Monitoring And Controlling Of Industrial Sewage Outlet Using IOT

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***Abstract*— The contamination of water bodies due to industrial contaminants has been a major issue for which the conventional methods involve collecting and testing samples of water from various locations manually in laboratories. These old methodologies are time consuming, costly and no longer efficient to detect physical and chemical parameters of water. This requires a real time continuous monitoring system in every industrial outlet to reduce the risk of water contamination. This paper proposes an innovative revolutionary solution to curtail involvement of manual procedures. The solution involves placement of various sensors at the sewage water outlet, to detect physical and chemical parameters of the same. The data and metadata captured will be communicated to an online platform using IoT. Wide range of chemicals are used in the industries, and relevant equipment will be used to monitor the data which will optimize the solution. The data will be accessible by the user on the online platform and also notifications will be sent whenever alarming data is identified.**

Keywords— Water pollution, IoT, Cloud, ESP-32.

I. INTRODUCTION

Water is the most essential basic necessity for survival. Even though about 71 percent of earth's surface is covered by water, only 3.5 percent of that is fit for human consumption. Water can generally be classified into four types as potable, palatable, contaminated and infected.In which potable and palatable water are consumable, whereas contaminated and infected are not fit for drinking purposes. In India almost 6.2 billion liters of water per day is contaminated due to various pollutants. Inexorable diseases like cholera, malaria, hepatitis, diarrhoea etc... are caused due to consumption of polluted water. The industrial wastewater is one of the major causes for water contamination which is a major concern. As per law, the wastewater from industries should be treated in Common Effluent Treatment plants before letting it into the fresh water bodies, but few industries are not completely treating the wastewater since it is not continuously monitored. The conventional methods of water quality monitoring involves collection of samples from various water bodies and testing it in the laboratories involving a lot of manpower and time still lacks accuracy and sustainability. But this requires a continuous monitoring system in real time. This paper proposes a system which functions autonomously using IoT, since IoT is one of the existing technologies which saves time, reduces human effort, increases efficiency and accuracy and enhances data collection. Usually the data which is collected and stored in Database are manually fed, which may decrease the veracity of data. Whereas in the proposed system the data is directly collected and stored in the cloud via the prime controller ESP-32 which makes the live data transparent. The warning message is sent to the user once the parameters of water cross the threshold value. The basic parameters of water are pH, turbidity, temperature, dissolved oxygen which are measured by the respective sensors and the values will be calibrated. Different industries release different contaminants. For example, In petroleum industry fuel oils, petroleum products are released. In chemical industries, acids like sulfuric acid, hydrochloric acid are released in wastewater. The dying industry includes sulphur, nitrates, chlorine compounds, arsenic, mercury, nickel and cobalt. The sulphate compounds, arsenic, and vanadium are emitted as pollutants from the thermal plants. Ammonia is one of the major pollutants which is commonly found in many of the industries, which will be detected using ammonia gas sensor.

II. LITERATURE SURVEY

A. *Ashwini Doni and Chidananda Murthy [1]*, proposed a methodology in which they study the water parameters which would provide a close indication about the water quality, then transmit the data from sensor to microcontroller for further processing, as most of the data from sensor are analog they are converting it to digital and transmit it with UART protocol using GPRS to end user.
B. *Nayla Hassan Omar [2]*, addressed the classification of water and the parameters like turbidity, color, temperature, taste and color, electrical conductivity (EC), pH, acidity, alkalinity, chloride, chlorine residual, nitrogen, sulfate, fluoride, iron and manganese, copper

and zinc, hardness, dissolved oxygen, biochemical oxygen demand (BOD), chemical oxygen demand (COD), Toxic organic and inorganic substances, radioactive substances and water quality requirements.

