ONLINE MONITORING AND CONTROL OF INDUSTRIAL EFFlUENTS IN IOT ENVIRONMENT

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Abstract: - : Industrial wastewater treatment covers the mechanisms and processes used to treat wastewater that is produced as a by-product of industrial or commercial activities. The effluents constantly undergo changes because of seasonal variations in water chemistry, varying plant operating conditions, new environmental laws, and other factors. Because of this, proper monitoring is essential to ensure that the water treatment program applied to industrial wastewater system is satisfactorily controlled so that the desired results are achieved. A design and development of a low cost system for online monitoring and control of different parameters of industrial effluents are presented in the proposed system. The sample parameters such as temperature, pH and conductivity are monitored and its values are kept under control. The measured values from the sensors are processed by the core controller and is updated in the website using the weaved service. Thus the parameter values can be viewed on internet from anywhere and the proper control and treatment of industrial effluents can be ensured.

Index Terms : control, monitoring, online, wastewater, parameters

I. INTRODUCTION

Effluent in the artificial sense is in general considered to be water pollution, such as the outflow from a sewage treatment facility or the wastewater discharge from industrial facilities. Until the mid18th century, water pollution was essentially related to small localized areas. Then came the Industrial Revolution, the development of internal combustion engine, and the petroleum-fuel explosion of the chemical industry. With the rapid development of various industries, a huge amount of fresh water is used as a raw material, as a means of production, and for cooling purposes. Many kinds of material, intermediate products and wastes are brought into the water when water passes through the industrial process. So in fact the waste water is an essential by product of modern industry, and it plays a major role as a pollution sources in pollution of water environment.

Traditional methods of monitoring the effluents take longer time and no longer are to be considered efficient. Although the current methodologies analyses 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 online information to enable critical decisions for public health protection. Therefore, there is a need for continuous online water quality monitoring.

There are many types of industrial wastewater based on the different industries and the contaminants; each sector produces its own particular combination of pollutants.

The metal-working industries discharge chromium, nickel, zinc, cadmium, lead, iron and titanium compounds, among them the electroplating industry is an important pollution distributor. Photo processing shops produce silver, dry cleaning and car repair shops generate solvent waste, and printing plants release inks and dyes. The pulp and paper industry relies heavily on chlorine-based substances, and as a result, pulp and paper mill effluents contain chloride organics and dioxins, as well as suspended solids and organic wastes. The petrochemical industry
discharges a lot of phenols and mineral oils. Also wastewater from food processing plants is high in suspended solids and organic material. Like the various characteristics of industrial wastewater, the treatment of industrial wastewater must be designed specifically for the particular type of effluent produced.

The block diagram of the proposed system is discussed in section II. Section III deals with the flowchart of the work. The software description and challenges of the proposed system are discussed in sections IV and V respectively. Section VI deals with the results and discussion. Conclusion and further scope of the work is given in section VII and VIII respectively.

II. PROPOSED SYSTEM

The basic schematic diagram of online monitoring system is shown in the Fig.1. The hardware setup consists of a tank in which the effluents are monitored. The parameters pH, conductivity and temperature are monitored and controlled.

![Schematic diagram of online monitoring system](image)

The diagram consists of sensors such as temperature sensor, pH sensor and conductivity sensor which are connected to core controller. The effluents whose parameters are to be sensed get collected in the inner tank. An outer tank is provided for coolant circulation when the temperature of the effluent goes high. The inner tank consists of two inlets which are controlled by two valves.

The core controller accesses the sensor values and processes them to transfer the data over internet. Raspberry Pi 2 model B is used as a core controller. The Raspberry Pi is operating on Linux kernel and the Linux OS is boot on to the Raspberry Pi. The output of the temperature sensor, pH sensor and conductivity sensor are in analog form. As the Pi does not have a provision to take analog inputs an analog to digital converter is used to interface the sensors with the Raspberry Pi. The output obtained from the converter is in 12-bit form. Interfacing of analog to digital converter with that of Raspberry Pi is through SPI serial communication. The output is taken from the Dout pin of MCP3208 which is the analog to digital converter used in this system.

