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AUTOMATED WARNING SYSTEM FOR PIPE LEAKAGE DETECTION

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ABSTRACT

This paper presents a module which is used for detecting the leakage in PVC pipes which is used for liquid transaction in industries. This paper proposes new leak detection techniques using water flow sensors which are handshake with the help of ESP8266 Wi-Fi module for surveillance purposes. The relationship between the leak values and leak location is plotted in the graph by forming polynomial equation using regression. In this work, a server will be maintained which automatically stores the sensor data in the XAMPP server especially in MySQL database. An automatic warning message will be send to the webpage.

Keywords: *Waterflowsensor, ESP8266 wifi-module, Regression, Leak detection.*

1. INTRODUCTION

This paper deals with the pipe leakage detection. Pipe leakage has become a serious issue now a day in most of the industries. There are various solutions available for these issues. They are: FSR sensor [1] which is used for sensing the changes in pressure inside the pipe. This is then processed by Arduino UNO for further processing. The pressure gauge [2] for pipe has been used in order to sense the pressure inside the pipe and wireless sensor networks are being used in order to transfer the information. MIT leak detector [3] is another technology proposed, which uses a robotic vehicle designed to move inside the pipe along with the liquid. But this has the disadvantage that when the flow of the liquid is more, the robotic wheel may get damaged. Another method is Twin Ball technology [4]. Here two balls are used which are capable of travelling inside the pipe along with the fluid. This technique has two balls one ball will detect the leak and it will communicate to other ball which is capable of healing that hole with the healing liquid. Another methodology [5] to detect the leakage in pipe is by using vibration sensors. When the pressure in the pipe changes due to leakage, the vibration in the pipe also changes. Prediction of leak location [6,7,8] can be analyzed using time difference techniques and correlation techniques. Now days, in industries mostly transportation of liquids is helped by PVC pipes. The leakage detection methods can be categorized as Hardware based, software based or hybrid [9].A hybrid model [10] based water leak detection is explained by Fereidooni et.al., Further the automatic leak detection and analysis has been carried out by several researchers using machine learning algorithms [11,12]. Leak detection with federated learning method [13,14] was also described in the literature. In a slightly different way, the Kalman filtering technique also used to locate the leak.

The PVC pipes when exposed to sunlight will get damaged and creates a leakage in it. This small leakage may lead to serious issues. According to Applied Physics, it is known that when the water flows normally in the pipe there will be a constant pressure and flow rate. So, by predicting this flow rate, the leakage can be detected. This can be handshake with the help of water flow sensor. By calculating the value of leak at various places and by plotting it using linear regression the leak can be predicted accurately.

2. PROPOSED WORK

The block diagram is shown in the fig.1. In this work, a sensor node is taken. The sensor node consists of water flow sensor, ESP8266 and Arduino Uno. From ESP8266 the values will be forwarded to the XAMPP server. From that server, the value of the sensor is being displayed in the webpage by using SQL queries. In XAMPP server, there is a need to install the XAMPP in any PC and a static IP has to be set for that PC and the ESP8266 has to be connected to the access point and then the values in the XAMPP server will be transferred. The values will be stored in the MySQL database. For retrieving those values, a PHP code along with queries is used and then redirected it into the HTML webpage.

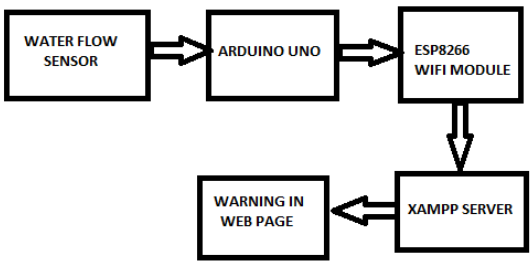

Fig.1 Block diagram

The water flow sensor consists of a rotor and a hall magnetic sensor. The rotor moves when there is motion of any liquid passing through it. When the water flow sensor is connected to the pipe set up and when the water starts to flow, the rotor tends to rotate accordingly. The rotation is then measured with the help of hall magnetic sensor and the output is in the form of pulses (digital).The water flow sensor is connected to arduino Uno so the digital pulse is being counted by the arduino which then calculates the flow rate per minute automatically using the Equation (1),

$$\text{Litre per hour} = \frac{60 \times PulseFrequency}{Q} \quad \text{-(1)}$$

$$\text{where, Q} = 7.5 \times (Flowrate / Minute)$$

Arduino Uno is a microcontroller which has open source software for programming in electronics. Arduino microcontroller used in this work is ATMEGA328P. It has 14 digital inputs/outputs and 6 analog inputs and it has 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. Operating voltage is 5 Volt.

