Home Water Leakage Detection and Monitoring System Using IOT

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Abstract - The water supply shortage has increased in recent years due to overpopulation, climate change and obsolete water facilities, where deteriorated pipes cause most of the water leaks. The problem is not the size of the leak, but the time it takes to detect it. This paper presents the implementation of a system installed in the hydraulic facilities of a residence, to detect water leaks. The system consists of a water sensor installed by a water reservoir of interest, a microprocessor to interpret the data and evaluate. The design of a water level sensor device that can detect and control the level of water in a certain water tank, the system firstly senses the amount of water available in the tank by the level detector part and then adjusts the state of the water pump in accordance to the water level information. There has been wastage of water daily through the pipeline leakages due to its full water were never arrived to the taps. The aims of our proposed work are to develop a real-time prototype pipeline leakage alert system whether it is a water leak or not, an SMS alert message, and an electrical actuator to shut off the main water supply to avoid leakage.

Index Terms – NodeMCU, Water Flow Sensor, Ultrasonic Sensor, Buzzer, IOT.

1. INTRODUCTION

With the growth of the world population, the demand of fresh water has increased causing serious problems in the field of water supply. Therefore, control of water has become a considerable issue today. With the growth of the world population, the demand of fresh water has increased causing serious problems in the field of water supply. Therefore, control of water has become a considerable issue today. Scientists, technicians, politicians, and generally, many other inhabitants of the planet become increasingly educated on the subject. The threat of pollution hovers over and limits water supplies. The shortage of this vital liquid requires great attention. The proportion of fresh water found in rivers, lakes, and underground sources comprise only 3% of the total amount of water on earth. In addition, the water found needs treatment for human consumption, to eliminate particles and organism harmful to health, and ultimately must distribute through pipes to homes safety.

This work focuses on the issue of distribution, more specifically, on the issue of "water leaks" in residential areas. In a developing country like India, loss of water in domestic sector on account of leakage is approximately 30 to 40% of the total flow in the distribution. This leads to high risks in public health, money invested and on the valuable natural resource. India had an irrigation efficiency of ~36 percent in 1993-1994 and projected that efficiency would have to increase to 60 percent by 2050 to bring a balance in the demand and supply of water. Even those slow leaks that only because mold damage require expenses to repair. The more water spilled (or splashed) the more money the repairs cost to residents. For this reason, it's crucial to have some system installed in residences to detect water leaks. Current digital water leak detection systems can locate multiple water leaks to within 1-meter resolution over a complex network of cables running several kilo meters.

2. RELATED WORKS

Water leak detection is an expression more commonly used for larger, integrated systems installed in modern buildings or those containing valuable artifacts, materials or other critical assets where early notification of a potentially damaging leak proves beneficial. Specifically, water leak detection has become a necessity in data centers, trading floors, banks, archives, and homes. The water leak detection industry, small yet specialized, has only a few manufacturers operating world-wide. The existing water supply systems incorporate high range acoustic and pressure detection devices are way costlier to be implemented in developing countries. Some irrigation leak detection systems use heating coils to detect the flow rate difference which has a drawback of detecting the fast change over in the system due to the uniform response of the temperature sensor. This single parameter does not help

in stopping leakage in the system. In this paper, a flow sensor-based system integrated with microcontroller to detect the leak due to breakage has been discussed. This system is designed to prevent the further leakage of water flowing through the pipe line. This paper is organized in the order of methodology which explains the working of the system, components used to build the system and the results which signify the efficient leakage prevention based on a prototype. The only available process information is velocity and pressure at the inlet and outlet of the pipe. Simulations demonstrate accurate quantification and localization of the leak under transient operation of the pipeline, such as for instance during shut-down. Current work focuses on replacing the simple model presented in this paper with a state of the art fluid flow simulator and incorporating [1]. Previous researches on water pipeline monitoring and detection in water pipes have been conducted before.

