Remote Monitoring of Water Quality Through IOT Protocols

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***Abstract*: Drinking water is the most valuable resource for all human beings so the quality of water should be monitored in real-time. But, in Pakistan, Especially in remote areas. Real-time monitoring of water quality is a difficult job due to the lack of laboratories, awareness and taking a long time in order to collect manual samples and preservation. So, here is a need for real-time monitoring of water quality in order to clean and safe supply of water to consumers. This proposed system ensures water authorities and gives the live reading of water parameters for 24 hours/day. This system consists of various sensors that monitor pH, Turbidity, Temperature, Dissolved oxygen and Total dissolved solids of water and transfers the data towards the microprocessor which analyzes and transmits the data over the server through the Wi-Fi connection. But when there is unavailability of the Wi-Fi GSM module is used through which data is sent towards the user in the form of SMS and Email. If the value of contamination increases from guideline values then the buzzer beeps, and email, SMS is sent towards the user about the condition along with the condition treatment is also suggested by the system.**

***Keywords*: Internet of things, Water pollution, Water quality, Remote monitoring system, Sensors Based, Raspberry pi.**

I. INTRODUCTION

Water is the most important substance in the world without water we cannot survive. Water is polluted due to industrial sewage, chemical waste from factories, pesticides. It all transfers to the water supply network. There are many methods for safe and clean drinking water because water pollution causes diseases in human health. Many people are dying due to water pollution. Back in 2000 BC, People had perceived simple methods for water purification. Those methods had not effective for the water monitoring and People, could not differentiate between nasty and clean waters because of lack of education and they think that water which is free from turbidity is cleaner water and drinkable. In today's world peoples are aware of the importance of safe, clean drinking water, but still, water is poorly monitored. The existing system for water quality monitoring is laboratory testing, but the disadvantage of the existing water monitoring it requires manpower, time, and patience. There is a need for wireless communication technology which gives human comfort and performed humans' activates tasks on a daily basis. The proposed system for the water monitoring solves these existing water monitoring disadvantages. It is also beneficial for the society it consumes low cost and simple installation, maintenance the user has permission to connect the device with different communication standards such as WI-FI, Bluetooth, cayenne application, GSM module. The proposed system using the sensors, buzzer and WHO guidelines. The proposed project fulfills the following sustainable development goals good health, clean water and sanitation, Renewable energy, water below life [1]

II. BACKGROUND

Water is essential for every human being. Every human being requires clean water, but water pollution has increased with time with a lot of factors like the increase in population, industrialization, and urbanization, which results in affecting human health. After 1500 BC, the Egyptians first invented the principle of coagulation. They had tested the alum for suspended particle settlement. Picture of the water purification was found on the wall of the tomb Amenophis II and Ramses II. After 500 BC, Hippocrates had invented the healing power of water, they had invented the first bag which filters the water and called by the 'Hippocratic sleeve'. The main motive of the bag was to stop the sediments thatcaused bad tastes or odors. In 1627 the water treatment history goes to Sir Francis Bacon. He was starting experiment to remove the salt particles from the water, but unforunately it did not work then his work continues the other scientists [2]

III. LITERATURE REVIEW

1. (Nikhila et al, 2018) Proposed the smart water quality monitoring system in the IOT environment for the remote areas by the means of real-time data had stored and processed. In this proposed system pH, Turbidity, water level, conductivity, Temperature, WIFI Module, and Arduino UNO had used. Sensors sensed the data and transmitted to the Arduino UNO and then the data transferred to the cloud through a PC. First, he login the cloud. After the data was uploaded on the cloud and the file was downloaded through the application in the android phone. Data had displayed in the form of a graph [3]
2. (K. Raghava Rao et al, 2018) The proposed system checked the water quality in overhead tanks, and the level of water is also calculated how much quality based water is required for a particular area. In this system pH, Temperature and ultrasonic sensor had used. Sensors had connected to a microcontroller and place it at the top of the tank. Sensors sensed the data and processed in the microcontroller through the Wi-Fi data had stored in the cloud. After that Data had sent to the app [4]
3. Rohit Kumar Rudrappa Wagdarikar et al, 2017) The proposed system and method which alert or indicate through mobile phone for the quality of water. The system had used the pH sensor, Temperature sensor, Nitrate sensor, Dissolved oxygen sensor, GSM module, RPI. The proposed system had used for the portable and automatic water quality monitoring and

notification system that save time and human resources. In the setup system GSM services provided and water quality monitoring sensor control unit and GSM module had installed [5]

IV. HARDWARE COMPONENTS OF THE PROPOSED SYSTEM

a) *RASPBERRY PI 3B*

It is a small credit card size computer. If you add a keyboard, mouse, micro SD card, power supply the Linux distribution the small computer is ready that can run the applications from word processors and spreadsheets to games. It also gives the set of GPIO that can allow the electronic components for physical computing like sensors and also provide internet cable [6]