The Raspberry Pi 2 comes equipped with a range of drivers for interfacing. However, it’s not feasible to load every driver when the system boots, as it will increase the boot time significantly and use a considerable amount of system resources for redundant processes. These drivers are therefore stored as loadable modules and the command `modprobe` is employed to boot them into the Linux kernel. Then Raspberry Pi sends the data to the internet using weaved services. In order to send the data to the webpage python program is used. The output can be viewed through internet from anywhere. The pH, temperature and conductivity values are monitored and are made to stay under control.

III. FLOWCHART

The flowchart of online monitoring system is shown in Fig.2
The sensor readings are taken and are uploaded into the internet continuously. The parameters are also controlled by taking necessary actions if the values of parameters go beyond the limits. If the pH value of the solution becomes greater than 8 valve 1 is opened so that liquid of low pH value flows into the solution under monitoring system thereby reducing the pH value of the solution. If the pH value of the solution becomes less than 6 valve 2 is opened so that liquid of high pH value flows into the solution under monitoring system thereby increasing the pH value of the solution.

Similarly, the temperature and conductivity of the solution is also monitored. When the temperature goes above 40°C a coolant is made to circulate around the solution by opening valve 3. A buzzer is made to turn on when the conductivity of the solution goes beyond 150 µS/cm. Thus the values of parameters are being controlled and are continuously uploaded into the internet.

IV. SOFTWARE DESCRIPTION

The Raspberry Pi can be used as a mini computer as it can process, store and retrieve the information. It consists of an SD card which operates as the hard disk of the system. The Raspberry Pi cannot be accessed directly through Personal Computer. We require an operating system for communicating with the controller. The operating system used here is Raspbian Jessie.

A. Qt creator

Qt Creator is a cross-platform C++, JavaScript and QML integrated development environment which is part of the SDK for the Qt GUI Application development framework. It includes a visual debugger and an integrated GUI layout and forms designer. The editor's features include syntax highlighting and auto completion, but not tabs (although plug-ins are available). Qt Creator uses the C++ compiler from the GNU Compiler Collection on Linux. In this system, Qt creator is used in order to interface the sensors with the Pi.

B. Putty

In order to communicate with Raspberry Pi through PC, ethernet cable is used. By assigning an IP address it is possible to communicate with the Pi through PC. In order to access it through the ethernet port PuTTY software have to be installed in the PC. PuTTY is a free and open-source terminal emulator, serial console and network file transfer application. It supports several network protocols, including SCP, SSH, Telnet, rlogin, and raw socket connection. It can also connect to a serial port. Here the IP address assigned to the Pi is given by 150.150.12.162 and it is accessed through the PuTTY software installed in PC.

C. Weaved Service

Weaved is software that can be installed on Raspberry Pi that lets it to be accessed from anywhere over the internet. SSH, VNC, HTTP, SFTP file transfer and any other TCP service running on Pi can be enabled for secure remote access over the internet without port forwarding.

In order to connect Pi over the internet using weaved services the raspbian package lists have to be updated using the command `sudo apt-get update`. Then `weavedconnectd` package is installed using the command `sudo apt-get install weavedconnectd`. After creating weaved user account in [https://developer.weaved.com/portal/index.php](https://developer.weaved.com/portal/index.php) the weaved installer is run on the system. The Pi can now
be accessed by logging in to the account at www.weaved.com.

V. CHALLENGES OF PROPOSED WORK

The traditional method of water quality monitoring was done by taking a sample and checking the values of parameters in a laboratory setup. This method does not require sensors which can be interfaced with a PC. But in the proposed system, the sensors are required to be interfaced with the system so that the values should be uploaded in the internet. Such types of low cost sensors are difficult to find as this is only an emerging concept in the industries.

The speed of response of the system can be a challenge to this system in future. All the data from the sensors are processed and are uploaded into the internet. Since this concept is only in the infant stages the amount of data which are uploaded over the net is of small amount. Once this system is well established in industries the amount of data uploaded over the net will be abundant. This may be too much for the present servers to handle.

The necessity of internet is another important factor in this system. All the investments in this system can be of no use if there is any kind of discontinuity in the network. Apart from these challenges the proposed system is an efficient method of monitoring and controlling the quality of the effluents.

