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IoT BASED AUTOMATION IN SEWAGE TREATMENT PLANT

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Abstract: Generally, the manual Sewage Treatment Plant ought to be monitored by an individual all the time in our college. To eliminate human dependency, we have come with an idea that completely automates the sewage treatment process in our college. This project detects the level, pH, quality, toxic level and quality of gasses of the STP by using IOT technology with different sensors, Wi-Fi modules and Arduino to make the traditional STP more robust and efficient. All these parameters are tracked by the authorized people through the website which indicates the tank's activity periodically and alerts the user. The STP automation aims to achieve this by making use of IoT technology, to reduce power consumption, human dependency and give a better water quality which can be used for further use.

Keywords: Automation of Sewage Treatment Plant; IoT; Arduino; Ultrasonic Sensor; STP

INTRODUCTION

The Traditional Sewage Treatment Plant works in a manual mode where the motor should be operated manually. It needs the involvement of an experienced operator to make sure if the process is completed in each reactor. The main purpose of the treatment of sewage water is to remove contaminants from sewage to produce an effluent that is suitable for discharge to the surrounding environment. This provides the residential and commercial areas clean and pure water by reusing the wastewater. A sewage treatment plant in our college consists of three tanks namely the BBR reactor, FAICR reactor, and AICR reactor. The BBR stands for Baffled Bio-Reactor i.e., primary reactor, FAICR stands for Fluidised Advanced Immobilised Cell Reactor i.e., secondary reactor and AICR stands for Advanced Immobilised cell reactor i.e., tertiary reactor.

The plants are under the supervision of the operator and they will be deciding the processing time to time. Once the reactor is full or based on time, they have to turn on the motor to fill the next tank. The operator in general has no tool or device which can help him know if the plant is running smoothly or there is a problem in the plant. As seen above the whole process is not very reliable and also time-consuming this is because it is dependent on the operator.

So, we have come up with an idea to automate our college STP using IoT by using various sensors, Arduino UNO and Wi-Fi module. The proposed system is installed with an Ultrasonic sensor to track the level of the reactor and turns on the motor automatically and closes the valve when the reactor reaches a certain level. We use a pH sensor to detect the pH of the reactor.

Generally domestic sewage contains high concentration of pathogens, carbonaceous matter, harmful microorganisms and toxic compounds. Due to decomposition of organic waste products the wastewater has a high level of toxic contents. So, we use special sensors to detect the toxic level in the reactor by using the MQ-4 sensor that detects the methane level. We use an MQ-135 sensor to detect the air quality of the reactor. MQ-135 senses hazardous gas levels of NH3, NOx, Alcohol, Benzene, smoke. Both the sensor measures the values in terms of ppm. This parameter helps to ensure reduced health hazards for the staff working in STP. These are the parameters we consider to automate the Sewage Treatment Plant to make it work more robust and efficient.

The authorized users can view the reactor's activity from anywhere and anytime by viewing the webpage.

LITERATURE SURVEY

- [1] Control Console of Sewage Treatment Plant with Sensors as Application of IoT. Automation is achieved by deploying sensors in the STP to detect the number of different gasses present in the plant. This paper handles the security of the details that are being exchanged between the server and the database by having different logins for different users. The limitations of the project are that it is not completely automated.
- [2] IoT Based Water Supply Monitoring and Controlling System. An IoT-based water supply monitoring and control system is discussed in this paper. The Arduino UNO is mostly used for controller units, while the Raspberry Pi 3 serves as a mini-computer and data uploader to the Adafruit cloud server. Sensors, relays, pumps, and other devices can all be regulated with

Arduino. The data in this device can be accessed from any location with internet access.

- [3] A Minimalist Model of IoT based Sensor System for Sewage Treatment Plant Monitoring. The method was found to be successful for monitoring ETP/STP plants in this paper. Outside the STP plant's tank, Arduinos with sensors have been mounted. The Arduinos' raw data was sent to a Raspberry Pi-based local data concentrator via the built-in Wi-Fi Modules. Using various data mining techniques, the collected data can also provide a wealth of useful knowledge.
- [4] IoT based Sewage Monitoring System. To prevent exposure to certain occupational risks, an IoT-based surveillance system is being implemented. Many factors were taken into account, including humidity, temperature, and the generation of live videos. There will be live video streaming from the camera connected to the Raspberry-pi when assisting sewage employees to search for blockages.