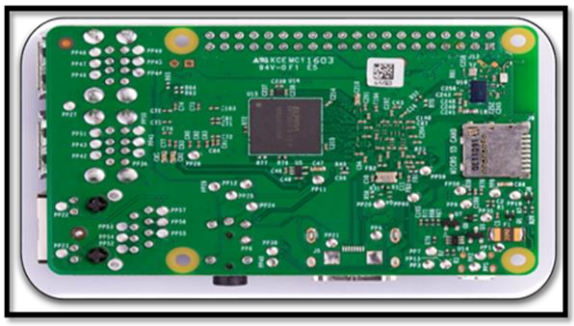

Fig 1: RASPBERRY PI 3B

b) *GSM SIM900A MODULE*

GSM stands for Global system for Mobile Communication. It is a mode of communication. It is a chip or circuit that is used to create communication between a mobile device and a computing machine. Bell Laboratories first introduces this idea in the late 19870's. This mobile communication system is innovative and widely used in the world. It is an open digital technology that provides a mode of communication between system and operator. It enables the system to Send and receive calls and SMS [7]

Fig 2: GSM SIM900A MODULE

c) *SENSORS*

TEMPERATURE SENSOR (DS18B20)

Temperature Sensor DS18B20 which is a probe type temperature sensor used to read the temperature from -55 to 125^{0}C. In our project, we have used this
temperature sensor to note the temperature of the water with time to time [8]

Fig 3: TEMPERATURE SENSOR

TURBIDITY SENSOR:

The Turbidity sensor detects the water quality and measuring the level of turbidity in water. The sensor uses the light to detect the suspended particles in water by measuring the light movement and scattering rate, which changes with the amount of total suspended solids. When the total suspended solids increase turbidity increases. This sensor provides both analog and digital signal modes. The threshold is flexible when in digital signal mode. You can select the mode according to your MCU [9]

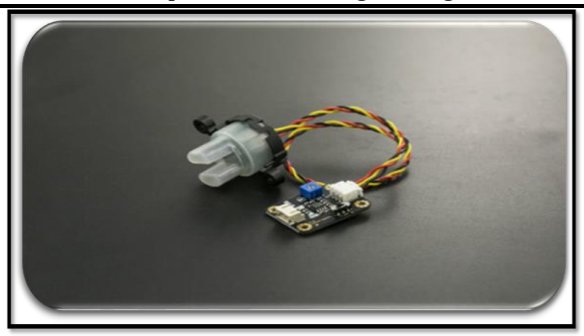

Fig 4: TURBIDITY SENSOR

DISSOLVED OXYGEN SENSOR:

This sensor is used for measuring the dissolved oxygen in the water. The sensor has a galvanic probe and the probe is available at any time because the probe has no polarization time. The filling solution is 0.5 Mol /l of NaoH solution, this solution is used in the sensor and spill in the membrane cap before use. The sensor is used for the water projects [10]

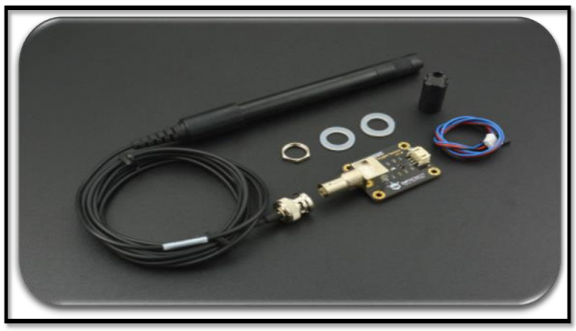

Fig 5: DISSOLVED OXYGEN SENSOR

pH SENSOR

pH sensor uses to measure the pH of water. It is consisting of a module that is connected with the raspberry pi and the head or probe of the pH sensor is dipped into the water. A pH scale ranges from 0 to 14 with 0 being the most acidic and 14 being the most basic [11]

Fig 6: pH SENSOR

TDS SENSOR:

TOTAL DISSOLVED SOLIDS illustrates how many milligrams dissolved in one liter of water. The higher the TDS value in water the more dissolved solids in the water and the less clean water is. The TDS pen is widely used equipment to measure the TDS value The TDS probe is waterproof, it can be consumed in water for long time measurement [12]

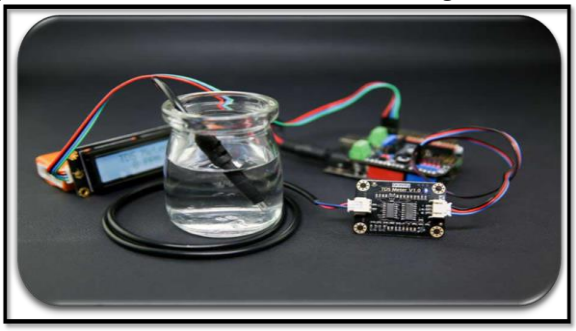

Fig 7:TDS SENSOR

V. SYSTEM ARCHITECTURE

The key parameters monitored in the proposed system are Temperature, Turbidity, Total dissolved solids, Dissolved oxygen and pH in which all components are connected with each other. The block diagram of the proposed system is shown in Fig.

