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REALTIME WATER QUALITY MONITORING

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ABSTRACT

In order to ensure the safe supply of the drinking water the quality needs to be monitor in real time. In this presentation we present a design and development of a low cost system for real time monitoring of the water quality in IOT(internet of things).The system consist of several sensors which is used to measure physical and chemical parameters of the water. The parameters such as temperature, Acidic nature, turbidity, conductivity of the water can be measured. The measured values from the sensors can be processed by the core controller. The AVR model can be used as a core controller. Finally, the sensor data can be viewed on internet using desktop application.

Keywords-Water quality, PH, Conductivity, Temperature, Humidity, Turbidity, IOT and GSM.

1.INTRODUCTION

Water-quality monitoring technology has been taken a great attention in aquaculture because of increasing aquatic products and impact of food safety vicious incidents. In order to meet the technology requirements of water-quality monitoring in multi-parameter, dynamic, and networked monitoring, a water-quality dynamic monitoring system was developed to monitor multi-parameter water-quality variables such as water temperature, pH, dissolved oxygen, electrical conductivity, and oxidation reduction potential dynamically, and communicate with remote information servers in a high security. As result of a two-years testing experiment in a seawater aquiculture company, relative errors of each water-quality parameter measured by the instrument were less than 5%, data lost percentage of remote communication was less than 3%, and power energy consumption was less than 13W. Therefore, the water-quality dynamic monitoring system as a node infrastructure of wireless sensor networks can be used to achieve a distributed water-quality network monitoring system in a large-scale aquaculture farm, or to construct a distributed water-quality monitoring network system in multipoint of different cities for aquaculture farm and administration section.

In order to ensure the safe supply of the drinking water the quality needs to be monitor in real time. In this paper we present a design and development of a low cost system for real time monitoring of the water quality in IOT(internet of things).the system consist of several sensors is used to measuring physical and chemical parameters of the water. The parameters such as temperature, PH, turbidity, conductivity of the water can be measured. The measured values from the sensors can be processed by the core controller.

The ADRUINO model can be used as a core controller. Finally, the sensor data can be viewed on internet using desktop application. Nowadays drinking water is the most precious and valuable for all the human beings, drinking water utilities faces new challenges in real-time operation. This challenge occurred because of limited water resources growing population, ageing infrastructure etc. Hence therefore there is a need of better methodologies for monitoring the water quality Traditional methods of water quality involve the manual collection of water sample at different locations, followed by laboratory analytical techniques in order the character the water quality. Such approaches take longer time and no longer to be considered efficient.

Although the current methodologies analyze the physical, chemical and biological agents, it has several drawbacks:

a) Poor spatiotemporal coverage

b) It is labor intensive and high cost (labor, operation; and equipment)

c) The lack of real time water quality information to enable critical decisions for public health protection.

Therefore, there is a need for continuous online water Quality monitoring. The online water monitoring technologies have made a significant progress for source water surveillance and water plant operation. The use of their technologies having high cost associated with installation and calibration of a large distributed array of monitoring sensors. The algorithm proposed on the new technology must be suitable for particular area and for large system is not suitable. By focusing on the above issues our paper design and develop a low cost system for real time monitoring of the water quality in IOT environment. In our design Adruino uno is used as a core controller. The design system applies a specialized IOT module for accessing sensor data from core controller to the cloud. The sensor data can be viewed on the cloud using a special IP address. Additionally the IOT module also provides a mobile data for viewing the data on mobile.

2. RELATED WORKS

In the late 20th century, the traditional system of water quality monitoring was to collect water samples from rivers or lakes, move them to the laboratories that are far away from the source, and do the water quality analysis. The major drawback of such a system was that it was non real-time monitoring; the results provided were confined to a small coverage area, reducing the coverage capacity; and the overall system was costly. The Ganga Plan, conducted by the Central Pollution Control Board (CPCB)[4], developed 2 real time monitoring stations that analyzed 5 parameters (temperature, pH, turbidity, dissolved oxygen and BOD) in 2011. The results were communicated to the laboratories and analysed. But the major drawback was that the system could not be sustained due to operation and maintenance problems. Also, due to the unavailability of sensors, the CPCB had to reduce the heterogeneity with respect to sensors in the network. In a due course of time with advancing technologies, a real time monitoring of surface water[5] was developed in which the monitored water quality parameters were communicated to the base station using ZigBee[8][9][10]. This methodology also suffered from the limited number of sensors for measurement of data and non-periodic verification.

