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Leakage Detection in Water Pipes: An Approach of Smart Water

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Abstract

This is an application of Wireless Sensor Network (WSN) to avoid the leakages, which are happening in the underground. It is quite hard to detect the leaks inside the ground, so this is a method which we can send some signals and detect where the leakage is happened and we can fix it easily. Our main aim is to detect the leakages happened in the water separation in water distribution network. To overcome this problem, we use the Smart Water Leakage Detection (SWLD) in pipelines. In this SWLD we measure water level in tank and control in pump to turn it on when the water level is less (low). The System contains 2 parts: the first part is alarm based on Global System for Mobile (GSM) technology to send Short Message Service (SMS) to the owner. This system is containing basic components like sensors, GSM module, Arduino. The second is the controlling part; it uses Android application mobile to control the pump.

Keywords: Arduino, Global system for mobile, Short message service, Smart water leakage detection, Wireless sensor networks.

1 | Introduction

We all know that the water is a limited resource and is essential for agriculture, industry and for home uses existence on earth including human beings. Many of us don't know that the 97.5% water present on earth is salt water and 2.5% being fresh water [1]. Lots of people don't realize the real importance of drinking water every day. More water is wasted by many people in many uncontrolled ways. This problem is quietly related to poor water allocation, inefficient use, and lack of adequate and integrated water management [2]. Therefore, efficient use and water monitoring are potential constraint for home or office water management system. Every living thing on earth needs water to survive. Human bodies are made up of more than 60% water [3]. We use clean water to drink, grow crops for food, operate factories, and for swimming, surfing, fishing and sailing. Water is vitally important to every aspect of our lives. Monitoring the quality of surface water will help protect our waterways from pollution. Farmers can use the information to help better manage their land and crop. Once imagine the world how it looks like if there is no water [4].

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This is not at all predictable one so, to overcome this many countries are making many changes to overcome this problem as of now many areas in India are drought and they are suffering from water cities like Rajasthan and many other cities [5]. The Indian government has done their best to overcome this problem. The main reason for leakage of the distribution water pipelines is the pressure on the pipelines when exceeds the maximum pressure rated by manufacturer when these pipelines designed. So, it will cause a deformation on the pipes and this will lead the pipes to explode during the water flowing through them [6]. After this occurs and the pipes explode, the water will leave its main track and will leave pipes and leakage will occurred. By using water monitoring system, Smart Water Leakage Detection (SWLD), we avoid the water wastage, power consumption and easily prevent the water for our generation. If our idea applied in fully technical true way, this will be very useful for domestic environment. This experimental system will save money for owners and will detect the leakage in water distribution pipelines and helps the owner to be familiar with the problems early to make the required maintenance [7]. In our system we make a home model to be a prototype for SWLD system. We arrange water pipelines and put water sensors on points which have high probability for water leakage. A microcontroller also required (Arduino) to control and process the actuators on its output ports, also to receive data from water sensors [8]. The Arduino connect to Global System for Mobile (GSM) to detect the water leakage and decreasing in water level rapidly and remotely and then send SMS to the owner. And we use the Android application to receive these data from GSM and control on pump [9]. The goal of this system is to design and manage a Wireless Sensor Networks (WSNs) that helps to monitor the location of water leakage with the help of information sensed by the sensors located above water hoses, so as to keep the water resource within a standard described for domestic usage and to be able to take necessary actions to restore the health of the degraded water quantity [10]. We use Arduino mega2560 microcontroller to design and build a water leakage detection and wireless control system which provides the user with new features such as water leakage detection and water level control in tank by mobile application. The purpose of the system is to bring comfort and energy saving to our lives [6].