ESP8266 Wi-Fi module is a self-contained SOC. It has TCP/IP. This Wi-Fi module when connected with any microcontroller will provide the access to Wi-Fi network. The ESP8266 module is being associated with AT commands.AT command stands for Attention. Operating voltage of ESP8266 is 3.3 Volts.

3. EXPERIMENTAL SETUP

At first, there is a need to arrange a pipe set up using PVC pipes. The water flow sensor can be inserted in between the pipe at anywhere in the setup. If the water flow sensor diameter is 0.5’ inch and the diameter of our PVC pipe setup is 0.75’inch then there is a need to join the sensor and the pipe using some joints and pipe threads. This is our experimental setup shown in the figure 4.1 and 4.2,

Figure 4.1 Experimental Setup

At first pipe setup is arranged. Our experimental setup uses 1 inch PVC pipes and ½ hp motor for pumping the water into the pipe.

Figure 4.2 Experimental Setup

The setup is made for the length of 275 cm. This setup has two elbows at the corner.

Figure 4.3 Fixing of water flow sensor

This figure well depicts the connection of Arduino with water flow sensors. In our setup, when there is no leakage the value of water flow sensor is above 2000. After that a leak is created at a distance of 20 cm from the sensor. The value of the sensor is being decreased as the flow rate is decreased due to the leakage. The leakage has been predicted at different places at different distances and the results is been obtained. The leakages and its corresponding values are tabulated. The leakage value and leakage distance using the regression is obtained. By using regression polynomial equation, the obtained values are shown in the Table.1 The readings for various leak distances is shown in the table 4.1,

DISTANCE	SENSOR VALUES
20 cm	1900-1920
75 cm	1700-1750
130 cm	1650-1690
205 cm	1620-1640

Table.1 Sensor values and leak location

The polynomial equation obtained using regression is shown in the table 4.2,

Table 4.2 Tabulation for Regression

y	x	xy	X^2	Y^2
15	1920	28800	3686400	225
20	1900	38000	3610000	400
70	1750	122500	3062500	4900
75	1700	127500	2890000	5625
130	1690	219700	28,56,100	16900
135	1650	222750	2722500	18225
200	1640	328000	2689600	40000
210	1600	336000	2560000	44100
Summation	13850	1423250	24077100	130375

By normalizing the values using regression formula the equation (2) is obtained,

Y'=1100.22-0.57X----------(2)

The plot obtained in Matlab for this polynomial equation is shown in the figure 4.4,

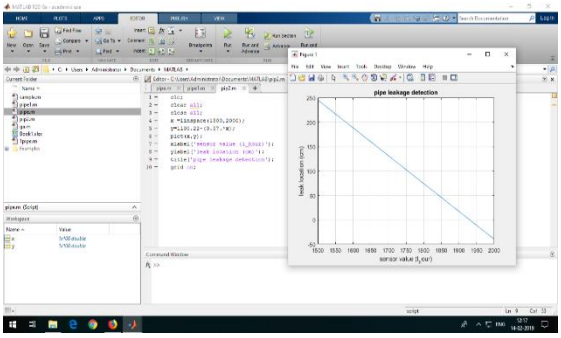

Figure 4.4 Matlab output

The Matlab plot is obtained for this regression equation by keeping the sensor values in the X-axis and the distance of leakage at the Y-axis.

4.2 CONNECTING TO WIFI AND LEAKAGE PREDICTION

Now the ESP8266 is connected with the Arduino and then check the ESP8266 module with AT command. The sensor data is uploaded to XAMPP server. Once XAMPP is installed open the XAMPP control panel and then create a database table and then create columns according to our need. And then a static IP is given for PC where XAMPP is being installed and then mention that static IP in the program need to be uploaded. This program is to be stored in the htdocs folder of XAMPP.

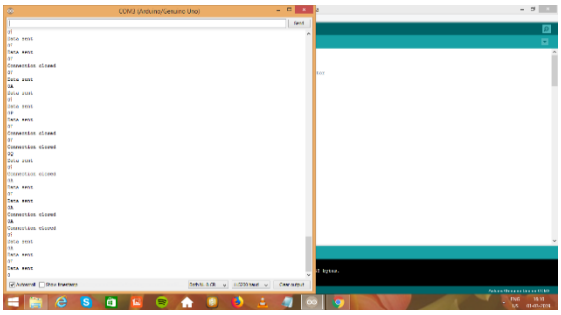

Figure 4.5 Arduino output

The sensor is used for counting the digital pulse from the Arduino board for every second. This is shown in the above figure 4.5,

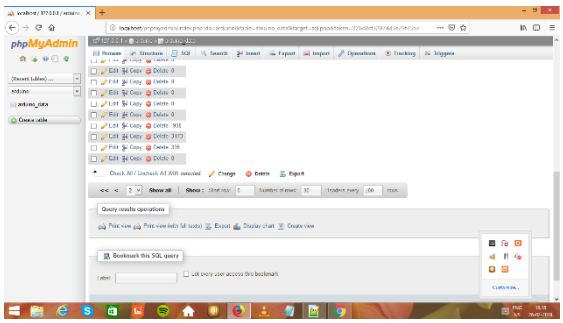

Figure 4.6 XAMPP Server

Here, one column named val which is under the database named Arduino_data is created.

