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SMART AND SUSTAINABLE WATER MANAGEMENT NETWORK SYSTEM FOR BURIED PIPELINES BY USING IOT HUBS IN SMART CITIES

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Abstract
In Sultanate of Oman the majorities of population is from capital city and are expected to increase in future due to smart city development. With this increasing population and smart life style the utilization of water resources are also in increasing phase. At the same time managing water resources infrastructure and its pipeline network in the cities has become a major concern due to leakage in water pipeline network which interrupts the water supply in the cities. Pipeline network plays a major role in transporting water resources to the entire city. At present the buried pipelines are monitored at key points using manual process by involving more manpower resources. In order to monitor the buried pipeline network remotely, this research study gives an innovative attempt by implementing Underground Wireless Sensor Networks (UWSN) and to monitor the entire buried pipeline network through Internet of Things (IOT).

Keywords: Internet of Things, Underground Wireless Sensor Networks, Pipeline Network, Smart City.

Introduction

The basic and most vital need of all living beings in this earth is water. Such a valuable water resources in Sultanate of Oman is in huge demand due to arid region by nature and the rainfall is also limited, every year the average rainfall in Oman is also getting very less. In order to conserve water and to protect water resources, since 1989, the government had implemented many laws and regulations as part of water protection and optimum utilization. At the same time, as part of smart city development in the country capital and due to industrial revolution and urbanization an increase in population at cities are facing the demand of water resources as part of their daily life and also it's increasing day by day.

The major water resources in the country is supplied from the conventional water resources and the other from non-conventional water resources in the form of pipeline network. While supplying the water through pipeline network it is in need to monitor and manage the buried pipeline network to avoid water leakage.

As part of the smart city development, managing the buried pipeline network has been an attractive research study for researchers in recent trends. This research study attempts an innovative technology based on Internet of Technology (IOT) using wireless sensors to monitor the buried pipeline networks in real-time environment for protecting water leakage.

The Significance of the Study

In line with the technological development and advances in digital technology, the main objective of this proposed research study is to design a system using IOT based Underground Wireless Sensor Networks to detect the leakage of water in the buried pipeline network in order to prevent wastage of water and to monitor the network remotely as part of smart infrastructures.

Review of Literature

Monitoring leakage in water pipelines and its negative impacts due to leakage is very significant to monitor in order to avoid to physical losses of water [1]. The traditional and physical monitoring system of water pipeline needs more manpower resources. In line with the technological development according to a world's leading

research and advisory company (Gartner.com), "8.4 billion things connected over IoT in use worldwide in 2017, which was increased to 31 percent comparing to 2016, and also it was expected to reach the level of around 20.4 billion connected things by 2020". But the concepts of IoT model based sensors are reported rarely in water pipeline related projects. In order to accommodate future services and to propose new communication architecture, which was identified as a gap in this project and gives an opportunity for implementing IoT based monitoring system for further development in this project [2].

Proposed System

When compared to ground surface wireless network, The transmission range in the form of Radio Frequency (RF) underground wireless network is significantly low in range due to buried surface, so the communication between the adjacent nodes is limited in distance which needs more sensors to be placed to cover the distance and it leads to an impact in the change in the topology of the buried network.

Communication System Components

The suitable sensor for the underground pipeline should be considered as non-offensive to the pipeline, low in power consumption and easy to implement. The main role of the underground sensors placed adjacent at a communication distance is to gather the surface data and transfer it to the master node. The components involved in this transmissions are Sensors, Power management, data gathering unit, processing unit, transmission unit comprises as Micro Controller Unit (MCU) and is responsible for the function of the sensor nodes. The main feature of this MCU is to consume ultra-low power during idle mode and low power during transmission mode which leads to increase the self-life of the battery.

System Design

The main factor in monitoring the water pipeline is to measure the internal water pressure of the pipeline, leakages can potentially alter the normal water pressure inside the pipeline and hence monitoring the water pressure can hypothetically help to identify the leakage. To monitor the water pressure we have introduce the Underground Wireless Sensor Networks. The concept of implementing Underground Wireless Sensor Networks based on maser nodes is to reduce the communication distance between adjacent sensors. In our proposed research work we have introduced a master node between adjacent communication sensors. The master node acts as an interface between the underground sensors and the internet cloud. The nearby sensors under the ground will communicate to the master node which is placed at a distance close to the communication sensors. The master node receives the signals from various nearby sensors and it forwards to the internet infrastructure communication network to the internet cloud in the form of real time data. The data stored in the cloud infrastructure is then accessed by number of end user devices with the help of internet cloud communication infrastructure as shown in the figure-1.

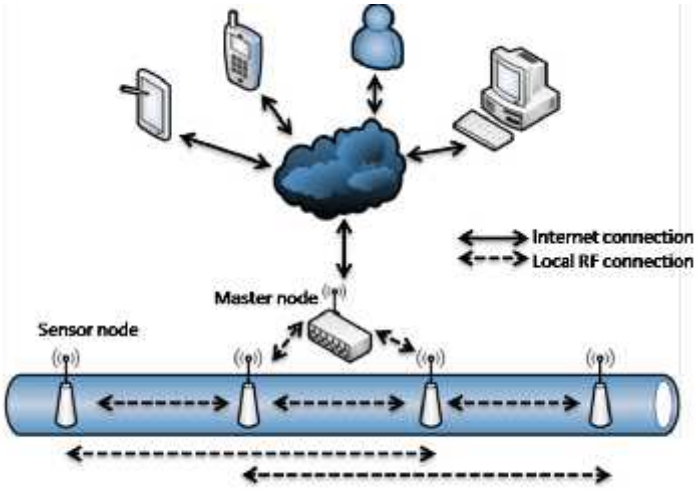

Figure-1: Implementing Master Node between underground sensors.

Results

The prototype of the design using the said block diagram was successfully deployed using the underground wireless sensor networks for monitoring the pipeline. The wireless sensors detects the pressure rate at constant intervals and sends to the master node which in turn it forwards the data to the internet cloud and it was accessed through end devices. Using this prototype model water leakage in the underground pipeline can be detected and monitored remotely.

Conclusion

As part of smart city development, maintaining the underground water pipeline network and identifying the leakage in the pipeline using smart sensor networks are feasible to manage with Internet of Things and also its easy to monitor continuously from anywhere in the country. Hope this research study gives an insight for further development as part of smart city projects to monitor the underground pipeline network.

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