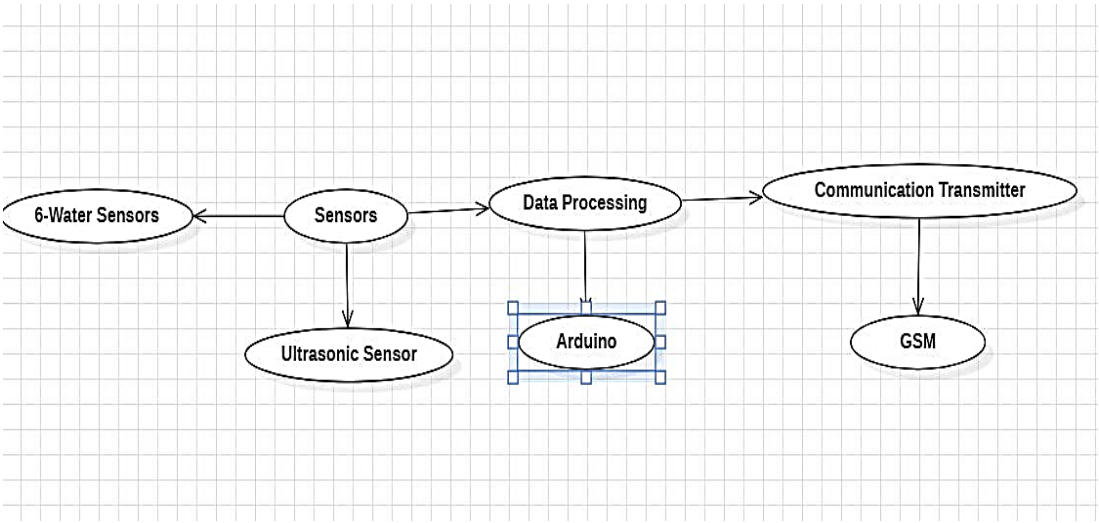

Fig. 1. Work Flow of sensors.

1.1 | Technical Tools Required to Use

- *GSM 900.*
- *Arduino mega2560.*
- *SIM900 for Arduino controller.*
- *Water sensor.*
- *Ultrasonic sensor.*
- *ULN2003.*
- *Processor.*
- *Processor.*
- *Flash memory.*

- *Data memory.*
- *EEPROM.*
- *Digital I/O pins.*
- *PWM outputs.*
- *Analog outputs.*
- *Clock speed.*
- *Serial ports.*

2 | Literature Review

The system hardware setup step by step in details for combining the components with each other to establish the desired tools and making the connection between the hardware parts with the software commands to get automation sensing unit and actuators. Hardware part of the system nearly was simple and easy to understand and deal with, it contains the controller which is Arduino mega category #2560, water leakage sensors, solenoid valves, ultrasonic sensor, water pump, electrical relays to control the activation of the valves and the pump depending on the input data from sensors and we use ULN 2003 to connect the output pins of the controller with the electrical relays [11].

2.1 | Advantage

Moderately priced designed for well water, no valves or plumbing, no external power 120 VAC needed system is powered from the well pump can be used for either pressure switch-controlled systems or constant pressure systems and I/O for house alarm option. Moderate expense; sensors are usually wireless; multiple sensors available; cell phone text capability; and I/O for house alarm options [12].

2.2 | Disadvantage

Valve must be installed and exercised every six months due to sediment corrosion; 120 VAC outlet plug needed to power the system; some wireless systems have limited signal range. Expensive, valve must be installed and exercised every six months due to sediment corrosion and 120 VAC outlet plug needed.

2.3 | Discussion of Existing System

Early we have only audio alarm system. We can understand that it just informs only that the leakage is happening but it's the big task to find where the leak has happened. It is also some ward better by alarm system we can turn off our motors so that the water couldn't be wasted. This system is inexpensive, can be installed at any water supplied device; no need for AC outlet; and battery-powered with low battery warning [13].

2.4 | Disadvantage of Existing System

Does not shutoff any supply and must be home to mitigate leak. Valve must be installed and exercised every six months due to sediment corrosion; 120 VAC outlet plug needed to power the system; some wireless systems have limited signal range and also sensors are wired.

