Water Quality Monitoring Using Remote Control Boat

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Abstract. Health of human beings, animals, and plants depends a lot on the quality of drinking water. There are many sources of drinking water such as lakes, canals, reservoirs, etc. Manually monitoring the water quality of these water bodies requires lot of effort as operators need to get in a boat with all the sensors and manually check the entire water body. In this work, to ease the water quality monitoring of water bodies, a remote control (RC) boat was used. This RC boat accompanied by different sensors was used to measure the PH level and turbidity level. When there is a deviation of water quality parameters from the standard values, the system will send an alert message to the remote user. Water quality was measured using two different sensors such as PH, temperature and turbidity sensors. PH sensor monitors the PH value of water and the turbidity sensor will find the suspended or unwanted particles in the water. The location from where the data collected from pH sensor, Turbidity sensor, and Temperature sensor was determined by using the GPS module. The measured values were displayed on the LCD. This data with respect to the location will be stored in the SD card and also the system will alert the user by sending a message with location, when the RC boat is about to sink and/or if the measured water quality is abnormal.

Keywords: Water quality monitoring · Remote control boat · PH sensor · Turbidity Sensor

1 Introduction

The health of animals and humans depends on the quality of their drinking water. There are several sources of drinking water such as rivers, reservoirs, lakes, etc. Water quality is extremely important to irrigation, fishing, and energy producing businesses. Water quality of these water bodies is important to be maintained at a specified level for water supply in urban houses and available water sources. However, it is not fundamentally secure for use in rural areas. In fact, despite the fact that it is the obligation of the government to ensure that its residents have access to clean water. Imperfectly the constant expansion of the population puts a burden on the infrastructure. The quality of drinking water plays a vital role in the lives of human beings and animals. Monitoring is defined

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as the gathering of data at certain locations and intervals in order to produce information that may be utilized to guide present situations, establish trends, and so on. Sampling and laboratory procedures are two common approaches for determining water quality. These procedures, on the other hand, are inefficient and time-consuming, resulting in a delay in the detection of impurities and reactions to those pollutants in water. As a result, more efficient and effective water quality monitoring systems are needed. Water-dependent microbiological and physiochemical data can be used to do this. Turbidity, power of hydrogen pH, and temperature are some of the physiochemical properties of water [1, 2].

Instead of water sampling and laboratory testing, these characteristics are frequently assessed more economically and rapidly [3]. According to a study and research conducted by the United States Environmental Protection Agency [4], pollutants impact water parameters in precise ways that may be discovered, detected, and monitored using appropriate or specific water quality sensors. Commercially accessible probes and meters for water quality testing are available. These products analyze the parameters individually.

In this work, a low-cost, real-time, multi-sensor boat system that is specifically built for large-scale aquatic environments including rivers, reservoirs, and lakes is presented. PH, temperature, and turbidity sensors from WHO standards are used in the system. All sensor data is collected, evaluated, and communicated to the observer through a wireless communication system. The graphical user interface GUI approach is used to create and show these findings, complete with their readings and as well as their nominal ranges.

2 Methodology

In the proposed system, multiple components, modules like Arduino mega, GPS module, GSM modul, SD card module, battery, pH sensor, Temperature sensor, Turbidity sensor, water sensor, etc. were integrated to achieve the desired tasks. It is used to detect, monitor and keep track of records of the real instance parameters like pH, temperature and turbidity using the corresponding sensors like pH sensors, temperature sensors, and turbidity sensors to check the water quality [5]. A water sensor is used along with these sensors to detect if there is any water entering inside the remote control (RC) boat. The obtained data is processed in microcontroller and is sent to the user or costumer, as a message with real location and display on LCD display. Arduino mega 2560 is a development board based on the ATmega 2560 micro controller. It can be used and applied into work for lots of IOT projects and several other applications as this board gives a more view and add-ons for the projects that requires more GPIO pins and memory space. Arduino is the heart of our project. GPS Module contains tiny processors and antennas, which receives a certain location, along with timestamps, from a satellite through dedicated RF frequencies. Using this module, the RC boat can send real-time messages to the user. Global System for Mobile communication is shortly termed as GSM. Basically is designed and was used for wireless radiation monitoring through Short Messaging Services (SMS), mainly in transmitting the data as text SMS to a host server. Out of the box, the shield will work with the Arduino Uno. An SD card Module is a breakout board used for SD card processes such as reading and writing with a