C. *Nikil Kedia [3]*, discussed ways about improving water quality using a sensor cloud system which initially was a sensor actuator system. He proposed different sensor systems, embedded designs and information dissipation along which also stated the technical challenges, economic viability of the system which involves a vital play of government and mobile network operators, and the citizens. Improving water quality was not feasible at that point but systematic usage of technology and economic practice will help to improve the water quality.

D. *Satish Pasika, Sai Teja Gandla [4]*, proposed a system using four sensors to detect pH, temperature, turbidity, moisture etc. in real time. From the sensors, the measured values are transmitted to the controllers Arduino Mega, the prime controller and Node MCU, a slave device, using which the data measured from the sensors are calibrated. The processed values are transmitted remotely to thingspeak server from which the end user can access the data. The system ensures safer supply of drinking water.

E. *V.Vysokomornayaa E. Yu. Kurilenko, Anastasia A. Shcherbinina [5]*, provided an overview on the major contaminants of water in both industrial and domestic wastewater and its types. They analysed the wastewater from petrochemical plants, pulp and paper mills, electroplating industries, power plants, and municipal sources (households and small industries) for hazardous substances and described those for each individual industry. The study involved direct study of wastewater from industries and laboratory studies to produce accurate results.

F. *Vaishnavi V. Daigavane and Dr. M.A Gaikwad [6]*, proposed a methodology which uses Arduino Mega controller and a WiFi module ESP-82. The system is mainly based on IoT. They divided it into two parts hardware and software. Hardware AtMega328 converts analog values from sensors into digital values which is then transmitted to BLYNK app using WiFi module, the values can be accessed in real time by the end user using a mobile app.

G. *Interpretation*

From all the above papers we conclude that the major water parameters provide clear indication of water quality are pH, temperature and the common pollutant emitted from all industries is found to be ammonia. Almost all the paper focuses on giving a safer supply of drinking water whereas the major cause of water pollution is industrial sewage which inspired us to control the cause rather than monitoring the effect. The proposed system uses ESP-32 as prime controller to calibrate and transmit the data to the online cloud based firebase application from which the end user can access the data anytime and anywhere alongside we will be sending alert messages to the user once the value reaches an alarming level.

III. DESIGN AND WORKING

A. *Proposed Methodology*

In this section we will discuss the methodology of the proposed system. We will be using various sensors which will be connected to the prime controller ESP32 which has an inbuilt WiFi module. The system reduces complexity by collecting water quality data from the sewage outlet, which is updated in the web server to access from anywhere at any time. Figure 1 shows the block diagram of the proposed system.

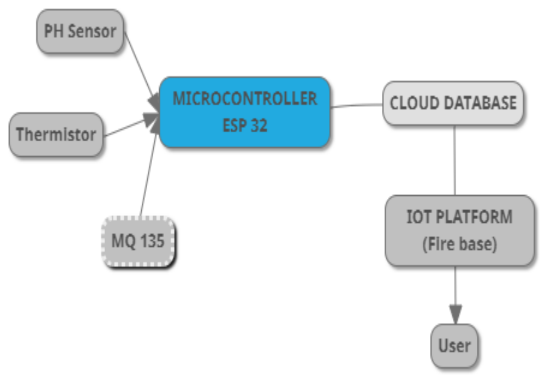

Fig.1. Block diagram

B. *Components*

a) *Hardware*

i. pH sensor - Robocraze pH sensor module

pH is a quantitative measurement of how acidic or basic the sample is, it denotes the hydrogen ion concentration in the sample. The pH range is from 0 to 14, 7 being the neutral, below 7 is acidic as it has higher hydrogen ion concentration and higher than 7 indicates alkalinity with higher hydroxyl ions. Figure 2 shows the pH sensor, which has two electrodes suspended in potassium chloride solution, the glass electrode is contained inside a thin glass bulb, it is made of silver based electrical wire. The second electrode is a reference electrode made of potassium chloride. The hydrogen ions accumulate around the bulb when placed in water, replacing the metal ions which in turn generates electric current flowing through the silver wire. This voltage output is produced by comparing with the voltage from the reference electrode, and then it is calibrated to be displayed as pH value.