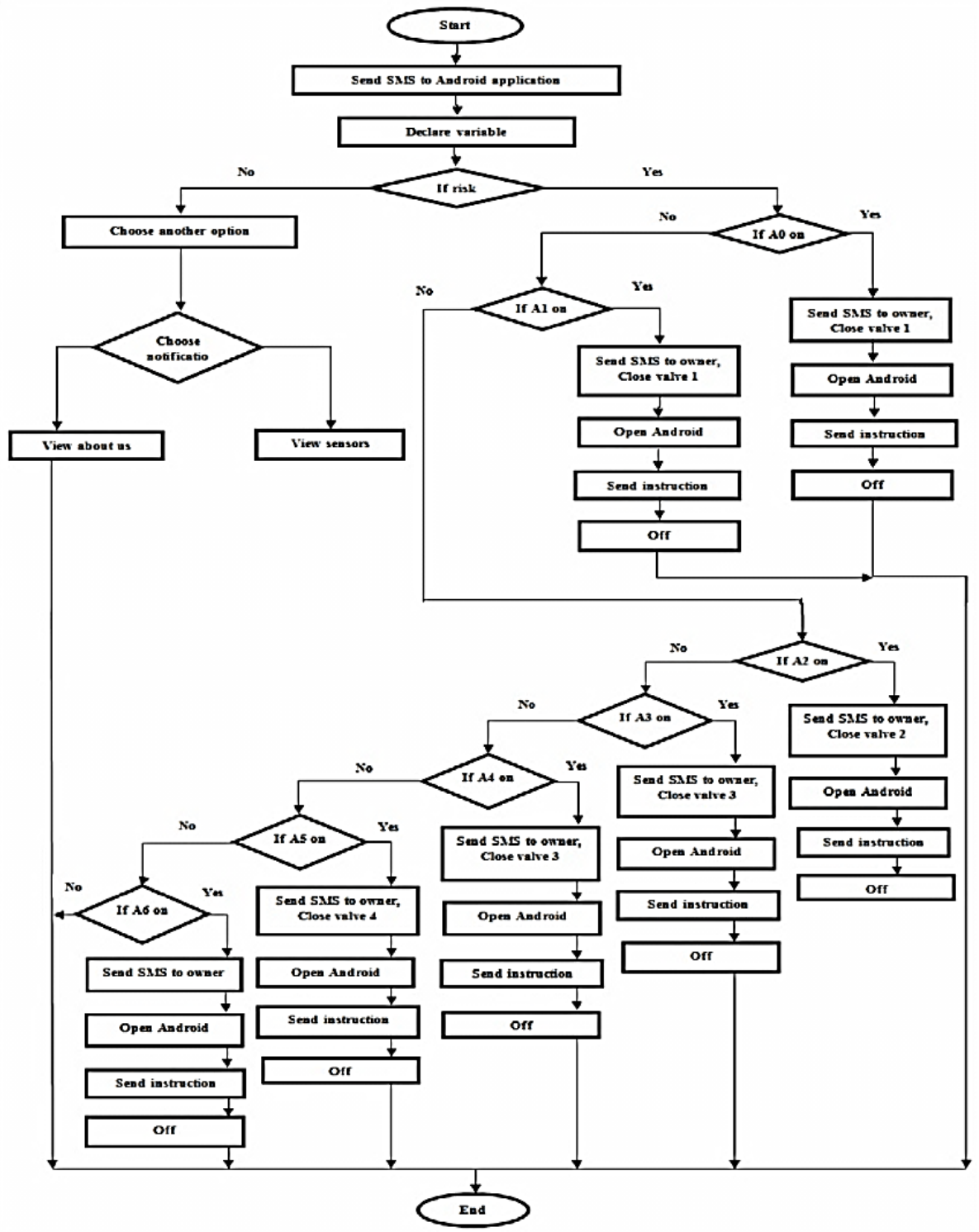

Fig. 2. Work of entire system.

