Water usage audit of household

N. Bhuvaneswari [1], *Manoj kumar S* [2], *K N Kashyap* [3], *Mohammad Ibrahim* [4], *Punith kumar N* [5], *Jayanth S* [6]

[1] *Assistant Professor,Dept.of Electronics And Communication Engineering,Sri Sairam College Of Engineering,Karnataka,India*

[2] *Student,Dept.of Electronics And Communication Engineering,Sri Sairam College Of Engineering,Karnataka,India*

[3] *Student,Dept.of Electronics And Communication Engineering,Sri Sairam College Of Engineering,Karnataka,India*

[4] *Student,Dept.of Electronics And Communication Engineering,Sri Sairam College Of Engineering,Karnataka,India*

[5] *Student,Dept.of Electronics And Communication Engineering,Sri Sairam College Of Engineering,Karnataka,India*

[6] *Student,Dept.of Electronics And Communication Engineering,Sri Sairam College Of Engineering,Karnataka,India*

Abstract- *Water has long been the basic forgotten utility. It is inexpensive. Water use audits trace water from its point of entry into the facility through its discharge into a sewer .* ***The purpose of a water audit is to accurately determine the amount of unaccounted water loss in a water distribution system. effective leak detection and location mechanism, development of auditing software ,an web based mobile application,*** *stop the water supply whenever the flow rate exceed a predefined limit. use of ultrasonic waves along with the strain based sensor to determine the water leak .use of wavelet transform and leak location formula to locate the exact location of the leak point in the pipe line. It is proposed to employ a Internet of things for wireless communication so that the information can be passed to many responsible officers cell phone for immediate action.*

Key words: strain based sensor, wavelet transform ,ultrasonic waves.

1.INTRODUCTION:

Hydro-informatics emerged in 1991 when numerical modeling of water expanded its range from one that was restricted to the modeling of flows to a much wider ranging sociotechnical discipline that supports stakeholders in addressing their water-related problems. Water-related problems are ranked as some of the greatest problems facing mankind in the present century. It has become evident that the world's availability of water is reduced due to excessive consumption, contamination of aquifers, inadequate waste management, lack of proper water collection and distribution technologies, and excessive farming. There are numerous reports that over 1 billion people in developing countries lack access to safe drinking water and almost 3 billion have no access to adequate sanitation facilities. Hydro-informatics[1] offers a considerable opportunity to address some of these water-related issues in a way that it can meaningfully provide integration between data, models and decision support. the purpose of hydro informatics is to transform the corresponding social environment from a reactive one.

The purpose of hydro informatics[2] is to transform the corresponding social environment from a reactive one. Therefore, the primary role of hydro informatics now-a-days is in the development and installation of sociotechnical arrangements that can truly enable the right balance between quantities (i.e., measurable substance, matter, structure) and qualities (i.e., patterns, dependencies, interrelationships, contexts, perceptions, subjective experiences, etc.) and apply them meaningfully in our research and practice.

The future of hydro informatics is directed at supporting and indeed enabling holistic analysis, design, installation and development of on-line and real-time construction, operation and management of water systems that will be highly adaptive to changing conditions. The approach that is envisioned here is then incremental, sequential, reflexive and evolutionary.

1.1. TECHNOLOGY:

Water from the dam is supplied to the regional tanks after the confirmation that the supply line is crack free, depending upon the availability of the water and demand for supply. This will be monitored by audit software. From the regional tanks, water is supplied on the crack free pipeline to the residence with certain prescribed volume equally to all houses in the particular area. After reaching the prescribed limit the resident gets a notification about crossing the prescribed limit. If the resident requires excess water than the prescribed limit, he can contact the regional water distribution authority through the mobile application in which he can pay the amount for the quantity of water needed. The mobile application used by the resident is linked to the water audit software which in turn notifies the higher authority.