microcontroller, which allows communication with the memory card and write or read the information on them. The Arduino in our model can create a file in SD card to read, write and save data using the SD library. A battery is used in this device, to convert chemical energy into electrical energy. Here come the main components. PH sensor helps to measure the acidity or alkanity of the water with the value range between 0–14. pH stands for potential hydrogen. The basic principle of the pH sensor, or a pH meter, is to measure the concentration of hydrogen ions. To detect and measure the degree of hotness and coolness, and convert it into an electric signal, a temperature sensor is used. To measure the amount of light that is scattered by the suspended solids in water, turbidity sensors were used. With the use of LED light sources, turbidity sensors determine the level of particulate or suspended matter in water or other fluids. The vital component, water sensor is used to detect the presence of water, a leak, level, volume, etc. When Wi-Fi is enabled, the sensor can send out a notification to the homeowner through a Smartphone app. Besides these components, we used several other supporting components like LED, LCD (16*2), buzzer, jumper wires, motor driver modules (L298N), PCB (Printed Circuit Boards) and power supply circuits like resistor, voltage regulator, diodes, capacitors, analog joystick and etc.

In the proposed system, RC boat is accompanied by various types of sensors which are used to measure the pH level, turbidity level, temperature level. This will enable automatic monitoring of water quality in water bodies, more particularly in aquaculture [6].The RC boat is implemented [7, 8], integrating the GSM Module, GPS Module, Water sensor, LCD display, SD card Module, Temperature sensor, Turbidity sensor, pH sensor, LED and buzzer, to the Arduino Mega 2560. Block diagram of the proposed system is shown in Fig. 1.

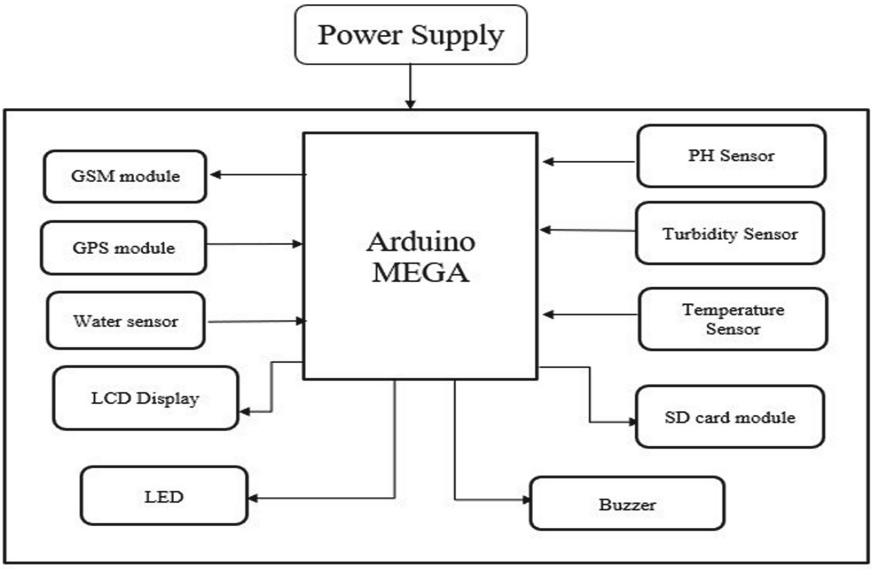

Fig. 1. Block diagram of water quality monitoring system

The power source is given to the device; the device comes to on condition. The commands are given through Arduino nano to the transmitter. The transmitter transmits the input signal to the receiver. The receiver, receives the input signals and decodes it into valid signals, and sends it to the Arduino nano, in which, several other components that are mentioned in above description. This process is a part and parcel of the device. Since, the operation of sensors and modules, is mainly is based on the input signals, which effects the final output or result.

Interfacing of Sensors, Modules (GSM, GPS, SD card), LED, LCD with Arduino MEGA by power supply in circuit diagram is as shown in Fig. 2.