Abdallah [2] conducted a research in monitoring the level of water flow, by utilizing web services and Zigbee as a communication device as well as some sensors such as level sensors, water flow sensors, and temperature sensor. In addition to web monitoring, the owner of the sensor can also get important information about the flow of water via SMS to a personal mobile phone number of the owner. Akyildiz et al. [3] was conducted to detect leakage of water pipeline. The research investigated the impact of various pipe diameters on pressure of the water flow in the pipes and the temperature changes around the pipe. FSR sensor is used to measure changes in the pipe diameter, and temperature sensors are used to measure the temperature around the pipe. In this research, they used 40 mm diameter PVC pipe with a constant pressure of 3 bars. 666 analyzed vibration in the pipe wall caused by collisions between the water flows to the pipe wall. Vibration is measured using a MEMS sensor.

Leakage is analyzed by comparing the vibration of the normal water flow and the vibration when there is a leak in the pipe. Tests are conducted by varying the pressure from 3 to 10 bar with a constant water flow rate of 300*m3/hr*. A research that compared the consumption savings of tap water using wireless sensor network has been conducted. Carrano et al. [5], this research uses Rfbee sensors to gather data received from the water flow rate transducer, as a sender and a recipient of the data. Data collected by Rfbee sensors will be transmitted by wireless network to a computer connected directly to the sensor Rfbee. A research to monitor and control the water flow through a web server is carried out in Reference [1]. Monitoring and controlling is done by using Hall Effect Flow Sensors, Arduino, Raspberry PI, and Solenoid Electro Valve. Hall Effect Flow Sensor with Arduino will measure fluid flow, while Raspberry PI will Control solenoid electro valve, which is used to close or to open the flow of fluid through the pipe. Chen, et al. [6] the actuator and water sensor used to deactivate the water pump is small and light enough for any user to carry and install. The actuator can obtain power from a wall socket which negates the need for additional power. India had an irrigation efficiency of ~36 percent in 1993-1994 and projected that efficiency would have to increase to 60 percent by 2050 to bring a balance in the demand and supply of water [7,8]. The existing water supply systems incorporate high range acoustic and pressure detection devices are way costlier to be implemented in developing countries. Some irrigation leak detection systems [9] use heating coils to detect the flow rate difference which has a drawback of detecting the fast change over in the system due to the uniform response of the temperature sensor. Some other systems [10-15] use the flow sensors to measure the flow rate. This single parameter does not help in stopping leakage in the system.

In this paper, a flow sensor-based system integrated with microcontroller to detect the leak due to breakage has been discussed. This system is designed to prevent the further leakage of water flowing through the pipe line. This paper is organized in the order of methodology which explains the working of the system, components used to build the system and the results which signify the efficient leakage prevention based on a prototype.

3. PROPOSED WORK

3.1 NodeMCU GPIO

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the dev kits. NodeMCU board as shown in fig 1. The firmware uses the Lua scripting language. It is based on the eLua project and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson, and spiffs.

Fig 1. NodeMCU Board

3.2 Water flow sensor

Water flow sensor consists of a plastic valve body, a water rotor, and a hall-effect sensor. When water flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The hall-effect sensor outputs the corresponding pulse Signal. The water flow sensor as shown in fig 2.

Fig 2. Water Flow Sensor

3.3 Ultrasonic Sensor

Fig 3 shows the ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.

Fig 3. Ultrasonic sensor

3.4 Buzzer

A buzzer or *beeper* is an audio signaling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Typical uses of *buzzers* shown in fig 4 and beepers include alarm devices, timers, and confirmation of user input such as a mouse click or keystroke.

Fig 4. Piezo Electric Buzzer

3.5 Internet of Things

Fig 5. Internet of Things

A thing in the internet of things can be a person with a heart monitor implant, a farm animal with a biochip transponder, an automobile that has built-in sensors to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an IP address and is able to transfer data over a network.

3.6 Block Diagram for Proposed Work

The block diagram consists of three main set of blocks and one microcontroller. In first block contains the converting circuits. It has the step-down transformer, bridge rectifier and 7805 regulators. The 5v d.c supply is may use in the circuit for supply, then it reduces the circuit complexity, but it has one disadvantage recharging the battery after it will discharge completely. To overcome the disadvantage, we preferred the combination of step-down transformer, bridge rectifier and 7805 regulators. These increases the complexity of the circuit, but the increase the life time and efficient use the project. The main supply as 230v a.c supply is given into the step-down transformer. The step-down transformer is a device to decrease the primary voltage into the secondary voltage. This process is to reduce the primary voltage as 230V a.c voltage into 12V a.c voltage. Then the 12V a.c voltage is given to bridge rectifier and it converts the a.c voltage into the d.c voltage.