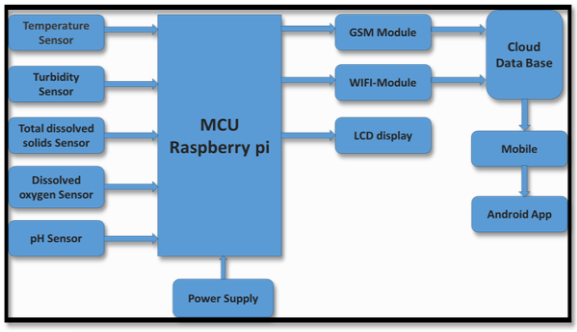

Fig 8: BLOCK DIAGRAM OF PROPOSED SYSTEM

VI. METHODOLOGY

The project consists of multiple Water quality sensor which is connected to a 12v power bank and use the Wireless sensing network to detect the contaminants of water. The system contains several parameters such as Turbidity,TDS, pH, DO and TEMPERATURE will be sensed by sensors and the corresponding values will be recorded. The recorded values of sensor will be transmitted to the microprocessor (Raspberry Pi 3B) through the ADC (Analog to digital converter) which is integrated on the PCB board. Whereas the data recorded by the DS18B20 don't require any ADC because it has the capability of directly transferring analog data by means of using its library name as DS18B20.h so this sensor is directly connected to the digital pins of Raspberry Pi 3B. After receiving the digitized data from particular sensors, we applied the digital to analog processing by using the ADC library i.e. ADSX1115. h. After that we have initialized infinite loop in order to continuously read data on every clock cycle (SCL). In order to send the data over the internet we required some sort of protocol, therefore we have used MQTT communication protocol/library to send the data over portal (cayenne). Then we initialized the MQTT library with our API (application program interface) IDs. Over the portal we created separate channels for each sensor so that the specified data can be communicated to the specified channel. After the completion of transferring the sensed data over the portal, we provided a delay of 500 ms (milli seconds). In the case of absence of network, sensed values will be stored on SD card and when the network gets available the stored data will be sent to the portal. When there is the unavailability of Wi-Fi and the cellular network is available then the communication gateway will be switched to GPRS via GSM module. If the contamination of water parameters increases from WHO guidelines then automatically the buzzer beeps, and the email and SMS are sent towards the end-user about the condition along with the treatment and mitigation measure.

VII. RESULTS

The IOT bases water monitoring system's aim is to obtain the concentration of different pollutants present in the water. Results were collected at one site which is MEHRAN UNIVERSITY FILTRATION PLANT, The aim to select the filtration plant is to check how much the water is filtered.

Parameters:

- Dissolved oxygen (DO)
- Total Dissolved Solids (TDS)
- pH
- Turbidity
- Temperature

- *MUET FILTRATION PLANT*

Fig 9: LOCATION OF MUET FILTRATION PLANT

Table (a) DISSOLVED OXYGEN (DO) DATA

S: No	Date	Time	Values	Unit
1	2-10-2019	12:48	13.33465481	(mg/l)
2	2-10-2019	12:49	12.44532967	(mg/l)
3	2-10-2019	12:50	7.631089211	(mg/l)
4	2-10-2019	12:51	6.64577961	(mg/l)
5	2-10-2019	12:52	6.320608139	(mg/l)
6	2-10-2019	12:53	6.159980774	(mg/l)
7	2-10-2019	12:54	6.340196609	(mg/l)
8	2-10-2019	12:55	6.472093582	(mg/l)
9	2-10-2019	12:56	6.226582527	(mg/l)
10	2-10-2019	12:57	6.521718025	(mg/l)
11	2-10-2019	12:58	6.370232582	(mg/l)

At 12:48 o'clock the dissolved oxygen concentration was 13.33 mg/l. This may be due to the bacteria were consuming oxygen in the decay process when the algae completed their life cycle. But as the time passed the dissolved oxygen concentration was decreasing slowly either may be device was taking time to stable or another possible reason may be the temperature variance.