The research publication [5] provided a different concept of using an aquatic drone for the environmental monitoring which included a multichannel sensing module for water quality and air quality measurement. This system was based on Raspberry Pi and multi sensing modules. The data was stored in the drone for a short period of time and then transmitted to the base stations. In the research publication [5], they used IPv6 connected IOT design for real-time flow metering and quality monitoring. The research publication [5] proposed a floating sensor node that could be used for automated billing, water quality monitoring near households, water conservation measures, etc. Another innovative approach to environmental monitoring used an Unmanned Space Vehicle (USV), which was proposed in the research publication [6]. The challenges faced were the inaccurate measurement of data, high power consumption by the drone, and sophisticated hardware design. Finally, [7] describes the conversion of fish wastage to nutrients for plants, i.e. Aquaponics using IOT and a self regulating wireless sensor network. However, with the advancing technologies such as IOT, edge computing, etc., we would like to propose a system that can solve some of the existing challenges in the area of water quality monitoring. The level of water pollution will vary with respect to the river, behaviour of the population and the presence of the industries around the river. The real-time concentration of contaminants will vary with respect to the river flow rate. So, a system design needs to integrate the heterogeneity in measurement techniques and adaptability in the selection of sensors. This heterogeneous sensing will complicate the spatio-temporal decision making as it needs to integrate the features from multiple parameters leading to varying impact on the state of the water body. The system needs to learn the interdependency between these parameters to derive accurate, efficient and real-time decisions concerning the water quality status and its impact on living beings.

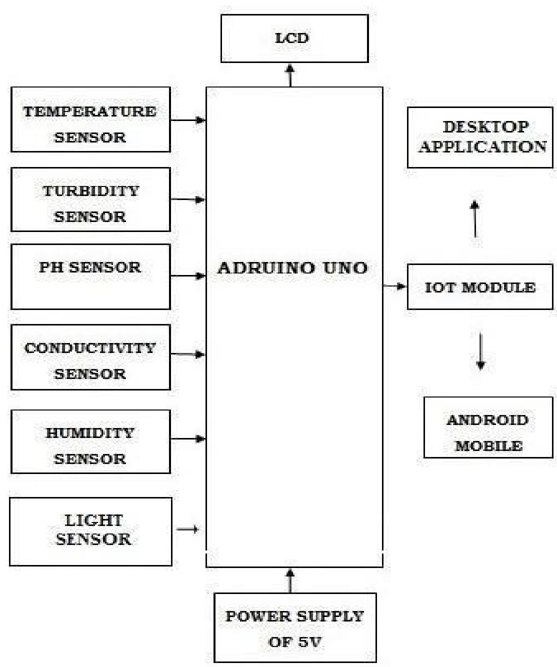
Water is free flowing liquid, and the natural bodies contain water current that is non uniform. The water current is uneven due to seasonal changes, which can pose a challenge to the position of the deployed nodes. Hence, the wireless sensor nodes that need to be deployed in the water bodies should be adaptable to any level of variations in the water current. Therefore, the hardware design of such a floating wireless sensor node should ensure features such as buoyancy, non corrosiveness, compactness, etc. The continuous data collected from the wireless sensor nodes needs to be transmitted to different destinations. The propagation effects will vary with respect to the communication technology, climatic condition and terrain parameter. Therefore, for seamless communication, the system would require a heterogeneous, fault tolerant communication platform.

The complete system needs to be low power consuming to achieve the lifetime extension for the complete network. The software system needs to integrate interoperability [11], flexibility [11], and remote maintenance [11]. All these challenges must be considered in designing the network. The existing systems lack integration of challenges such as scalability, heterogeneity and maintainability. Hence, in this work, we explore a unique design that integrates the above challenges along with the existing solutions for other challenges such as fault tolerance and low power consumption. This proposed system will provide wide area monitoring through highly heterogeneous, interoperable and fault tolerant methodologies integrating the different subsystems.

3. **METHODOLOGY**

In this section, we present the theory on real time monitoring of water quality in IOT environment. In section III A, the overall block diagram of the proposed method is explained. In section III B, each and every block of the system is explained in detail. In section III C, desktop application is explained. In section III D, result and analysis is carried out. Lastly in section III E, conclusion is provided.

