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Smart Water Leakage Monitoring System

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Abstract: The main aim of this project is to develop an intelligent monitoring system for water leakage detection in the water distribution system. Leakage constitutes a major loss of drinking water when supplied through pipeline systems. Introducing automated leakage detection systems would save a huge amount of water globally. Water leak detection by means of a simple embedded system aids water conservation in a cost-effective way. It focuses mainly on two parts: The first part is a real-time water leakage detection system using a flow meter. The second is the controlling part; it uses Arduino to control the solenoid valve and alert the owner using the Blynk application with the aid of a Wi-Fi module. The system is made up of basic components: flow rate sensors, a Wi-Fi module, Arduino, and relays to control the device. The result of using the proposed system is improving the efficiency of operation, reducing delay time and cost of maintenance pipelines after leakage detection.

Keywords: Leakage Detection, Automatic Response System, Arduino

1. Introduction

Pipelines are the most used mode of distribution for water around the world. They are used for almost everything from underground water distribution to home water supply. This situation creates a high demand for efficiency of distribution, quality of materials and long-term sustainability of the pipes. Usually, spills happen because of erosion caused by dampness gathered around areas with access to oxygen or natural disasters. Most of the time, leakages are only discovered when the damage is visible, causing a considerable loss in water [1].

To solve this problem, automated leakage detection systems are used as early prevention to reduce water waste drastically. For property owners, such as high-rise building owners, a pipe burst or break can be a bad dream, including brief lodging, contractual workers, destruction, basic support, compulsory construction standard redesigns, and the loss of imperative belonging, photographs, and treasures [2]. Also, the issue can reoccur over and over. For most people, the health risks of mold development caused by water damage are enough [3]. However, there are other dangers that a water leak could bring. This type of damage is more structural, and it can be just as costly, if not more, than

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the medical bills that mold can cause. Staining, discoloration, and streaks along the walls are the most visible and immediate symptoms of water damage. Many water leak detector systems were created to find the position of a water leak in a hidden pipeline system. However, the system has many components and calculations to enhance its function. R.F Rahmat *et al* present a method for monitoring and leakage detection of water using a Flow Liquid Meter Sensor [1].

In this project, flow rate sensors will be used to identify the leak in a pipe using the change in water flow rate from different sensors placed in different sections of the pipe. Furthermore, a Wi-Fi module will be used to connect to the Blynk IoT platform to monitor the output from the flow rate sensor and analyze the efficiency of using this system and the flow of water. The Wi-Fi module will also be used to inform the person in charge using a text message [4]. The system proposed is anticipated to be convenient and reliable for the user to monitor the water lines in their homes from all distances.

2. Materials and Methods

In this section, there are 3 stages that lead to the project's success by acknowledging each software and hardware function.

2.1 Smart Water Leakage Detection System Block Diagram

The main criteria in most of the projects are inputs, the control unit and outputs. The input of this project is flow rate sensors, the control unit is Arduino Mega and the output is a solenoid valve and OLED display. It also uses the ESP8266-01 Wi-Fi module to transmit data. Figure 1 shows the block diagram of this project [5].

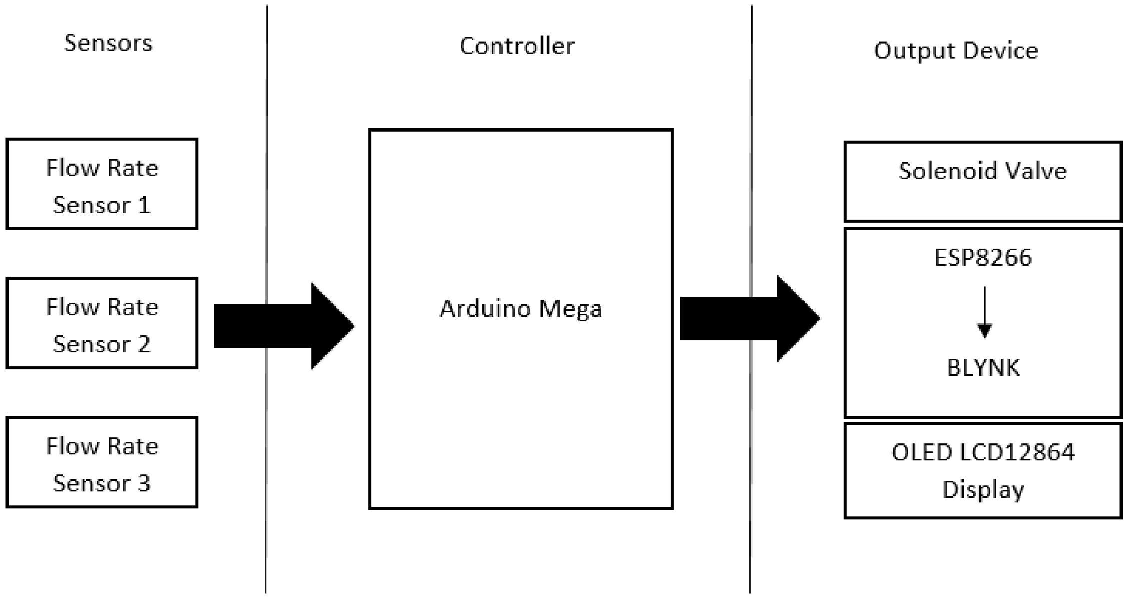

Figure 1: Block diagram of Smart Water Leakage Detection System

2.2 Methods

The suggested system employs a microprocessor that continuously reads data from numerous flow rate sensors, allowing the water flow to be monitored at all times. It calculates the difference in data from succeeding sensors to compare the flow rate and then takes the appropriate action. If the difference exceeds the defined threshold, the microcontroller instructs the solenoid valve to close and gives the user an alarm message. Figure 2 shows the process flow [6].