A hardware-based technique which uses ultrasonic wave's emission is used for pipeline inspection. Ultrasonic waves[8] are allowed to propagate in the pipe walls and reflected signal from leakage will be used for pipe analysis. Several Pipes with various dimensions and characteristics are modeled by finite element method with the help of ANSYS. Second order longitudinal modes of ultrasonic waves are emitted in the pipeline walls. For this purpose, the excited frequency is calculated such that it excites the second order longitude mode. In order to investigate the behavior of emitted wave in contact with leakage, sensors are used in the outer surface of the pipe. Waves are reflected when encountering leakage and the leak location is recognized knowing the wave emission speed and flight time of backscattered signals. The wavelet transform is used for processing these signals and recognizing leak location. The wavelet transform[7] method is used to find the sharp transition in the FGB trace corresponding to the movement of the negative pressure wave passes through the FBG sensor.

The ultrasonic waves of frequencies ranging from 25khz-75khz are generated from the transducer includes a piezoelectric crystal that converts electrical energy into mechanical energy i.e., sound waves. The pipeline is fitted with PGB sensors (the distance between each sensor is approximately less than or equal to 10km). The ultrasonic waves are transmitted through a pipeline, while traveling when the waves encounter crack/minute pores a negative pressure wave is generated at the point of crack these negative pressure waves can travel both back and forth. In this proposal, the magnitude of negative pressure waves is measured by FBG sensor.

2.PRINCIPLE OF NEGATIVE PRESSURE WAVE AND LEAK LOCATION FORMULA:

When leaks develop in a water pipeline, the water density near the leaking point will decrease rapidly. This results in a negative pressure wave, which passes through the pipeline from the leak point. Pressure sensors installed can collect such negative pressure wave signals. According to the time difference for detected signals and propagation velocity in the water medium, the exact position of the leakage can be calculated.

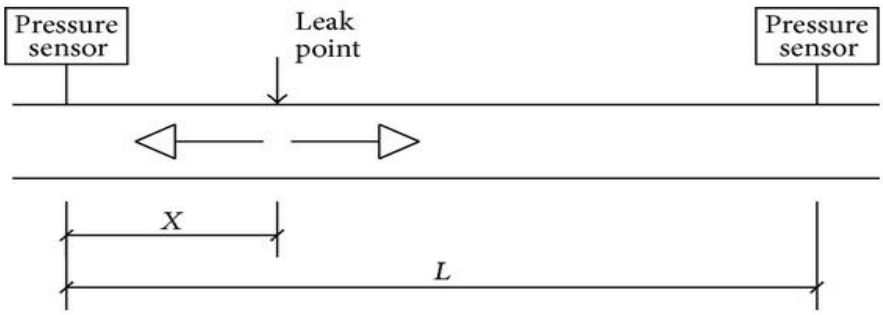

fig.1.Schematic of negative pressure wave propagation

Assume that the distance between two sensors is L, the propagation velocity of negative pressure wave in the pipeline is v, the distance between the leak point and upstream sensor is x, the times when the wave is detected by the two sensors are t1,t2, and the velocity of water in the pipeline is u.

As the pipeline diameter and water transportation velocity increase, the velocity of water cannot be ignored compared with that of the negative pressure wave. With the velocity of water taken into consideration in our study, the relations between the length and time variables can be developed as follows:

$$t1=\frac{x}{(v-u)}$$

$$t2=\frac{L-x}{(v+u)}$$

$$\Delta t=t1-t2$$

The time difference Δt=t1-t2, and the distance between the two sensors known we can calculate the exact location of the crack with ±4% accuracy using the formula.

$$x=\frac{1}{2v}\left[L(v-u)+\Delta t\left(v^2-u^2\right)\right].$$

This is the Traditional Leak Location Formula.

The traditional formula takes propagation velocity of the negative pressure wave, and the velocity of water in the pipeline into account and consider that they both are constants.

2.1. FIBER BRAGG GRATING (FBG SENSORS):

This sensor offers a number of advantages over traditional sensor, including immunity to electromagnetic interference, being light weight and durable, having small size, incorporating multiplexing capabilities, and is easy to install. Due to the above attractive application features, FBG sensors have been playing an increasingly important role in the sensing community. And have been vastly used in damage detection, aviation, and other fields .