The microcontroller contains the integrated processor, memory, small of RAM and program memory which are used to interact with things connected to the chip. It is the kind used in personal computer. In the circuit, the Node MCU is act as a microcontroller. The Node MCU is most preferred to interfacing the internet of things to our circuits. It requires the 5V d.c supply, so we want to interface the bridge rectifier into the bridge 7805 regulator. The 7805 regulator converters the 12v d.c voltage into the 5V d.c voltage and the converting voltage is given into Node MCU microcontroller. The water flow sensor and ultra-sonic sensor is embedded in the circuit, to play a vital role in the water leakage. Before starting the process, the flow rate of each pipe can be determined, and these values is known as the threshold value. This process can be repeated in all the pipelines in the home or industry.

Then the water level in the tank will be reduced means the flow rate can also reduce, it indicates the water leak in the pipelines. To overcome the disadvantage, we want to measure the amount of water in the tank by using the UV sensor. It is used to measure the distance between two points, by using the calculation we easily the amount of water present in the tank. Ifsuppose the water level in the tank will be too low means, the UV sensor send the signal to the microcontroller. The microcontroller switch on the single-phase induction motor, is to full the water in the tank. After that, there is any leak in any block can be reducing the flow rate in each water flow sensor. The flow rate is slightly differing from the threshold value; the flow sensor sends the signal to the Node MCU. Then the

microcontroller receives the signal from flow sensor and sends into the output devices as LCD, buzzer and IOT. The LCD receives the signal from microcontroller, it suddenly displays the notification as "Leak is Detected in Kitchen Room", if there is leak in kitchen. Similarly, there leak in any room in the home or industry, it easily identified and reported to the user. At the same time the buzzer will produce the sound signal to the entire surroundings. The block diagram of proposed work is shown in fig 6.

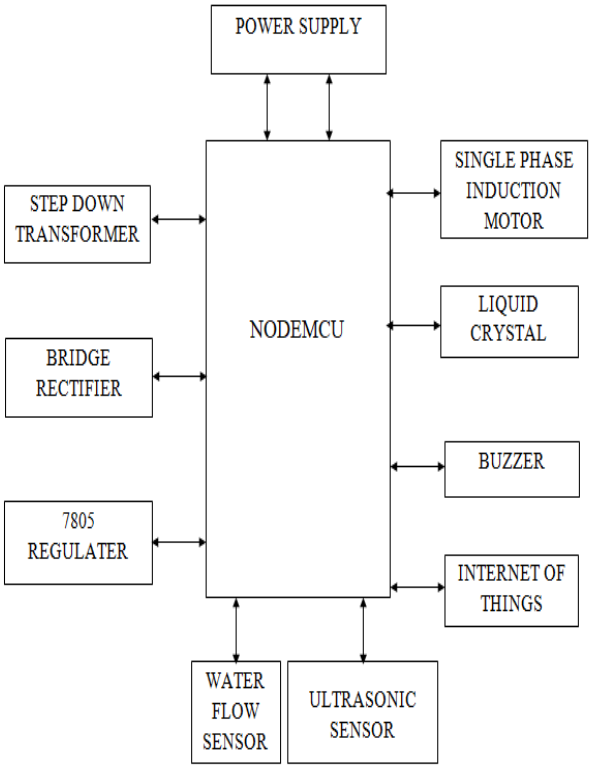

Fig 6. Block Diagram for Proposed Work

After receiving the notification, the user is to be alerted and automatically cut off the main supply and after repair the pipe and it is used to promote water consumption. The IOT is used to send the alert signal to the email and web browser. These will be easy and more secure, and it is pretty good in industrial purpose, because of the water leak is to cause the damage in the machinery system by using the project to promote the water consumption and usage. These will come under the home automation. Now-a-days these projects will alert the people "How to use water", "How to maintain the water wastage" and these things will be more important. We all are must do these, because of to protect our future generation and environment.