Fig 2. pH Sensor

ii. Ammonia sensor - MQ135

MQ135 is the most commonly used sensor to detect gasses such as ammonia, sulphate, benzene and other harmful gases. It consists of a measuring electrode made of tin dioxide inside aluminium oxide micro tubes. Inside a tubular casing it contains a heating element. The sensing element under the steel exoskeleton gets ionised when exposed to the gases, the inbuilt variable resistor changes its resistance based on the concentration of gases. The gas concentration and resistivity are inversely proportional. This requires a load resistor to balance between the sensor sensitivity and accuracy. The basic features of MQ135 shown in Figure 3 includes wide scope of detectivity, fast response, high sensitivity, have long life, high stability, the operating voltage range 5V, it can be used as both digital and analog sensor, the preheat duration is 20 seconds.

Fig 3. MQ135

iii. Thermistor

The thermistor shown in Figure 4 is made up of semiconductors hence they show greater resistivity than conducting materials, but lower resistance than insulators.

Fig 4. Thermistor

It is one of the most commonly used temperature sensors, in a circuit it acts as a passive component. Its electrical resistance changes with change in temperature.It is available with both negative temperature coefficient and positive temperature coefficient. In an NTC type thermistor the resistance decreases with increase in temperature and vice versa. In a PTC type thermistor when the temperature increases the resistance also increases. Among these NTC is the most commonly used. The NTC thermistor graph is shown in Figure 5 and the PTC thermistor graph is shown in Figure 6.

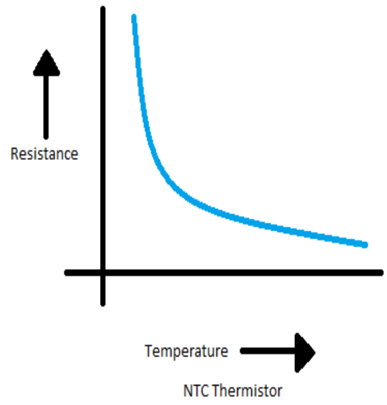

Fig 5. NTC Thermistor Graph

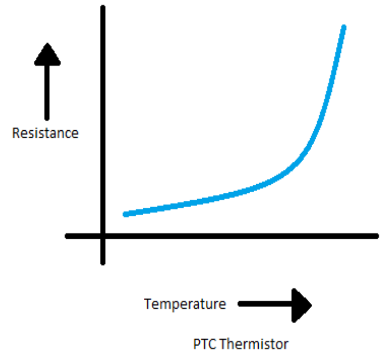

Fig 6. PTC Thermistor Graph

iv. ESP - 32

ESP-WROOM-32 can act as both standalone device or slave device to another MCU, it can provide a WiFi and bluetooth facility with its SPI/ SDIO or UART interfaces. The microprocessor interfaced in ESP-32 is Tensilica Xtensa LX6, It also has inbuilt antenna switches, power management modules, power amplifier, RF balun, low noise receive amplifier and filters. It is an enhanced version and a successor of ESP-8266 with ultra low power consumption with dynamic power scaling and fine-grained clock gating. It has four (MiB) embedded flash memories. Figure 7 shows the schematics and pin configuration of ESP-32 module in detail.

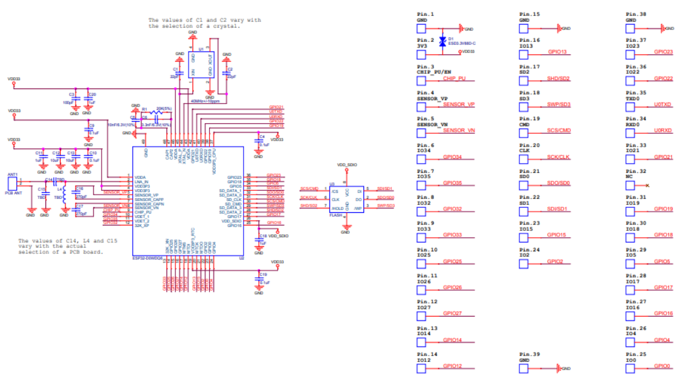

Fig 7. Pin Configuration Of ESP- 32

b) Software

i. Cloud backup

The practice of using a network of remote servers hosted on the internet to store, manage and process the data rather than a local server or a personal computer is called cloud computing.