2.2. Principle of FBG strain based sensor:

FBG based strain sensors are wrapped around the wall of a pipeline, as shown below. A change in pressure within the pipeline leads to its expansion or contraction with the hoop (circumferential) strain of the pipeline changing accordingly. The FBG strain sensors detect pressure variations within the pipe by sensing the hoop strain. The hoop strain within a pipeline system can be expressed as

$$\varepsilon_y=\frac{\sigma_y-v\sigma_z}{E}$$

Where ε_y is the pipeline hoop strain, v is the pipeline Poisson ratio, σ_y is the pipeline hoop stress, σ_z is the pipeline axial stress, and E is the pipeline elasticity modulus.

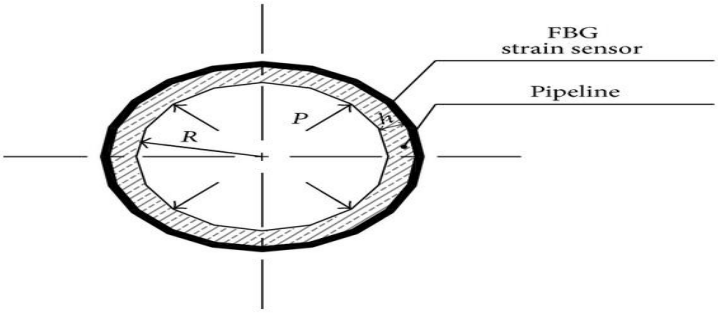

fig.2 Schematic of a FBG based strain sensor as installed on a pipeline

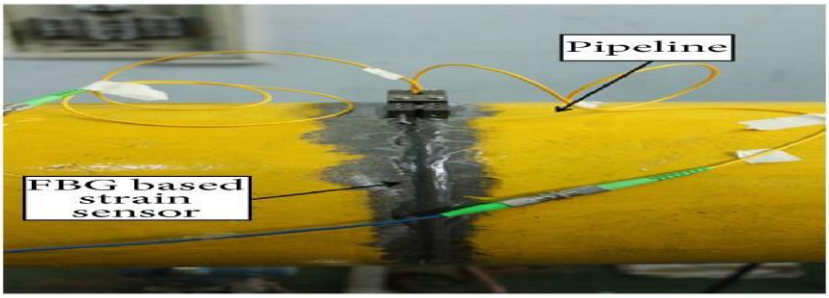

fig.3 Pipeline with FBG based sensors

2.3. Identifying the pressure drop points using wavelet transform:

Definition of wavelet transform:

The wavelet transform method is used to find the sharp changes in the FGB trace, in accordance to the movement of the negative pressure wave which passes through the FBG sensor location. This method is used because it can scale up the signal to find the sharp transition.

The definition of wavelet transform for a function x(t) is given in:

$$WT_x(a,b) = \int x(t)\,\psi^{*}\frac{[(t-b)/a]}{\sqrt{a}}\,dt$$

$$= \int x(t)\,\psi^{*}_{a,b}(t)\,dt = \left\langle x(t), \psi_{a,b}(t)\right\rangle$$

In this equation a, b and c are continuous variables, which is also the reason the above equation is called the continuous wavelet transform.

2.4.The application of wavelet transform and positioning results:

The maximum value of magnitude of wavelet transform on all possible transform scales correspond to the positions where the signals have sharp transition are obtained. So the singularity can be obtained by finding the maximum value of wavelet transform. Further, the wavelet transform modulus of real singularity is almost fixed value on all scales. In contrast, the modulus of faked singularities is inversely proportional to the scale. Consequently, it is easy to find the real singularity with the help of this property. However, the detection of singularity is more accurate on a small scale, but this process is likely to be affected by noise, due to this noise the faked singularity may appear. On the other hand, in the large scale, although noise has little influence on the detection, the variation between the real singularity and the detective one is large. Since practical pressure signals are mixed with noise even after filtering, it is beneficial to consider multi-scale transforms to find the real singularity. The following procedure is used to determine the location of singularities. Firstly, the approximate range wherein the singularity was located was determined by large scales. Secondly, the real singularity is located within this range by taking help of the small scales.