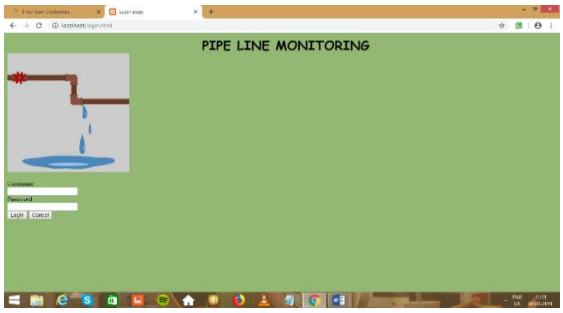

Figure 4.7 Login page

This the ip address 172.16.28.38/login.html used for obtain the login page shown in the figure 4.7. The login name and password for our HTML page is pipe.

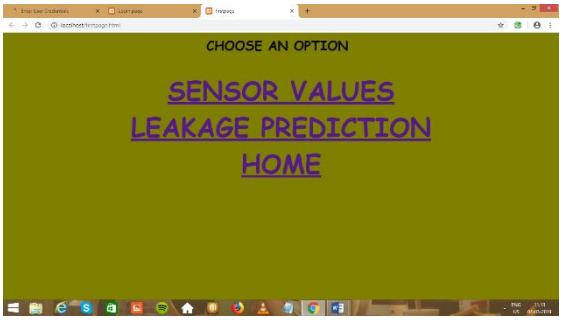

Figure 4.8 Option page

The next page have options mention as shown in the figure 4.8,

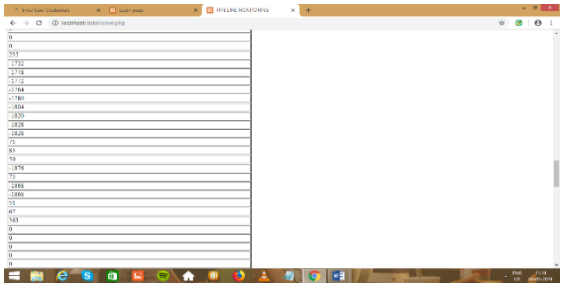

Figure 4.9 Data records

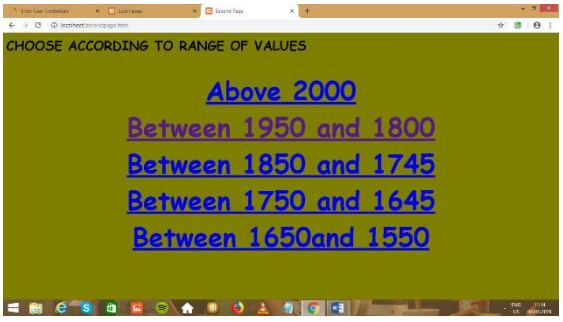

Figure 4.10 Sensor Values

This is the web page for leakage prediction. This will have five categories for every range of values. These five values according to our set up.

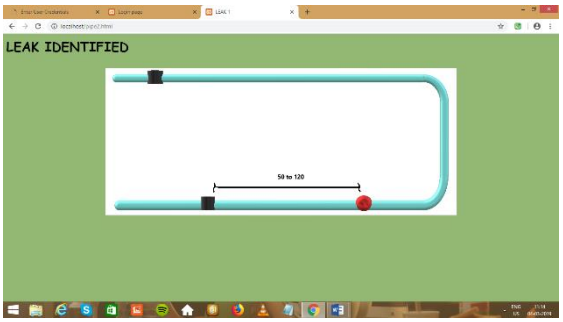

Figure 4.11 Leakage prediction

This indicates that the leakage is at around 50to 120 cm before the sensor in our pipe setup. The red color mark indicates the leakage. Now according to the sensor value, web page is able to locate the leakage.

4. CONCLUSION

Thus the leak can be located and predicted the leak location accurately and quickly at anywhere when connected to the network. This will give the results according to the results obtained from the plot of Matlab and the polynomial equation obtained from regression. This will give the warning in the webpage. By using this technique it is easy to monitor the pipeline in the industry.

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