VI. RESULTS AND DISCUSSION

The Water quality monitoring is important for several applications such as environment monitoring of pond and ecosystem, drinking water distribution and measurement, contamination detection in drinking water etc. such applications need a separate technique for monitoring the water quality. In the proposed system, the water quality parameters are being monitored on the internet in a webpage. The Figure 5.1 shows the results from the webpage where the readings of the parameters are displayed.

Figure 3. Parameter readings in webpage

Here only three parameters such as pH, temperature, conductivity are monitored and controlled. The values of these parameters are very important when considering the pollution in water bodies. The changes in pH value of the industrial effluents determine whether it is acidic or basic in nature. Therefore when it is discharged into the water bodies the pH value has a great importance. In order to keep the pH value in control, two valves are made to turn on and off depending on the changes in pH value. Thus the pH value of the sample monitored and is kept under control.

The temperature of the effluents is another important factor that has to be monitored. The process water in industries are used for many purposes like cooling, building purposes etc. Therefore the temperature of process water will be increased drastically. When it is discharged into the water bodies it will affect the aquatic lives very much which leads to massive fish kill as it is being reported in news. It is not that efficient to take the sample and monitor the temperature continuously in a laboratory setup. In the proposed system the temperature of the effluent is monitored continuously through the internet. If the temperature goes high a coolant is made to circulate outside the effluent tank so that the temperature of the effluent is reduced.

Conductivity defines the total amount of dissolved solids in the waste water. It is an easy and informative water quality test. It is sometimes used as a watchdog environmental test- any change in the ionic composition of a solution can quickly be detected using a conductivity probe. In industrial
waste water the amount of dissolved solids will be high. It should be monitored and controlled as it can affect the concentration of water bodies. Here conductivity probe is used in order to measure the conductivity and it is monitored online. If the conductivity goes high then a buzzer is turned on indicating that the solution should be filtered properly. Thus three parameters were monitored online and controlled successfully using the proposed low cost system.

VII. CONCLUSION

Water pollution has many forms, all of which are damaging and none of which are less important than the other. Whether it be oil pollution, which is a largely silent (excluding the occasional large spill) but deadly polluter or the widely encompassing chemical pollution which can include Persistent Organic Pollutants (including PCB's and DDT), all water pollution have unimaginable consequences. Some of these effects, which can also be considered further pollutants, are Acid Mine Drainage and Eutrophication. These effects effectively choke out the water they pollute and have the ability to devastate entire ecosystems centered on a water supply.

Increase in the number of industries has been a blessing as well as a curse for the society as our natural resources are being extremely polluted. Most of the industrial belt will be around the river banks considering the transportation facilities and the availability of the resources. All the waste discharges will be finally reaching the water bodies as they find it easy to dispose it there. But the continuous exploitation of the water resources has started to unbalance our ecological system. Many governments have started to search for an efficient low cost system for controlling and monitoring the pollution in water bodies. The proposed system can be installed in industries and they can claim that they are having a good control over the effluents which are being discharged into the water bodies and the important parameters are well monitored by them.

Not only in product based industries but also in water theme parks where the quality of water needs to be monitored continuously, this system can be installed. As of today in water theme parks they are checking only the pH value and the chlorine content of the water in a traditional manner. This requires additional laboratory setup and lab assistance which add to the economy of the industry. Moreover, the continuous display of measured values are not possible in such a system. By installing the proposed system, it is possible for them to continuously monitor the parameters and display the values in their website there by allowing the customers to view the data and be sure about their safety. Thus this system has application in various industries in different ways.

VIII. FUTURE SCOPE

The three parameters pH, temperature and conductivity have been measured using the proposed system. Some of the other parameters that should be considered are dissolved oxygen, turbidity, chlorine etc. The measurement of these parameters were not done because of the lack cost effective sensors which can be interfaced with the controller. As of today these parameters were measured by taking the samples such sensors which can be interfaced with the system were of low importance. With the successful implementation of such system more cost effective sensors which can be interfaced with the system can be developed.

The parameter values are maintained to be under control by implementing a simple on-off control. It has got several limitations in terms of response time, settling time etc. Therefore we can include some advance controllers or some soft computing techniques so that the speed of the system can be improved.

REFERENCES