Cloud backup is backing up of data in a cloud based server. Similar to cloud storage, cloud backup data is the data stored in accessible format.

ii. IoT

IoT stands for Internet of Things which connects a lot of devices to the internet without any human intervention. It is embedded with both hardware and software parts. It has a power of collecting and feeding datas to the big network called cloud computing. The datas can be fetched through online IoT platforms available in the market by installing it in any of the electronic devices and appliances. The huge amount of data from the sensors embedded in all the physical devices is fed into the cloud using a common platform by providing common language for all the devices to communicate with each other. The further analytics is performed on the collected data and valuable information is extracted as per the user requirement.

IV. Working

The entire design is mainly based on one of the current leading technologies, IoT. The system comprises two parts, hardware and software. Here we have used pH sensor, Temperature sensor(thermistor) and ammonia sensor, among which pH and thermistor are analog sensors hence connected to the analog pin, whereas ammonia sensor - MQ135 can be used as both digital and analog, here we will be getting the analog output connecting it to the analog pin of microcontroller. The range of pH sensor is 0 to 14pH, we will be marking 6.5 to 8.5 pH as the allowable limit. For MQ135 the range to detect ammonia is 10 to 300 ppm, the ammonia concentration should not exceed 250ppm. Temperature sensor range is 0 to 100 degree celsius the water temperature should be within 0 to 45 degree celsius. The data from the sensors will be later transmitted to the IoT platform via ESP32. For the software part, the Arduino (IDE) software is downloaded from the official website. The code is written in Arduino IDE to calibrate the values from the sensor, the firebase library is included, The code is finally debugged, compiled and dumped into the microcontroller board. The data is then fed into firebase - google's cloud computing and web and app development platform. Firebase curtails difficulty in maintaining backend infrastructure, monetization and makes user engagement easier. The new project is added in the firebase console, which can be used under zero cost. The firebase tools are installed after setting the google cloud platform (GCP), the microcontroller and local environment is connected using the authentication. The user gets a warning notification whenever an alarming change in data is encountered.

V. Results and Discussion

The different water samples from industries were collected and tested using our project module. The values of each parameter are displayed in Firebase platform from which the user can easily access the data. Figure 8 shows the obtained result.

Fig 8. Result

VI. Conclusion

The project is designed and implemented cost effectively and it is user friendly. The system is entirely based on the emerging technology, IoT which will reduce manual monitoring and testing, the data will be monitored 24x7 real time, the data could be accessed from anywhere at any time. The users will get notified via email and message whenever the data crosses the permitted level. The system can be used in two ways either in the private sector or the public sector. In the case of the private sector the industries can monitor their own sewage system, and act accordingly. For the public sector, the government can monitor the quantity of waste discarded from each industry and take actions over them, this would drastically reduce water contamination as we detect the contamination in the source cause itself, there is reduced chance of drinking water to get contaminated. Eliminating the root cause would completely eliminate the problem as well.

VII. Future Scope

Each industry discards its own wastes into the water bodies, the future scope of this project would be identification of sensors to detect the each contaminant more precisely for individual industry. In addition to that we will also be implementing a water quality management system to ensure safe drinking water for all along with a safer ecology. The project when implemented on a larger scale, will also handle the EB, and water connections to the industries. Whenever the industry releases an alarming amount of contaminants, we will cut off the water inlet and Electric supply to it.

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