3 | Proposed Work

The system is designed based on an Adriano mega2560 microcontroller which based on ATmega2560 micro-processor. In this paper, some of the basic concepts of circuits that are used in the system design are explained. The system contains water sensors to detect leakage and ultrasonic sensor to measure water level in tank [14]. The sensors collect information and the system is controlled by the mega Arduino, the controller decides the risk and sends SMS to the owner using a GSM module, according to the sensors information. The system also consists of two parts: the first is the alarm, if there is one of the risk the system sends SMS using GSM it also decreases the risk by opening the water solenoid valves in case of leakage [15]. The second part is controlling using Android application. The application controls the pump and turns on if there is low water level in tank. Tank water level monitoring is used to avoid overflowing

and under flowing level of water in the tank. Water controlling system implementation makes potential significance in home applications. The existing automated method of level detection is described and that can be used to make a device on/off [16]. Moreover, the common method of level control for home appliance is simply to start the feed pump at a low level and allow it to run until a higher water level is reached in the water tank [17]. This is not properly supported for adequate controlling system. Besides this, liquid level control systems are widely used for monitoring of liquid levels, reservoirs, silos, and dams etc.

Using Arduino and sensors setup I think no need of calculation's we need a code program so that where the sensors can send ultra-sonic waves and detect the damaged part.

But, using locating leaks using time difference, we can need the calculations i.e:

$$\Delta t = t_1 - t\_2, \quad (1)$$

where t is time.

$$t_1 = x/v_1, \quad (2)$$

$$x: 0 \leq x \leq L_1, \quad (3)$$

where x is length up to the damaged part and L1 is length of the pipe1.

$$\Delta t = (2x - L1)/v1 - L2/v2. \quad (4)$$

L2 is the length of Pipe 2.

These are some of the calculations needed to detect the leak.

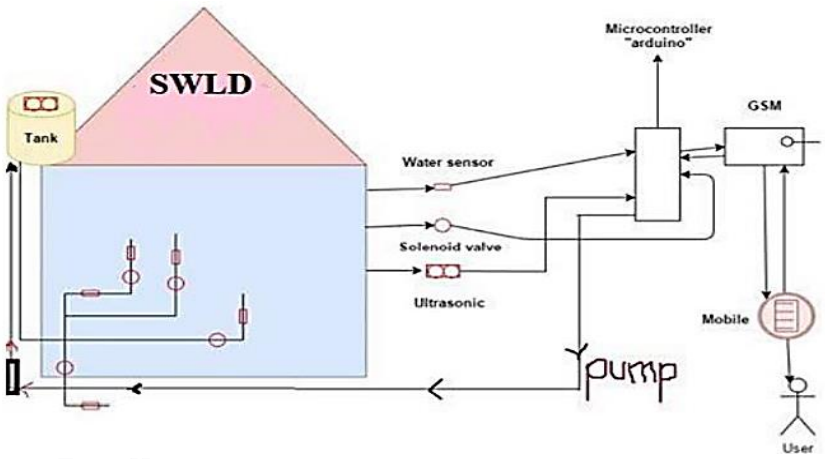

Fig.3. Hard ware setup for an example for leak detection system.