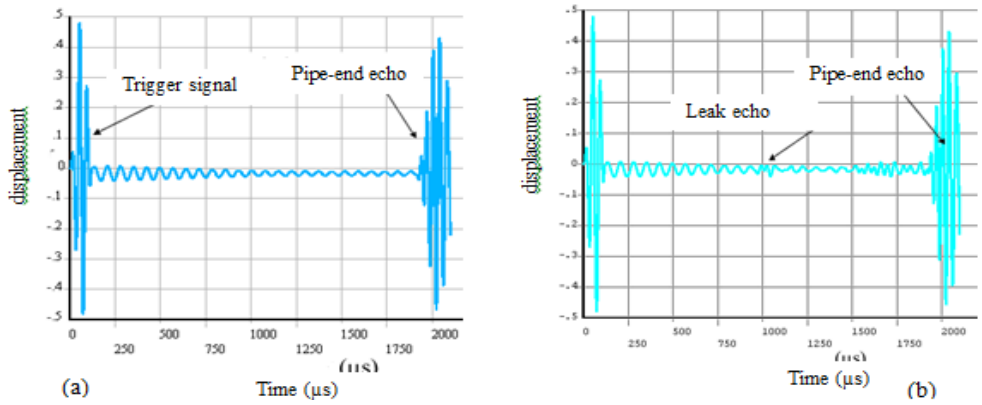

fig.4 Received Signal: a) No Leak b)With Leak

3.MECHANISM OF WATER AUDIT SYSTEM

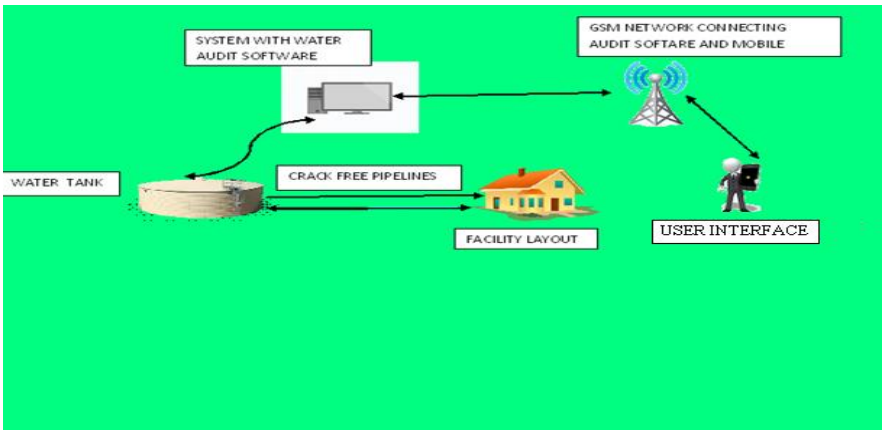

Table 1:

WATER AUDIT FORM:

Facility Name:XXX

Part 1:Water Meter Readings:

Meter Read Date & Time:	Meter Value:	Water Consumption for Period:
15 MARCH 2017	123456 GALLONS	**123456789 GALLONS**

4.DEPENDENCIES:

Project proposal mainly depends on

4.1. GSM Modem :

In this system collection of water meter readings will be done by GSM network by using SMS facility provided by GSM Technology .Amount of water usage by user will be transmitted by the GSM modem at customer side by sending just a SMS. This SMS will be received at the office end GSM modem. Hence no manual labour is required , reading collection work is done automatically by GSM network which is already installed no need to make any special arrangement in GSM .

4.2. Billing Unit :

Data of reading will be given to PC for billing purpose by GSM modem through DB9 connector. For billing we will be using GUI based on VB . In it total bill based on tariff ,taxes, discount will be displayed . We can print the same bill for circulation or may send E-mail or SMS.

4.3.INTERNET OF THINGS:

The Internet of Things is creating a whole new digital agenda for Water. To Control water leakage and for effective management we require a new model that brings IT innovation to the Water Distribution System. A model that integrates information, data, people, and processes across water supply chain. That keeps processes and product flowing. Keeps people safe and out of harm's way. Scales resources. And secures your networks and equipment.