EXISTING SYSTEM

In our existing system, we have a Baffled BioReactor (BBR), Fluidised Advanced Immobilised Cell Reactor (FAICR) and Advanced Immobilised cell reactor (AICR) which is handled by an operator. The problem with traditional Sewage Treatment Plant is that they have a manual system of running the plant. It involves an operator being at the plant all the time to check if everything is running smoothly. The operator in general has no tool or device which can help him know if the plant is running smoothly or there is a problem in the plant.

For example, if the motor that transfers sewage from one tank to the other is dry running then the operator will know about it only after a certain duration i.e., when there is no change in the destination tank. By the time he realizes this issue, the motor would have either broken-down or significant damage would have been done to the motor. As seen above the whole process is not very reliable and also time-consuming this is because it is dependent on the operator. Thus, there is a need for automation.

PROPOSED SYSTEM

The main aim of the project is to control and automate the appliances in STP by using different sensors. The proposed system consists of Arduino Uno, Level sensor (Ultrasonic sensor), Turbidity sensor, pH sensor, MQ-4, MQ-135 sensors, and each sensor is explained below.

— Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The Mega 2560 board is compatible with most shields designed for the Uno.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

Arduino is an open-source prototype framework with simple hardware and software. It consists of a programmable circuit board and ready-to-use software called Arduino IDE (Integrated Development Environment) for writing and uploading computer code to the physical board.

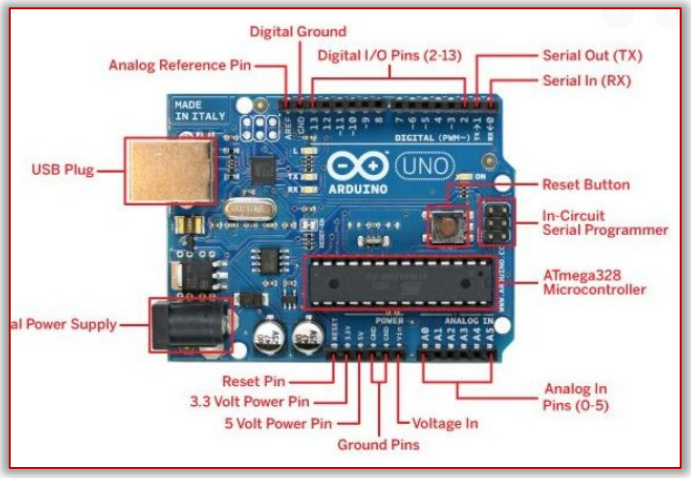

Figure 1. Arduino Uno

— Level Sensor (HC-SR04)

HC-SR04 Ultrasonic (US) sensor is a 4-pin module, whose pin names are Vcc, Trigger, Echo, and Ground respectively. A level sensor is a device for determining the level of fluids, liquids, or other substances that flow in an open or closed system. This sensor measures the distance or senses the objects.

This sensor has two modules i.e., Ultrasonic transmitter and Receiver. The Ultrasonic transmitter transmits an ultrasonic wave. When it senses an object by any material it gets reflected toward the sensor. Once the liquid level is detected, the sensor converts the data into an electric signal.

Ultrasonic sensor is used to track the water level of the reactor and turns on the motor automatically and closes the solenoid valve when water level reaches 90% of the reactor.

— MQ-4 SENSOR

To track the amount of Methane there is a MQ-4 sensor. This sensor measures the values in terms of ppm. Ensure that Methane value is less.

— MQ-135 SENSOR

To track the air-quality of the reactor there is a MQ-135 sensor. This sensor measures the values in terms of ppm. Ensure that CO2 value is high. MQ135 also senses hazardous gas levels of NH3, NOx, Alcohol, Benzene, smoke.

— pH SENSOR

pH scale is used to measure the acidity and basicity of a liquid. It can have readings ranging from 1-14 where 1 shows the most acidic liquid and 14 shows the most basic liquid. pH meter plays a vital role in STP as it determines the acidic component in the water. If the water is more acidic it can't be used for domestic purposes.

