ISSN No:-2456-2165

Automatic Leakage Detection of Gas Pipeline using Wireless Network in Oil and Gas Industry

Ikram
Assistant Professor – EIE
Bannari Amman Institute of Technology
Sathyamangalam, Erode, India

K. Shanmuga Priyan
U.G Scholar Department Ofeie
Bannari Amman Institute of Technology
Sathyamangalam, Erode, India

S. Siva Shanker
U.G Scholar Department of EIE
Bannari Amman Institute of Technology Sathyamangalam, Erode, India

N. Akil Raj
U.G Scholar Department of EIE
Bannari Amman Institute of Technology Sathyamangalam, Erode, India

Abstract:- Wireless sensor networks have extensively been used for placing the nodes in a linear topology, constituting a special class of networks called linear sensor networks. In a densely deployed linear network case, issues related to optimal resource allocation and networking may persist because the standard sensor network protocols attempt to manage the network as a mesh or ad hoc infrastructure. Pipeline transportation of fluid is controlled by many laws to avoid failure and therefore serious disasters. This paper presents a cost optimum solution to small leaks in pipelines through the use of an array of piezoelectric film sensors embedded in a mobile robot. From time to time, the new robot is passed through the pipeline to detect small leakage precisely before detrimental corrosion and then major failure occurs. This paper presents a cost optimum solution to small leaks in pipelines through the use of an array of piezoelectric film sensors embedded in a mobile robot. It's common in the industry to use an automatic system, which is installed at all joints along the pipeline, to detect a large leak and send its location wirelessly to the main controller. Main aim of this project is to improve efficiency of the system and provide additional features.

Keywords:- Index Terms leakage detection, overflow, microcontroller, CO_2 sensor, gates, gas leakage.

I. INTRODUCTION

Fluid transportation from field of production to end of use through pipelines encompasses in many cases carrying of toxic and hazardous fluid. This brings up the need for a 24/7 online monitoring system that continuously checks for fluid leakage. This paper presents an internally based pipeline leak detection system in accordance with the API (American Petroleum Institute) guidelines. The system starts by segmenting the pipeline where at each joint there exist a self-chargeable controller attached to a flow meter and an electromechanical valve. The segmentation of the pipeline in such a manner permits the prevention of huge leakage scenarios caused by major failures or by sabotage during armed conflicts or wars. It's common in the industry to use a system that monitors the difference between flow sensors at consecutive joints in order to detect leakage through a daisy chained wireless system that could send the leakage segment location to the main monitor. Upon the detection of a leak, the system closes the valves at the inlet and the outlet of the damaged pipeline segment, and the main monitor will also shut down the fluid pumps. However, the differential flow measurement is not sufficient for detecting small leakages due to the huge difference between the flow rate of the fluid inside the pipe and the small leakage itself. For this reason, this paper discusses the use of one or more mobile robots equipped with an array of piezoelectric film sensors. The robots will move back and forth along the pipeline in order to detect small seepages. The necessary power to operate these mobile robots will be generated from the fluid flow utilizing a small turbine. Advances in wireless communication protocols and embedded design have led to the emergence of low powered miniature-sized multifunctional sensor nodes for wireless sensor networks(WSNs) operating in fields ranging from battlefield and environment monitoring to health and entertainment. The sensor nodes are capable of detecting environment parameters within the sensing range and routing data over multi-loop to nodes within its communication range. Sensor nodes usually work in collaboration to monitor in accessible areas. WSN coverage requirements may allow uniform node layout or necessitate denser deployment for higher surveillance. Mostly, the cover-age requirement can be approximated with a finite set of points for regular structures. After deployment, the network reliability depends upon several parameters including connectivity. Data routing delay, and sensor event detection accuracy. WSN deployment involves several decision parameters, e.g., the number of sensor nodes deployed and the sensing rate for the node failure tobe easily detected, while nodes activity lasting for longer periods. Node deployment location and internode distances also insufficient energy usage. Data exchange frequency needs to be wisely scheduled to improve network lifetime by even distribution of energy load. Network lifetime is defined as the time period until all active sensor nodes fail to provide connectivity or are exhausted. Monitoring of oil and gas pipeline similar to bridges and tunnels not only proves

ISSN No:-2456-2165

challenging due to extensive linear span but also due to critical fluid condition sensing requirements.