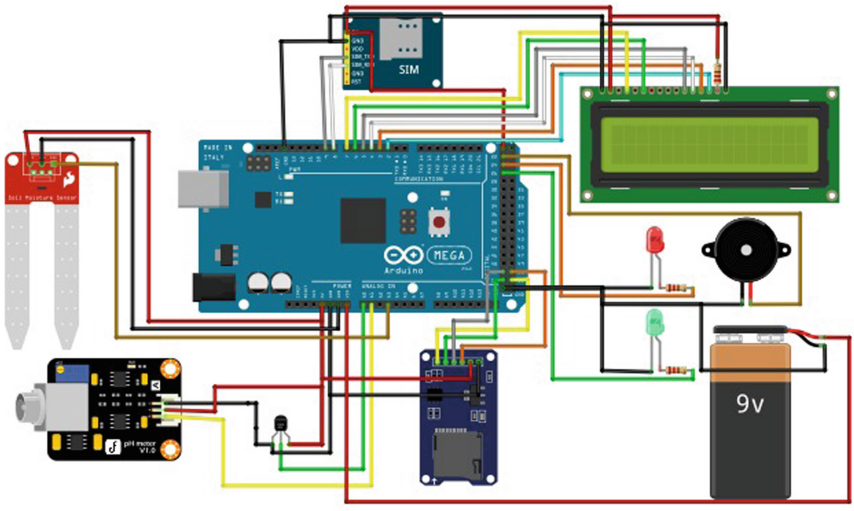

Fig. 2. Schematic of the proposed system

3 Working

The proposed project, GSM based Remote Control Boat (RC Boat) works as depicted in the flowchart shown in Fig. 3. There are various conditions and commands, operated in between the start and stop phase or on and off states or active and passive states. Let us discuss the operations performed in the active state, say when the device is on. Firstly, as the proposed project is remote control based, it obviously requires a remote to control the water quality analysis device. The movement of the boat, whether to continue using the boat, is based on the remote control commands. For the movement, if there is a command not to run the boat, then the process terminates. Else If the command is yes, the operations are executed step by step as follows. The microcontroller initializes the sensors and collects the detected, pH, temperature, turbidity values in real time from the sensors. These values were received by the microcontroller for further analysis and required action. If there is no deviation in the obtained data from the predefined

values of pH, temperature and turbidity, corresponding to the regional water bodies, then the obtained data is stored in the SD card and the device displays those values on the display. If incase, there occurs a deviation in the obtained data, the device sends a real time message to the remote user with location. In both the cases the next proceeding step is continuing the data delivery and the process are terminated once after the user is noticed with the monitored status.