— Wi-Fi Module

ESP8266 Wi-Fi Modules are embedded with Arduino UNO and using this network the three Arduino UNOs have been connected to Raspberry Pi. The arrays of sensors which are connected with Arduinos send the data to the Raspberry Pi with the help of Wi-Fi Modules. Raspberry Pi is connected with the central database using the Internet.

— 16X2 LCD

An electronic device that is used to display data and the message is known as LCD 16×2. As the name suggests, it includes 16 Columns & 2 Rows so it can display 32 characters (16×2=32) in total & every character will be made with 5×8 (40) Pixel Dots. So, the total pixels within this LCD can be calculated as 32 x 40 otherwise 1280 pixels.

SYSTEM DESIGN

In this proposed system, the inlet water is the wastewater or the polluted water i.e., discharged water from the college. Tank 1 or BBR tank collects the water from inlet and removal of coarse solids and other large materials are proceed. Tank 2 or FAICR tank does the sedimentation process and removes dissolved and suspended biological matter. FAICR tank fetches the treatment water to the AICR tank. This tank is the final tank which disinfect chemically and produces clean water. This water is used for gardening and other purposes.

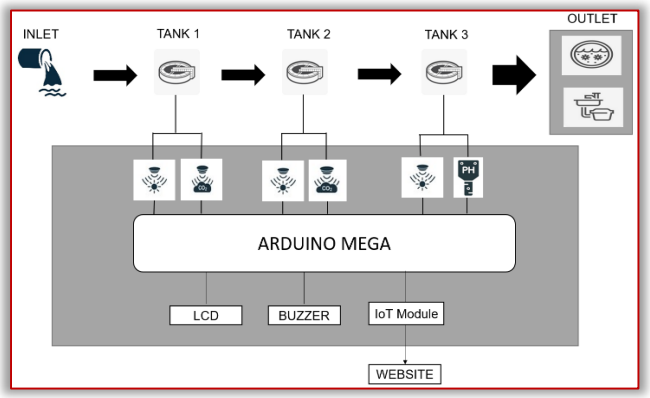

Figure 2. Prototype model

To automate this entire process, we are using an Arduino MEGA microcontroller which is used to interface with the sensors and to communicate with the devices. The MQ 135 – air quality sensor is used to monitor the quality of air like CO2 and other gasses. The MQ 4 – Methane sensor senses the methane value of the tank. The pH sensor evaluates the pH value which helps to pump the water to the outlets. Also, in each tank we have level sensor which calculates the water level in the tank and indicates the Arduino.

If all these sensor values come under the required condition, the final tank i.e., AICR tank allows the water to the outlet pipe.

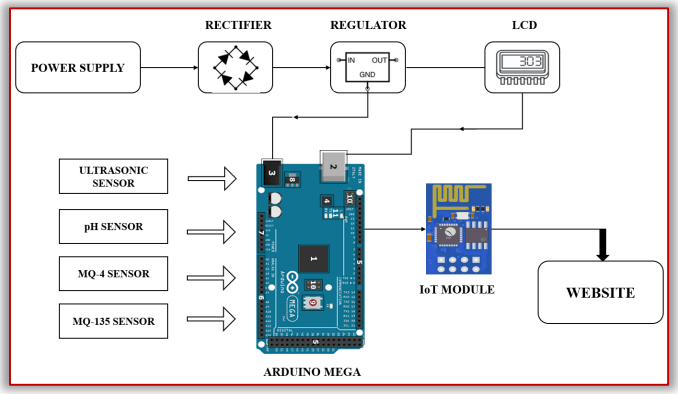

Figure 3. Prototype circuit

The end result can be monitored in the webpage. The LCD is used to display the updated value from the sensors and if any abnormality occurs it is indicated by the buzzer. The IOT module ESP8266 is used to update the information of sensors to the cloud.