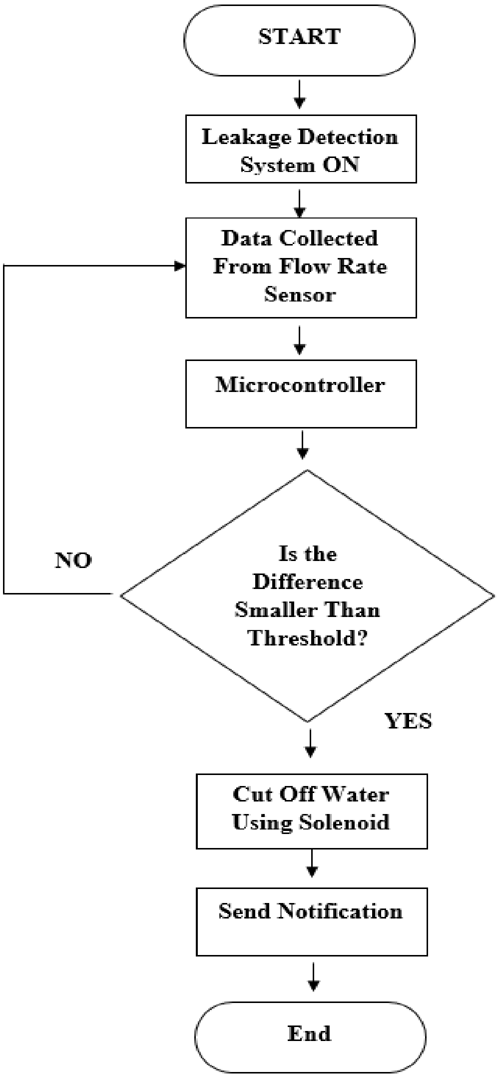

Figure 2: The process flow

2.3 Electronic Setup

All the sensors' connections are combined in this circuit diagram. Figure 3 shows the electronic setup of this project.

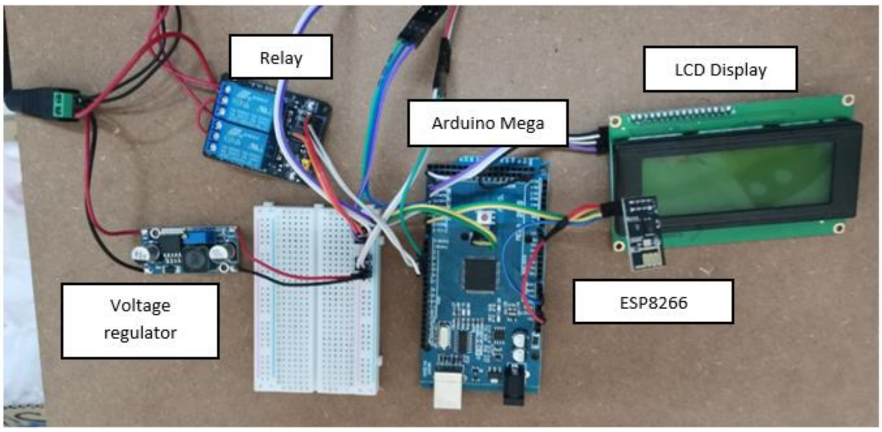

Figure 3: Electronic setup of the system

3. Results and Discussion

All the figures below show the results from the system developed. It consists of the result where there is a water leak detected and the output devices activate. Besides that, it also consists part where a notification to the user has been sent.

3.1 Result

Figure 4 shows the initial condition of the system where the power supply is connected. The esp8266 will connect to the designated Wi-Fi ssd set in the coding, in this case, which is "abcd1234".

Figure 4: Initial condition of the system

After connecting to the Wi-Fi, the LCD will display a message as in Figure 5 where no water flow is supplied to the system and as in Figure 6 where water is supplied to the system.