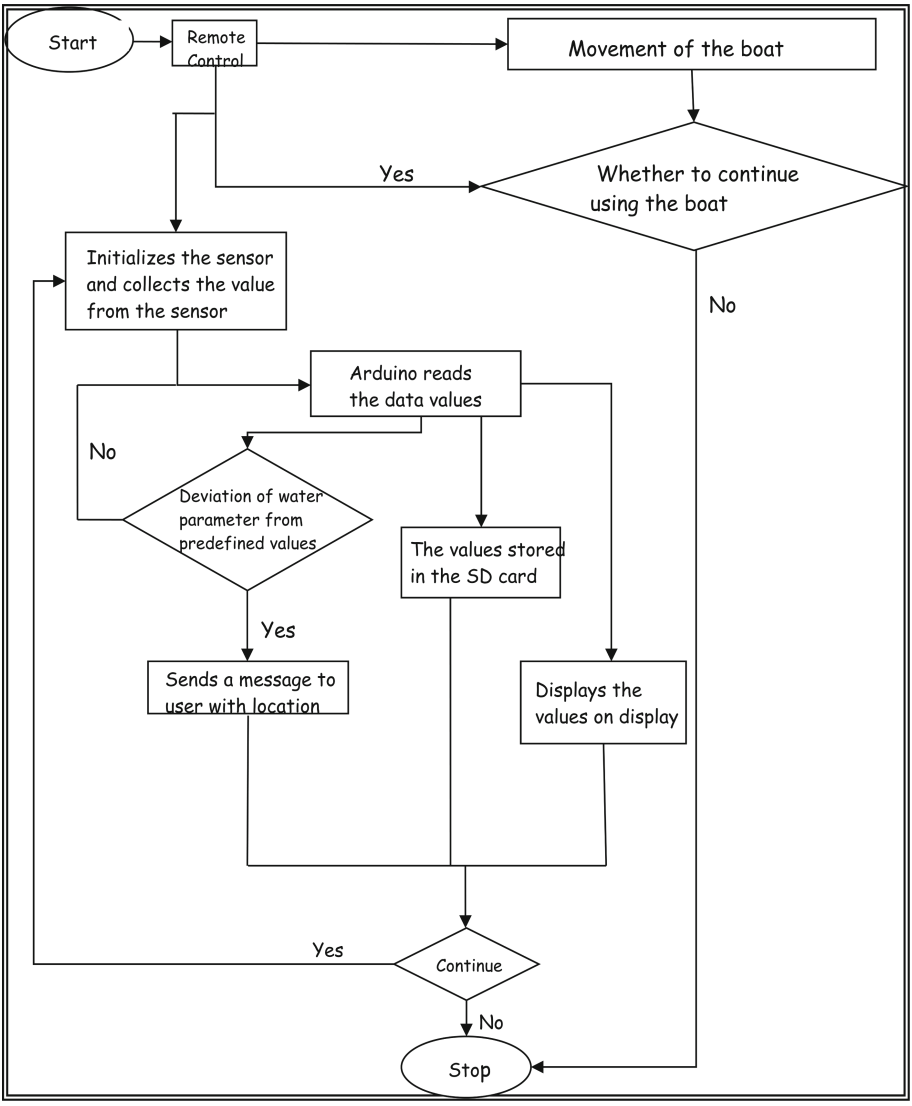

Fig. 3. Flow chart of the water quality monitoring system

The RC boat and remote controller block diagram is as shown in Fig. 4. In this system, Arduino Nano was used as a microcontroller for both remote controller and RC boat. Analog joystick and NRF24L01+ are connected to the Arduino nano in the remote controller. Power source for remote controller is given by using circuits and carbon zinc (HW) battery.

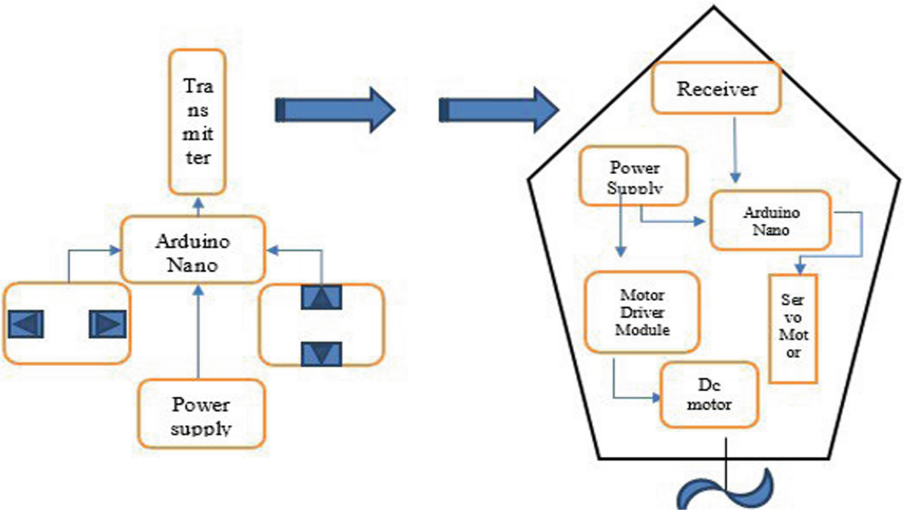

Fig. 4. Block diagram of remote controller and RC boat

NRF24L01, servo motor and motor driver module are connected to Arduino nano as input and output. DC motor is connected to motor driver module. Power source for remote controller is given by using circuits and Li-ion batteries.

4 Results

The water quality monitoring results were taken from different areas. The water quality parameters pH values, Turbidity values, temperature values and GPS coordinates [9] are collected by the Arduino and are stored in SD card module by using written command. It stores data for every 4 s. Further it will send message alerts through GSM and water, commands were displayed on LCD 16*02 display.