4.4.GPS TRACKER:

An intelligent integrated GPS device. The web-based software acts as the middleware (similar to how an operating system allows us to effectively use a computer), provides the gps way visibility to the operating center. It uses readers and antennas that communicates wirelessly with the Tracker enabling Software to track the direction in which water is moving.

4.5. SOFTWARE TOOLS:

Keil compiler is software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. Keil compiler also supports C language code. Hex code has to be dumped into the microcontroller placed in the programmer kit.

5 .CONCLUSION:

India is supposed to be one of the progressive Industrialized , Digitalized and Urbanized Country. Due to lack of water distribution management and audit system there is huge scarcity and leakage of water , Water audit is felt need of water sector. Since water audit can bring in accountability and transparency. Water audit system contain amount of water made available at source. Amount of water utilized both through metered & unmetered supplies. Water loss along with the reasons. Suggested measures to check water loss & improve efficiency. A proposal for detection of leak in distribution system. Data of type of connections metered[9], unmetered. Number of illegal connections and strategies to seal them. Cost-benefit study for optimum recovery of water loss. Water audit report.

REFERENCES:

1. Abbott, M. B. & Anh, L. H. (2004) Appling mass-customised advice-serving systems to water-related problems in ‘firstworld’
societies. In: *Proc. Sixth Int. Conf. on Hydroinformatics* (ed. by S.-Y. Liong, K.-K. Phoon & V. Babovic), 553–559, World Scientific, Singapore.

2. Hu, T. S., Lam, K. C. & Ng, S. T. (2001) River flow time series prediction with a range-dependent neural network. *Hydrol. Sci. J.* **46**(5), 729–745.

3. Richard J. Greene, John R. Yates and Eann A. Patterson, "Crack detection in pipeline using infrared methods", Opt. Eng. 46, 051013, May 2007.

4. Gijsbers, (2004), in Proceedings of the 6th International Conference on Hydroinformatics, Liong, Phoon and Babović (Eds.), World Scientific Publishing Company, Singapore, 1819-1826.

5. Most optics texts should have the Debye-Sears effect; all optics texts will discuss diffraction: Born, M. and Wolf, E., ``Principles of Optics'', Cambridge University Press 7th (expanded) edition 1999. Chapter XII, p. 674-694.

6. Seyoum, S.; Vojinovic, Z.; Price, R.K. Urban pluvial flood modeling: Development and application. In Proceedings of the 9th International Conference on Hydroinformatics, Tianjin, China, 7–10 September 2010.

7. Zhou, Y.Q. and Wang, Z.H. (2006), "Numerical simulation of crack detection in pipes using ultrasonic longitudinal guided-wave," *Journal of North University of China (Nature Science Edition)*, **27**(3), 260-269.

8. Hong, X.U., Wang, B. and Jiang, X.J. (2009), "Numerical simulation on pipe defect detection using ultrasonic guided waves," *Journal of Power Engineering*, **29**(11), 1019-1022.

9. Roy McKenzie and Brian Houston "Implementing Automatic Meter Reading for Water: A Reflective Approach to Weighing Options" FLORIDAWATER RESOURCES JOURNAL AUGUST 2011

BIOGRAPHIES

The author N.Bhuvaneswari is working as a Assistant Professor in the Department of Electronics And Communication Engineering ,she has passionate about Sensor networks, Embedded systems, and she has published Various research papers and she is Interested in Research activities.

The author Manoj Kumar S, student Department of Electronics And Communication Engineering, passionate about networks, Electronics and he has published two research papers and one survey paper. Interested in Research activities.

The author K N Kashyap is a student Department of Electronics And Communication Engineering, passionate about networks, Electronics and he has published two research papers ,and one survey paper. Interested in Research activities.

The author Mohammad Ibrahim is a student Department of Electronics And Communication Engineering, passionate about networks, Electronics he has presented and published two research papers ,and one survey paper. Interested in Research activities.