II. LITERATURE SURVEY

Failure of pipeline leak detection can lead to many losses. Firstly, it can cause loss of life in population in the region of fluid lines. Secondly, the environment will be affected negatively and a clean-up cost will be incurred on top of direct loss of product. The majority of systems that have been developed up to this date still don't fulfil one or more of the following requirements: sensitivity (detect small leaks quickly), reliability (not generate false alarms), accuracy (in locating leaks) and robustness (as to operate in tough environments with little maintenance over long periods). Numerous studies have been conducted and some are still in progress to investigate new state-of-the-art technologies that could improve pipeline leak detection. The objective is to detect a daily discharge equal to not more than one percent of daily throughput. Technologies range from Flow Meter based technology to Acoustic Detection of the rarefaction pressure wave, Volume Balance Technique, Mass Balance and Flow Balance Techniques. In addition, non-meter-based methods like Fibber Optic techniques and Double-Wall pipe are also known pipeline leak detection technologies. However, some traditional leak detection systems that are even high in cost operate at relatively low limits of operating pressure and temperature ranges. Outside those limits, failure to detect leakage is not uncommon, certainly in cases of small leaks.

III. PROPOSED SYSTEM

A. Pipe Leakage

An experiment was conducted using a 50.8 mm pipe in diameter and a hole of 5 mm was excavated on its wall. A CFD analysis was investigated to study the pressure and velocity profiles of the flow inside the pipe, particularly around the hole.

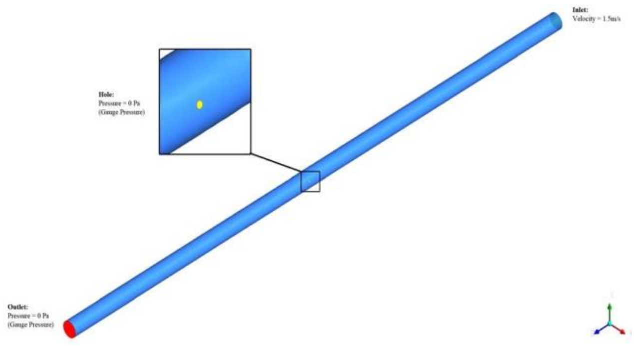

Fig. 1:- Boundary Conditions of the CFD simulation

IV. SIMPLIMOTE PLATFORM DESIGN

SimpliMote includes support for a number of peripheral connections including pressure and temperature sensors. The pipeline fluid data and events like leakage and movement detection are sent using ZigBee interface. An LCD interface provides user interaction with SimpliMote. The device also includes an accelerometer. Simlimote's power source is a rechargeable battery. The device is compatible with industrial temperature range (−40 to 85 °C) excluding the LCD display. Simplot houses a powerful ARM-based microcontroller (MCU) in order to provide support for scalar and multimedia data to which integrated circuits and interfaces are connected through various protocols [see Fig 2]. Simplot designs as well as the algorithms that run over it are made energy efficient to prolong the device runtime. Integrating devices with shut-down mode are chosen to conserve energy whenever possible.

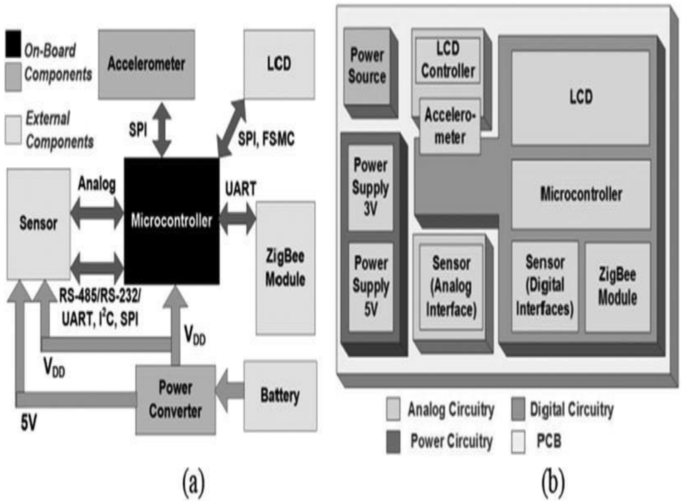

Fig. 2:- Simplot. (a) Scheme. (b) Implementation

V. MAIN PROCESS FLOW

The main process at each node starts by checking whether the node is a coordinator or router. In case of coordinator, the networking process defined in is initiated by the coordinator. Once networking process gets completed, coordinator initiates the periodic data packet by adding its periodic data and forwarding it as a unicast to the next node according to its routing algorithm after the periodic time interval. The routers, receiving the data packet from their backward nodes, forward the packet to their next node with their own periodic data appended in it. The main process at the node will be interrupted whenever fluid leakage or node movement is detected at the node due to data's high priority. The leakage and movement packets will be sent to the base station on priority according to the algorithms discussed in.