Table (b) TOTAL DISSOLVED SOLIDS (TDS) DATA

S: No	Date	Time	Values	Unit
1	2-10-2019	12:48	0.376159459	(gram/litre)
2	2-10-2019	12:49	0.390571237	(gram/litre)
3	2-10-2019	12:50	0.424857482	(gram/litre)
4	2-10-2019	12:51	0.37847048	(gram/litre)
5	2-10-2019	12:52	0.374448657	(gram/litre)
6	2-10-2019	12:53	0.371355861	(gram/litre)
7	2-10-2019	12:54	0.370288402	(gram/litre)
8	2-10-2019	12:55	0.373766601	(gram/litre)
9	2-10-2019	12:56	0.384818435	(gram/litre)
10	2-10-2019	12:57	0.392232269	(gram/litre)
11	2-10-2019	12:58	0.392947733	(gram/litre)

At 12:48 o'clock the total dissolved solids concentration was 0.376159459 gram/litre but as time passed the total dissolved solids were decreasing gradually because the device was taking time to stable. The graph shows a perfectly non liner relationship between TDS value and time.

Table (c) POTENTIAL OF HYDROGEN (pH) DATA

S: No	Date	Time	Values
1	2-10-2019	12:37PM	8.971578598
2	2-10-2019	12:38PM	8.963283539
3	2-10-2019	12:39PM	8.973958969
4	2-10-2019	12:40PM	8.957893372
5	2-10-2019	12:41PM	9.014420509
6	2-10-2019	12:42PM	8.954603195
7	2-10-2019	12:43PM	8.886438847
8	2-10-2019	12:44PM	8.867835999
9	2-10-2019	12:45PM	8.852907658
10	2-10-2019	12:46PM	8.838785172
11	2-10-2019	12:47PM	8.871578598

The pH indicates the degree of acidity or alkalinity of water. In this study, we took readings of pH for 10 minutes in the Muet Treatment Plant. The pH value crosses the permissible limit of (WHO standards) and the value of pH was being changed continuously with respect to time. At 12:37 PM to 12:41 PM the value of pH was increasing slowly. But after 5 minutes the pH value is rapidly decreased.

Table (d) Turbidity (NTU) DATA

S:No	Date	Time	Values	Unit
1	2-10-2019	12:37PM	28.94744968	NTU
2	2-10-2019	12:38PM	28.94744968	NTU
3	2-10-2019	12:39PM	28.96501732	NTU
4	2-10-2019	12:40PM	29.12447166	NTU
5	2-10-2019	12:41PM	28.51533318	NTU
6	2-10-2019	12:42PM	28.11995697	NTU
7	2-10-2019	12:43PM	28.06635475	NTU
8	2-10-2019	12:44PM	28.11995697	NTU
9	2-10-2019	12:45PM	28.0586977	NTU
10	2-10-2019	12:46PM	28.10454941	NTU
11	2-10-2019	12:47PM	28.47449680	NTU

Turbidity is the measurement of scattered light that results from the interaction of incident light with particulate material in a liquid sample. The turbidity is often caused by the presence of particulate or dissolved matter in the river. Turbidity is measured in NTU unit. The Turbidity crosses the permissible limit of

(WHO standards) and the value of turbidity was being changed continuously with respect to time. At 12:37 PM the value of turbidity was 28.9 NTU. Initially, the turbidity value was 28.94744968. But at 12:40 PM turbidity value was 29.1 NTU.

Table (e) Temperature (Celsius)

S:No	Date	Time	Values	Unit
1	2-10-2019	12:37PM	31.43700027	℃
2	2-10-2019	12:38PM	31.43700027	℃
3	2-10-2019	12:39PM	30.875	℃
4	2-10-2019	12:40PM	31.43700027	℃
5	2-10-2019	12:41PM	31.31200027	℃
6	2-10-2019	12:42PM	31.375	℃
7	2-10-2019	12:43PM	31.40600014	℃
8	2-10-2019	12:44PM	31.43700027	℃
9	2-10-2019	12:45PM	31.21850014	℃
10	2-10-2019	12:46PM	31.5	℃
11	2-10-2019	12:47PM	31.43700027	℃

Temperature is measured in Celsius. The value of temperature was being changed continuously with respect to time. The highest value of temperature is 31.43°C at Different times. Initially, and after 9 minutes the temperature value was the same.

VIII. CONCLUSIONS

The paper presents a detailed survey of 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 a sensor to provide online data to consumers. The experimental setup can be improved by incorporating algorithms for anomaly detection in water quality. Our proposed system solves the problem of the existing system and it can alert the user about the current situation of the water

IX. RECOMMENDATIONS

In the Future, IoT based Water Quality monitoring systems can be extended not just for the monitoring of the quality of water ponds, rivers. But also for water storage tanks, reservoirs and water pipes too. The same work can be extended by looking into other water parameters rather than just PH, TDS, TURBIDITY and DO.

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