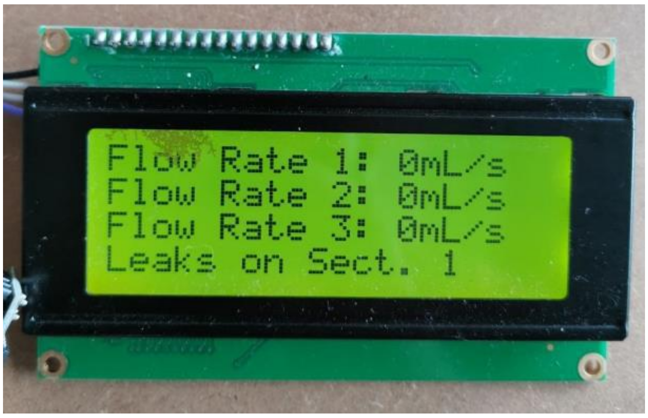

Figure 5: Display when no water flow is detected

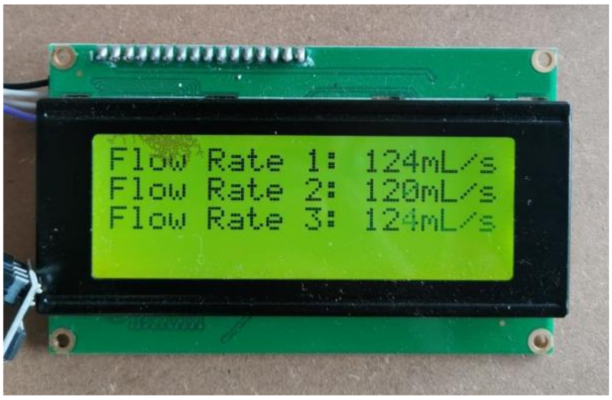

Figure 6: Display when there is water flow detected

Figure 7 and Figure 8 show the display in the Blynk application when the system is started without water supply and with water supply.

Figure 7: Blynk interface with no water supply

Figure 8: Blynk interface with water supply

In this demonstration, we have 2 conditions in our project testing. Condition 1 will initiate a leak in section 1 of the system and Condition 2 will initiate a leak in section 2 of the system. Condition 1 where the leakage is detected in section 1. In this demonstration, we will open the leak located between sensor 1 and sensor 2. As we can see after the leak is initiated in Figure 9 the flow rate of sensor 2 and sensor 3 has become 0 which can be seen in Figure 10. From here the system will determine the leak has occurred in section 1 and will stop the water flow using valve 1. Figure 11 shows the Blynk application interface and the leakage notification in section 1.

Figure 9: Leakage in section 1

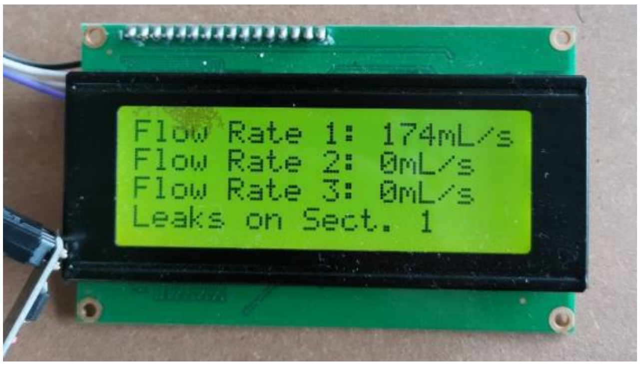

Figure 10: Display for leakage in section 1

Figure 11: Blynk notification for leakage in section 1

Condition 2, where the leakage is detected in section 2. In this demonstration, we will open the leak located between sensor 2 and sensor 3. As we can see after the leak is initiated in Figure 12 the flow rate of sensor 2 and sensor 3 becomes lower, which can be seen in Figure 13. From here, the system will determine the leak has occurred in section 2 and will stop the water flow using valve 2. Figure 14 shows the Blynk application interface and the leakage notification in section 2.

Figure 12: Leakage in section 2

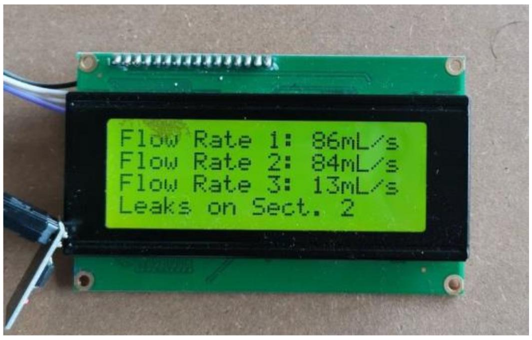

Figure 13: Display for leakage in section 2

Figure 14: Blynk notification for leakage in section 2

3.2 Discussion

From the results, it can be seen that the project worked successfully. The placement of sensor in a smaller distance between each other allows the user to find the location of leakage more easily. To enable the Wi-Fi to function properly in the system the Wi-Fi module should be placed in a position where there will be no signal interference. The cost of the project can be reduced by using quality components which has resistance to higher pressure and can last longer. This project will be able to reduce water wastage by early detection.

4. Conclusion

The Water Leak Detection system was a huge success in the end. It used a computer-programmed algorithmic approach to interpret leaks. The device that was produced was likewise not available on the market. While leak detection technologies have been reported and exist, the device that was designed and finished into a genuine printed circuit board assembly was created specifically for this purpose. The device was also designed with wireless communication in mind, allowing it to communicate with other devices in the vicinity. Because detecting systems are often spaced apart, this helped to replicate the real-life model of a pipeline. When communicating across long distances, wireless transmission is the ideal option. When a leak was detected in the pipeline, the devices' shared data and calculations helped to infer a water leak and also alerted the operator.

Acknowledgement

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