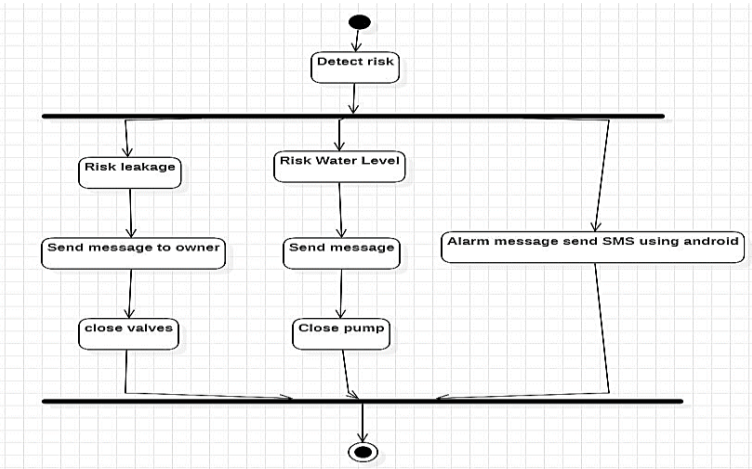

Fig.4. Activity diagram of SWLD.

4 | Result and Discussion

The graph describes how will be the response of the solenoid valve when leakage occurred in pipes and hoses of the plumbing in the home. The selected value that we use to the leakage sensor is 80 mL (microliter); that means when the water leakage sensor detects 80 ml and above, the controller will activate the solenoid valve that means the solenoid will be closed which will result stop supplying water to the track where the leakage occurred.

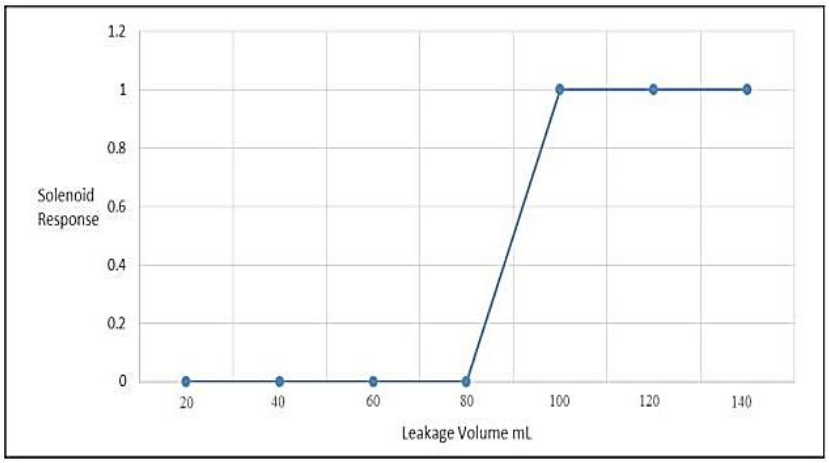

Fig 5. Valve response due to leakage volume.

5 | Conclusion

The proposed systems are tested on the model of SWLD. This system feature is expected to draw much attention in the next decades. Water is one of the most important basic needs for all the things in our life. But, unfortunately a huge amount of water is being wasted by uncontrolled use and uncontrolled leakages. The main issue that is being addressed in this system is about using an efficient wireless sensor based on water monitoring system. Two different ways to monitor the water such as water level monitoring and water pipeline leakage monitoring. Finally, the water monitoring system of homes, offices, industries research concept will be completed by using wireless sensor technology. By using the monitoring system, we can easily prevent the water and the water will be saving to our generation. In our system we mainly depend on technical method which deals with control and features and effective methods for monitoring the plumbing at homes. Based on microcontroller Arduino mega2560 and GSM technology we achieved the main general purpose of this system topic idea which is water leakage detection and wireless control of the water pump. Using GSM technology makes the work more efficient and ease the data translating. Firstly, this make the home owner able to be notified when leakage occurred directly, also the solenoid valves will be closed directly. Secondly, using GSM which deals with mobile allows the home owner to control the water pump whenever the water level is decreased in the tank which will be supplied from the main municipality supply using the pump.

Reference

[1] Mohapatra, H., & Rath, A. K. (2020). Fault-tolerant mechanism for wireless sensor network. *IET wireless sensor systems*, *10*(1), 23-30.

[2] Mohapatra, H., & Rath, A. K. (2019). Fault tolerance in WSN through PE-LEACH protocol. *IET wireless sensor systems*, *9*(6), 358-365.