A. OVERALL BLOCK DIAGRAM



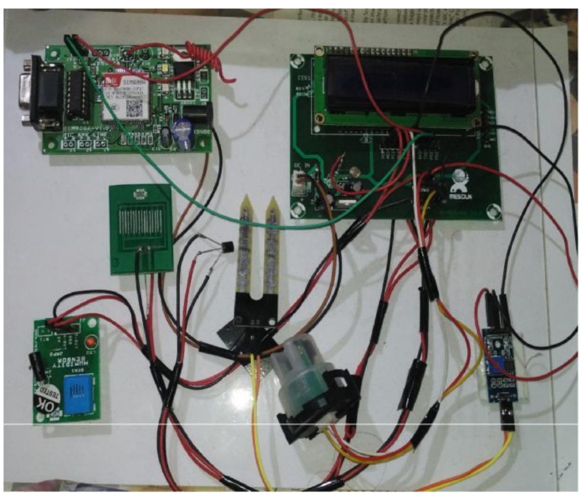
In this proposed block diagram consist of several sensors (temperature, Ph, turbidity, conductivity, humidity) is connected to core controller. The core controller are accessing the sensor values and processing them to transfer the data through internet. Atmega48 is used as a core controller. The sensor data can be viewed on the internet using desktop application.

B. PROPOSED SYSTEM

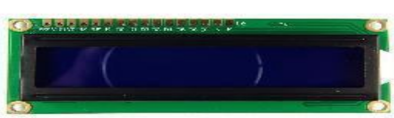
By focusing on the existing issues our project ensures in designing and developing a low cost system for real time monitoring of the water quality in IOT environment. In our design microcontroller (AVR) is used as a core controller. The design system applies a specialized IOT module for accessing sensor data from core controller to the desktop application. The sensor data can be viewed on the application using a special IP address. Additionally the IOT module also provides a mobile data for viewing the data on mobile.

a) SYSTEM ARCHITECTURE

The architecture of the proposed system is as shown in the figure below which comprises of all sensors such as temperature, ph, turbidity, conductance, humidity, light, LCD display, Atmega48 controller as core controller and GSM module combined and mounted on the board.

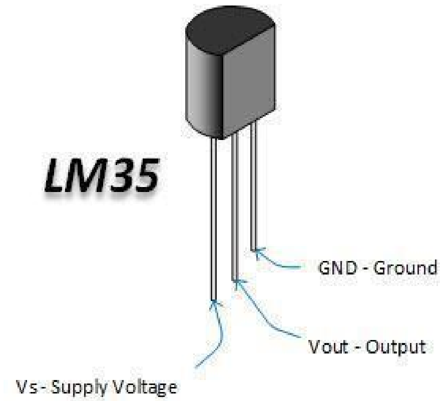


b) LCD Display:



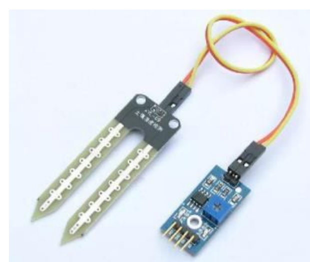
Whenever we work with embedded system we need a reliable output device with the help of which we get the required information, now this problem is solved with the introduction of 16 character by 2 (16X2) LCD. Uses - Alphanumeric output, Information Display, Process status, in short we can keep eye on every move of our microcontroller.

c) TEMPERATURE SENSOR:



The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ˚ Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4˚C at room temperature and ±3⁄4˚C over a full -55 to +150˚C temperature range.

d) PH SENSOR:



The pH of a solution is the measure of the acidity or alkalinity of that solution. The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7. Values above 7 indicate a basic or alkaline solution and values below 7 would indicate an acidic solution. It operates on 5V power supply and it is easy to interface with Arduino. The normal range of pH is 6 to 8.5.

e) CONDUCTIVITY SENSOR:

Conductivity is a measure of water's capability to pass electrical flow. This ability is directly related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic materials such as alkalis, chlorides, sulfides and carbonate compounds. Compounds that dissolve into ions are also known as electrolytes. The more ions that are present, the higher the conductivity of water. Likewise, the fewer ions that are in the water, the less conductive it is. Distilled or deionized water can act as an insulator due to its very low (if not negligible) conductivity value. Sea water, on the other hand, has a very high conductivity.

f) HUMIDITY SENSOR:

Model: HR202
Color: Blue
Material: PCB

Model 1:

Detects the ambient humidity, Applied to the storage compartment, indoor air quality control, building automation, medical, industrial control systems wide range of applications and research fields Adjustable sensitivity Operating voltage: 3.3V~5V

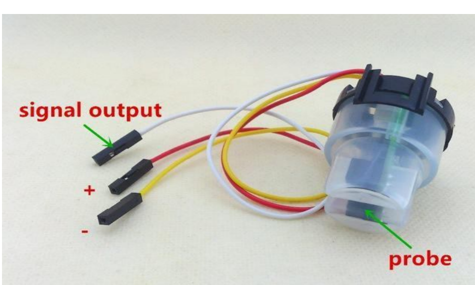
Output: a analog voltage output / b digital switch outputs (0 and 1) With fixed bolt hole for easy installation With stable LM393 chipset in comparator

Model 2:

VCC 3.3V~5V external power supply GND external GND DO digital output interface (0 and 1) AO analog output interface Packing list:

1 x HR202 humidity detection sensor module 2 x DuPont cables (20cm) Dimensions: 1.97 in x 0.59 in x 0.24 in (5.0 cm x 1.5 cm x 0.6 cm) Weight: 0.25 oz (7 g)

g) TURBIDITY SENSOR:



Turbidity is the quantitative measure of suspended particles in a fluid. Turbidity Sensor, which along with a micro controller unit, takes care of turbidity measurements. Crafted with plastic and some metal-alloy traces, turbidity sensor uses light to convey information about turbidity in water.

h) LIGHT SENSOR:

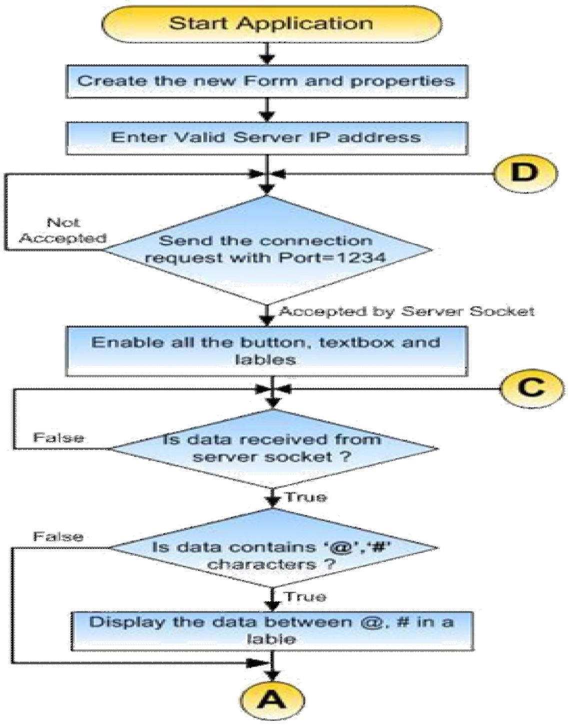
There are different types of light sensors available such as photo resistors, photodiodes, photovoltaic cells, phototubes, photomultiplier tubes, phototransistors, charge coupled devices, and so on. But, LDR (Light Dependent Resistor or photo resistor) is used as a light sensor in this light sensor circuit. This LDR sensor is passive and doesn't produce any electrical energy. But, the resistance of the LDR changes with the change in the (light illuminated on the LDR) daylight intensity. LDR sensor is rugged in nature, hence can be used even in dirty and rough external environments.

i) GSM MODULE:

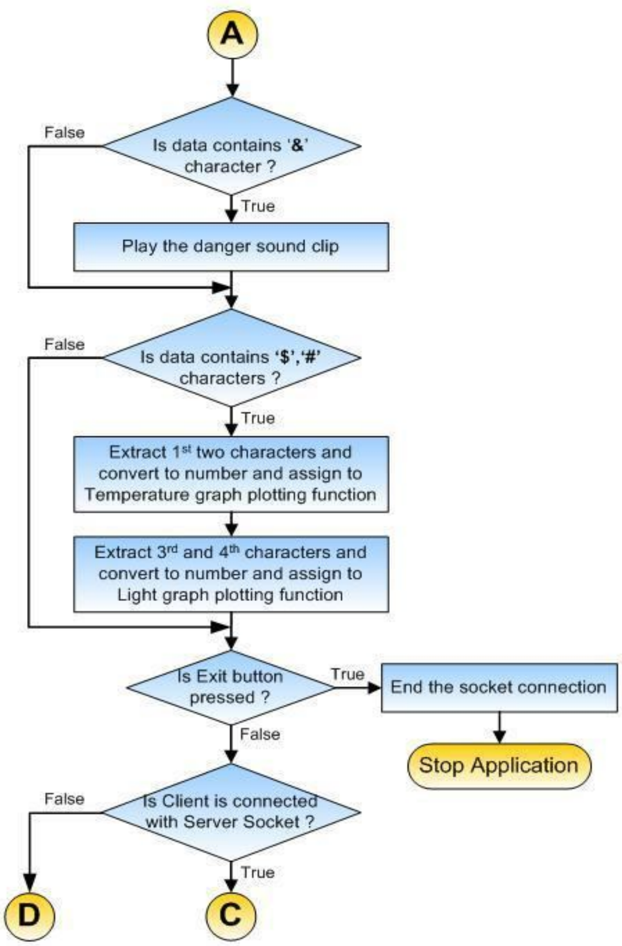
Sim900a GSM/GPRS USB Modem, Featuring an industry-standard interface, the SIM900A delivers GSM/GPRS 900/1800MHz performance for SMS, Data, and Fax in a small form factor and with low power consumption, With Aluminum enclosure to minimize noise.

C. DESKTOP APPLICATION

The application is implemented according to the steps shown in flowchart below.



Flowchart (a)



Flowchart (b)

4. RESULT AND ANALYSIS

The sensor data can be viewed on desktop application and the mobile device using GSM module for communication via generated IP address shared for connection.

FIG: The open page of application

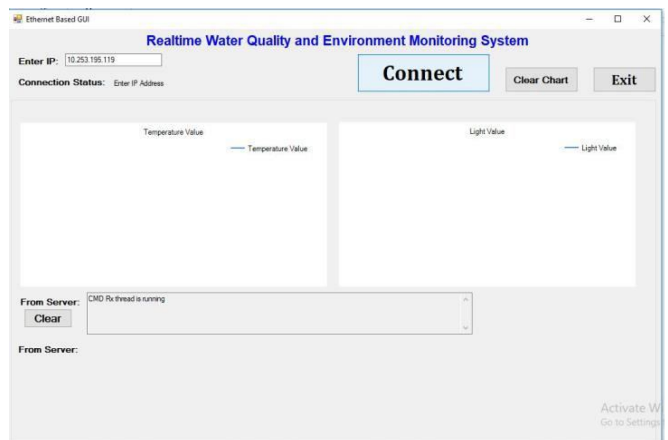


FIG: The page activated after entering valid IP

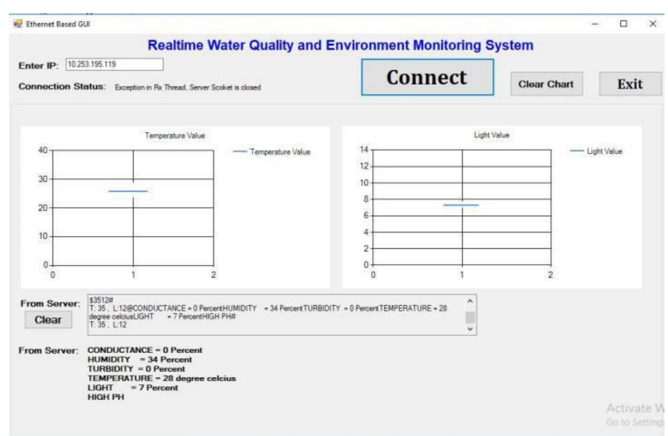
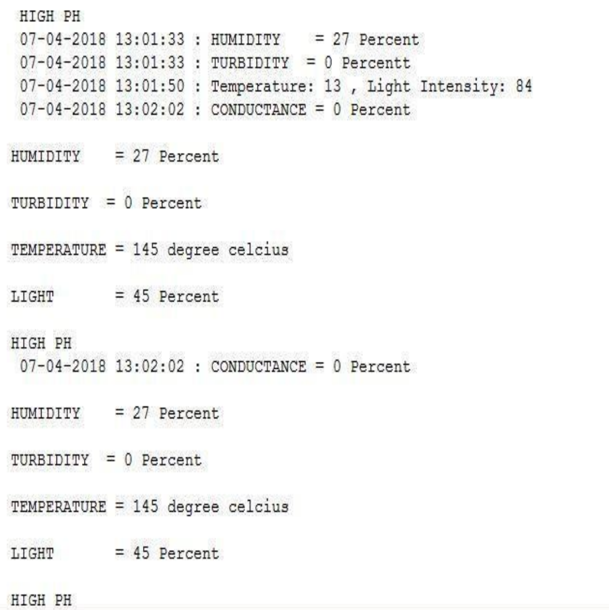