IMPLEMENTATION

A sewage treatment plant consists mainly of three tanks namely the BBR reactor, FAICR reactor, AICR reactor. When the BBR reactor gets filled up to 90%, the motor should be switched on automatically with the help of a level sensor and along with a level sensor it also has a methane sensor. MQ4 methane gas sensor is a metal oxide semiconductor type sensor, used to detect the methane gas concentration within the air at industries and generates output like analog voltage by reading it. This gas sensor mainly includes a detecting element like ceramic based on aluminum-oxide (Al_2O_3), coated with Tin dioxide (SnO_2) and arranged within a stainless-steel mesh.

Here, the range of concentration for sensing ranges from 300 pm – 10,000 ppm which is appropriate for the detection of a leak. When the methane level is higher than the required amount, the motor does not pump the water to the next tank. Also, the buzzer gives us an alert ring. If all the conditions are satisfied the pump motor fetches the water to the next tank.

In the FAICR tank, we have two sensors namely ultrasonic sensor and MQ-135 sensor i.e., level sensor and air quality sensor respectively. The MQ135 gas sensor has high sensitivity to ammonia gas, sulfide, benzene series steam, and can monitor smoke and other toxic gasses. It is widely used in domestic gas alarms, industrial gas alarms and portable gas detectors. The level sensor detects the level or length of the tank and MQ-135 detects the air quality. If both conditions are satisfied, the pump motor located between FAICR and AICR gets switched on automatically

and fetches the water into the AICR tank. Both the sensor, MQ- 135 and MQ- 4 measure the values in terms of ppm.

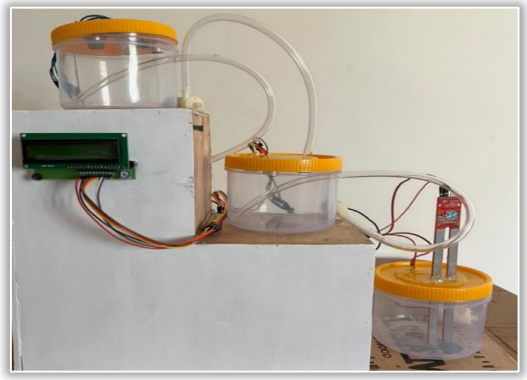

Figure 4.a. Prototype model

The final AICR tank consists of a level and pH sensor. The pH sensor is able to measure the amount of alkalinity and acidity in water and other solutions. Once used correctly, pH sensors are able to make sure the safety and quality of a product within a wastewater or manufacturing plant. Also, pH sensor will allow you to keep pH levels at a level that is most ideal for the process. When the condition of the pH sensor is satisfied then the motor pumps the water into the outlet pipe where it leads to many purposes like watering plants and used as flush water in toilets. If condition fails AICR tank motor pumps the water into the previous tank i.e., FAICR tank.

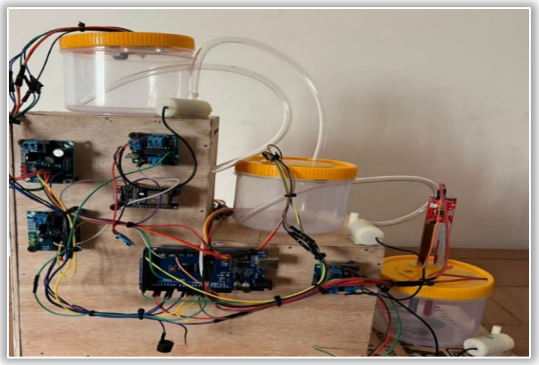

Figure 4.b. Prototype model

The LCD is used to display the updated value from the sensors so that we can watch the absorbed records of the sensor and the tank's activity and if any abnormality occurs it is indicated by the buzzer. The IOT module ESP8266 is used to update the information of sensors to the cloud. The end result can be monitored in the webpage. So that the user can view the tank's activity from anywhere and anytime. The final pump motor is activated based on the pH level.

CONCLUSION

Automation, cost savings, and security are the key goals of the project. To eliminate any human dependence and to avoid the expense of hiring someone to manage the STP at the plant all of the time we came up with this idea with Arduino and IoT module. We handle the security of the information that is shared between the server and the database when doing all of this by providing separate logins for different users.

Finally, the main goal of developing this model was to provide clean, treated water to all at a low cost. This is advantageous to both the people who use the water and the environment because water is conserved rather than wasted. This way, we will keep the environment in balance and contribute to keeping the planet clean and green.

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