Water quality monitoring system was tested in some different scenarios. Also, this system can be used to monitor the water quality in remote areas [10]. The scenarios considered here are water in water tank of a building, lake in different timing. If pH values are in between 6.5 to 7.5 then water is neutral i.e., drinkable water, less than 6.5 then water having acidic nature i.e., unsafe to drink, greater than 7.5 then water having basic nature, i.e., likely to be contaminated with pollutants. If turbidity value is greater than 4 NTU then water is clean, in between 4 to 3.5 turbidity is present i.e., water is slightly clean, less than 3.5 NTU then turbidity is present i.e., water is not clean and it is impure.

The measurements depicted in Table 1 were taken from water tank of building which is located in Jangareddygudem. The water quality parameters pH values, Turbidity values, temperature values are stored in SD card. Results of the water in water tank is slightly neutral i.e., pure water and having very less turbidity.

Table 1. Water Quality Measurement-1 at Water tank, Jangareddygudem Dated 23-05-2022

pH values	Turbidity values (NTU)	Temperature (°C)	Latitude	Longitude
6.73	4.45	34.44	17.1297595	81.3017427
7.01	4.63	34.63	17.1297400	81.3017377
6.83	4.65	34.75	17.1297424	81.3017381
6.74	4.63	34.50	17.1297560	81.3017337
6.67	4.69	34.38	17.1297618	81.3017333
6.62	4.66	34.25	17.1297638	81.3017353
6.74	4.67	34.25	17.1297554	81.3017276
6.87	4.68	34.44	17.1297560	81.3017337
6.83	4.66	34.31	17.1297583	81.3017358
7.02	4.29	34.13	17.1297695	81.3017447
7.03	4.32	34.00	17.1297570	81.3017357
6.93	4.21	34.02	17.1297485	81.3017390

Table 2. Water Quality Measurement-2 at Lake view, Vishnu Institute of Technology, Sri Vishnu Educational Society, Bhimavaram, Dated 24-05-2022

pH values	Turbidity values (NTU)	Temperature (°C)	Latitude	Longitude
7.23	4.65	39.13	16.5663129	81.5215628
7.08	4.63	39.19	16.5663167	81.5215554
6.97	4.69	39.31	16.5663309	81.5215413
6.82	4.66	39.50	16.5663167	81.5215467
6.78	4.67	39.56	16.5663293	81.5215390
6.70	4.67	39.25	16.5663492	81.5215185
6.67	4.68	39.90	16.5663726	81.5215306
6.64	4.66	39.85	16.5663717	81.5215437
6.65	4.29	39.75	16.5663646	81.5215531
6.63	3.68	39.82	16.5663591	81.5215702
6.57	3.61	39.70	16.5663517	81.5215631

(*continued*)

Table 2. (*continued*)

pH values	Turbidity values (NTU)	Temperature (°C)	Latitude	Longitude
6.58	3.54	39.55	16.5663437	81.5215567
6.51	3.61	39.13	16.5663627	81.5215360
6.87	2.39	39.00	16.5663521	81.5215353
6.85	3.53	39.02	16.5663665	81.5215685

Table 2 shows the water quality monitoring results taken from a lake which is located near Vishnu Institute of Technology, Sri Vishnu Educational Society, Bhimavaram. The water quality parameters pH values, Turbidity values, temperature values are stored in SD card. Results of the water in the lake is slightly neutral and having turbidity.

Different conditions and stages were displayed on LCD in the system as shown in Fig. 5. Initially when water quality monitoring system is switched on LCD shows display 1, then it checks SD card is connected or not, if SD card is connected, we get display 2 indication else we get display 3 indication. Display shows the sensor values as shown in Display 4. If system is sending message alert to user display as shown in Display 5, when message alert was sent then the display will be as shown in Display 6.

LED indications are shown in Fig. 6. When water quality monitoring system is switched on then power indication LED will be on. If SD card is storing the data, we get an LED blinking indication. Similarly, When GPS module is getting data of coordinates then we get LED blinking indication.