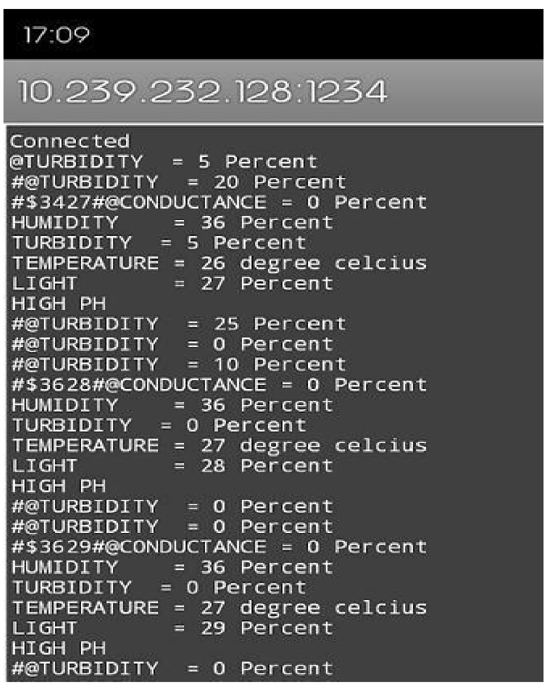
FIG: The result set for tap water

The result is stored in database in a text file as shown in following figure stating sensor values at respecting time and date.



```
HIGH PH
07-04-2018 13:01:33 : HUMIDITY    = 27 Percent
07-04-2018 13:01:33 : TURBIDITY  = 0 Percentt
07-04-2018 13:01:50 : Temperature: 13 , Light Intensity: 84
07-04-2018 13:02:02 : CONDUCTANCE = 0 Percent

HUMIDITY    = 27 Percent

TURBIDITY  = 0 Percent

TEMPERATURE = 145 degree celcius

LIGHT       = 45 Percent

HIGH PH
07-04-2018 13:02:02 : CONDUCTANCE = 0 Percent

HUMIDITY    = 27 Percent

TURBIDITY  = 0 Percent

TEMPERATURE = 145 degree celcius

LIGHT       = 45 Percent

HIGH PH
```

FIG: The results stored in text file with date and time specified.



```
17:09
10.239.232.128:1234
Connected
@TURBIDITY   = 5 Percent
#@TURBIDITY   = 20 Percent
#$3427#@CONDUCTANCE = 0 Percent
HUMIDITY     = 36 Percent
TURBIDITY   = 5 Percent
TEMPERATURE = 26 degree celcius
LIGHT        = 27 Percent
HIGH PH
#@TURBIDITY   = 25 Percent
#@TURBIDITY   = 0 Percent
#@TURBIDITY   = 10 Percent
#$3628#@CONDUCTANCE = 0 Percent
HUMIDITY     = 36 Percent
TURBIDITY   = 0 Percent
TEMPERATURE = 27 degree celcius
LIGHT        = 28 Percent
HIGH PH
#@TURBIDITY   = 0 Percent
#@TURBIDITY   = 0 Percent
#$3629#@CONDUCTANCE = 0 Percent
HUMIDITY     = 36 Percent
TURBIDITY   = 0 Percent
TEMPERATURE = 27 degree celcius
LIGHT        = 29 Percent
HIGH PH
#@TURBIDITY   = 0 Percent
```

FIG: The results viewed on mobile phone.

5. CONCLUSION

In this paper, the design and development of the real-time monitoring of water quality parameters in IOT environment is presented. The proposed system consists of several water quality parameter sensors, Atmega48 core controller and an IOT module. These devices are low cost more efficient and capable of processing, analyzing, sending and viewing the data on desktop application and also through WIFI to mobile device. This implementation is suitable for environment monitoring, ecosystem monitoring, etc and data can be viewed anywhere in the world.

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