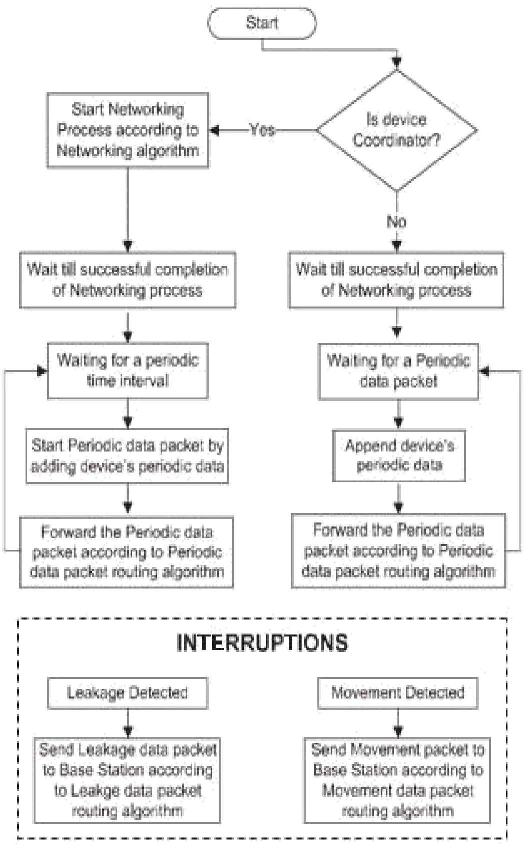

Fig 3:- Process Flow

VI. CONCLUSION

In conclusion, the simulation results demonstrate that the hole had a very minimal but noticeable effect on the flow pattern near the hole (both in velocity and pressure contours). This was caused by the high inertia of the flow. Moreover, Reynold number of the flow was estimated around 75000, implying an inviscid flow, which in turn means that Bernoulli equation can be applied on the hole.

Total pressure = Static Pressure + Dynamic Pressure

0.016 Newton force is estimated to be more than sufficient to stimulate the sensitive piezoelectric film sensor. As a future work, experiments on the system behaviour of both electrical and mechanical parts of the proposed system will be implemented encompassing elaborate simulations and testing. This work is still in its early stage.

Several WSN applications for oil and gas pipelines involve placing the nodes in a linear topology. The dense linear placement concerns issues related to optimal resource allocation and networking like recovering from non-connectivity holes and policies to establish a fast route for leakage data dissemination. To overcome these issues, in this paper, we proposed a LWSN deployment application for oil and gas pipeline using a custom sensor board named Simplot accompanied with algorithms to solve network creation, leak interrupt detection, and linear topology specific routing of high-priority messages with reliability. The novelty of the solution include method to effectively detect sensing events by removing the noise on custom nodes, routing the information while labelling it into different priorities and keeping the network alive at all times with provision of real-time remote monitoring. We compared system level performance of our solution with an Arduino-based Libelium Waspmote. Since Simplot is built around a more powerful microcontroller with open sensor peripherals, the embedded software can run complex algorithms more efficiently than a simple general-purpose sensor node. More importantly, the embedded application includes features including time synchronization and software interrupts necessary for handling smooth data flow and responding to critical situations. Results suggest that the proposed routing algorithms and leak detection approach is twice more energy preserving, reliable, and timely when implemented on mission intensive SimpliMote platform as compared to the generic Arduino node.

REFERENCES

[1] Shannon & Wilson, I. (Final Report March 2012). Pipeline Leak Detection Technology, 2011 Conference Report, Alaska Department of Environmental Conservation, Division of Spill Prevention and Response, Industry Preparedness Program. 555 Cordova Street, Anchorage, Alaska 99501.

[2] Inc., M. S. (n.d.). Piezo Film Sensors, Technical Manual. 950 Forge Avenue, Norristown, PA 19403, www.msiusa.com: Sensor Products Division.

[3] H. Mazumder, Q. CFD Analysis of Single and Multiphase Flow Characteristics in Elbow. Scientific Research, *Vol. 4, No. 4,* pp.210-214, 2012

[4] S. H. Yang, Wireless Sensor Networks. Principles, Design and Applications. New York, NY, USA: Springer, Oct. 2013.

[5] C. W. Chen and Y. Wang, "Chain-type wireless sensor network for monitoring long range infrastructures: Architecture and protocols," Int. J. Dis- trib. Sens. Netw., vol. 4, no. 4, pp. 287– 314, 2008.

[6] I. Jawhar, N. Mohamed, M. M. Mohamed, and J. Aziz, "A routing protocol and addressing scheme for oil, gas, and water pipeline monitoring using wireless sensor networks," in Proc. 5th IFIP Conf. Wireless Opt. Commun. Netw., May 2008, pp. 1–5.

[7] I. Jawhar and N. Mohamed, "A hierarchical and topological classification of linear sensor networks," in Proc. IEEE Symp.