4. RESULT AND DISCUSSION

After finishing all the Home water leakage Detection system connections and programming, system gives good response to the sensor and sends SMS when it detects leakage in water where the water sensor was fixed. The time taken by the system to deliver the SMS is dependent on the coverage area or range of the specified mobile network. If the mobile is in the range of the system, then the SMS is delivered in 4 seconds. The prototype of home water leakage detection system and the outputs are as shown in fig 7-10.

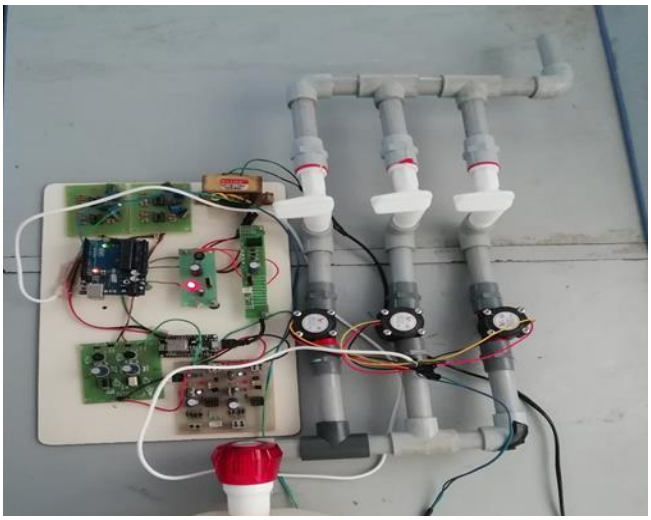

Fig 7. Prototype of Home water leakage detection system

Test Case 1:

Title: Water Leakage

System: Home Water Leakage Detecting and Monitoring System

Input Instructions: Acquire the water sensor reading while there was leakage in the master washroom pipes.

Output: Alarming the user on his mobile by sending an SMS to the Android mobile application

Result: Test Succeeded.

Fig 8. Result when leakage detected in washroom pipe

Test Case 2:

Title: Water Leakage

System: Home Water Leakage Detecting and Monitoring System

Input Instructions: Acquire the water sensor reading while there was leakage in kitchen pipes.

Output: Alarming the user on his mobile by sending an SMS to the Android mobile application and close valve2.

Result: Test Succeeded.

Fig 9. Result when leakage detected in Kitchen pipe

Test Case 3:

Title: Water Leakage

System: Home Water Leakage Detecting and Monitoring System.

Input Instructions: Acquire the water sensor (A4) reading while there was leakage in the master Bedroom pipes.

Output: Alarming the user on his mobile by sending an SMS to the Android mobile application and close valve3.

Result: Test Succeeded.

Fig 10. Result when leakage detected in Bedroom pipe

5. CONCLUSION

Water for domestic purposes is always very essential and it is mandatory to prevent it from getting wasted due to any pipeline leaks. Hence the designed prototype is an effective solution for monitoring the flow of water as well as detecting for leaks in the pipelines. The smart water leakage detection system can help in water distribution process by remote activation of solenoid valves. Usage of cloud logging technique enables the data acquisition and analysis in any point of the pipeline. This system makes cost efficient and simple. The flow of water through the domestic pipeline can be monitored, forecasted and visualize from anywhere in the world using internet through computer or Smartphone. The collected data can be analyzed for making predictions to the users for demand management, asset management, and leakage management. With water as a flowing liquid the system has been tested successfully. The work can be extended to forecast data for larger communities with customer satisfaction involving low cost and better performance of the overall system.

The location of the leak has determining a maximum distance of 2 meters and it can determine the location of the leak closest to the actual location of the leak with an average flow rate of 10 liters per minute. One plan in the future work is to extend the detection ability to more than 2 meters, which later on can be developed by considering the time duration of the reduction in water flow rate when there is a leak, so the accuracy of the leakage location is improved. Another future work is to implement the detection system to branched pipelines as well as using various water flow rates.

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