SMS messages shown in Fig. 7 are the alert messages to the user. When the device is switched on, then the user will get a message as "GSM based Water Quality Monitoring RC boat is started". If the values were abnormal when compared with predefined values then user get an alert message with sensor values and location as "pH value = …, Turbidity value = …, Temperature value = …, "Pollution found in water in this location","https://www.google.com/maps/?q=17.120454,81.298873". If RC boat is about to sink when it is detected by water sensor, user get an message alert along with location as "RC Boat is about to sink, Rescue the boat", https://www.google.com/maps/?q=17.120454,81.298873".

Display 1

Display 2

Display 3

Display 4

Display 5

Display 6

Fig. 5. LCD display at different stages

Fig. 6. LED indications

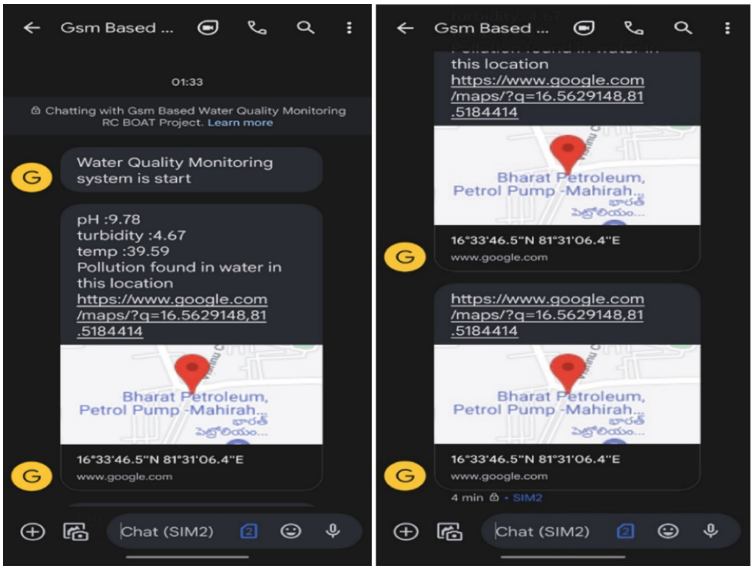

Fig. 7. SMS alerts-1 and 2

5 Discussions

Water is such a valuable resource for the existence of many living beings. Monitoring of water quality is very crucial for the healthy existence of living beings. Due to the scarce water resources, increasing population, and aging infrastructure, it is becoming a challenging task to provide good quality water to all living beings. As a result, better strategies for observing of state of water and novel methods of water characterization are required. Although current approaches analyze physical, chemical, and biological

agents, they have significant flaws, including inadequate spatiotemporal coverage, labor-intensive and high costs (people, operation, and equipment). Requirement of a system to provide real-time water quality data to enable public health choices is very essential in the present scenario. As a result, constant water quality monitoring is required. The proposed system is a low cost, real time water quality monitoring system consisting of different hardware modules such as Remote Control Module, Remote Control Boat, and a water quality monitoring system embedded with various sensors. Using this system, water quality was monitored at various locations having difference in quality of water. From the measurements, it was observed that the values of PH, temperature and Turbidity of water were varied depending on the quality of water indicating the whether the water is suitable for drinking or not. This kind of real time water monitoring assists the local authorities, Government authorities to understand the water quality and make the required arrangements to process it for better quality before supplying the water to the public. The proposed system can be modified for constant monitoring of water quality. Impure quality of water can be tested in laboratories for further analysis. Further the system can be modified to monitor the level of water present in lakes and reservoirs which are the main sources of drinking water. "Internet of Things" can be used to let everyone acknowledge about the water quality.

6 Conclusions

The proposed system is used to monitor the quality of water remotely, get the real time data and also this system alerts the remote user if the water quality is abnormal. The proposed system is used to test the quality of water in different locations and water bodies such as local water tanks, lakes, ponds, etc. Measurements were taken using the proposed system and observed the PH, temperature and turbidity of various water bodies. Variations in PH, temperature, and turbidity values were observed for different water bodies. These measurements enables the remote user to understand and analyze different water bodies and see whether the water is acidic, basic in nature, its turbidity is good or not for the health of living beings. This kind of real time water monitoring assists the local authorities, Government authorities to understand the water quality and make the required arrangements to process it for better quality before supplying the water to the public.

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