatically sent to the web server, when a proper connection is established with sever device.

**FUTURE SCOPE:**

Further, a low cost, less complex water quality monitoring system have to be implemented. 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.

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