[3] Mohapatra, H., & Rath, A. K. (2019). Detection and avoidance of water loss through municipality taps in India by using smart taps and ICT. *IET wireless sensor systems*, *9*(6), 447-457.

[4] Mohapatra, H., & Rath, A. K. (2020). Survey on fault tolerance-based clustering evolution in WSN. *IET networks*, *9*(4), 145-155.

[5] Mohapatra, H., & Rath, A. K. (2021). Fault tolerance in WSN through uniform load distribution function. *International journal of sensors wireless communications and control*, *11*(4), 385-394.

[6] Mohapatra, H., & Rath, A. K. (2020, October). Nub less sensor based smart water tap for preventing water loss at public stand posts. *2020 IEEE microwave theory and techniques in wireless communications (MTTW)* (Vol. 1, pp. 145-150). IEEE.

[7] Mohapatra, H., & Rath, A. K. (2022). IoE based framework for smart agriculture. *Journal of ambient intelligence and humanized computing*, *13*(1), 407-424.

[8] Mohapatra, H., & Rath, A. K. (2021). A fault tolerant routing scheme for advanced metering infrastructure: an approach towards smart grid. *Cluster computing*, *24*(3), 2193-2211.

[9] Mohapatra, H., & Rath, A. K. (2021). An IoT based efficient multi-objective real-time smart parking system. *International journal of sensor networks*, *37*(4), 219-232.

[10] Mohapatra, H., & Rath, A. K. (2019). Fault tolerance through energy balanced cluster formation (EBCF) in WSN. In *Smart innovations in communication and computational sciences* (pp. 313-321). Springer, Singapore.

[11] Panda, H., Mohapatra, H., & Rath, A. K. (2020). WSN-based water channelization: an approach of smart water. In *Smart cities—opportunities and challenges* (pp. 157-166). Springer, Singapore.

[12] Mohapatra, H., & Rath, A. K. (2020). IoT-based smart water. *IoT technologies in smart cities: from sensors to big data, security and trust*, 63-82.

[13] Mohapatra, H. (2021, September). Socio-technical challenges in the implementation of smart city. *2021 international conference on innovation and intelligence for informatics, computing, and technologies (3ICT)* (pp. 57-62). IEEE.

[14] Mohapatra, H. (2020). Offline drone instrumentalized ambulance for emergency situations. *IAES international journal of robotics and automation*, *9*(4), 251-255.

[15] Mohapatra, H., & Rath, A. K. (2020). *Fundamentals of software engineering: designed to provide an insight into the software engineering concepts*. BPB Publications.

[16] Mohapatra, H. (2021). *Designing of fault tolerant models for wireless sensor network* (Doctoral Dissertation, Veer Surendra Sai University of Technology). http://hdl.handle.net/10603/333160

[17] Mohapatra, H., & Rath, A. K. (2020). Social distancing alarming through proximity sensors for COVID-19. *Easy chair*, *18*. https://wvvw.easychair.org/publications/preprint_download/dMGk

[18] Mohapatra. H. (2021). *Smart city with wireless sensor network*. KDP.

[19] Mohapatra, H. (2018). *C Programming: practice.cpp*. Independently Publisher.

[20] Mohapatra, H., & Rath, A. K. (2020). *Smart bike wheel lock for public parking*. Application Number.

[21] Mohapatra, H., & Rath, A. K. (2020). *Advancing generation Z employability through new forms of learning: quality assurance and recognition of alternative credentials*. DOI: 10.13140/RG.2.2.33463.06560

[22] Mohapatra, H. (2009). *HCR using neural network* (PhD Dessertion, Biju Patnaik University of Technology). https://www.academia.edu/29846341/HCR_English_using_Neural_Network

[23] Mohapatra, H. (2019). *Ground level survey on sambalpur in the perspective of smart water* (No. 1918). https://easychair.org/publications/preprint/CWpb