IoT(Internet of Things)-based Underground Risk Assessment System Surrounding Water Pipes in Korea

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Abstract. IoT(Internet of Things) based underground risk assessment system surrounding water pipes enables an advanced monitoring and prediction for unexpected underground hazards such as abrupt road-side subsidence and urban sinkholes due to a leak in water pipes. For the development of successful assessment technology, the PSU(Pipe Safety Unit) is under development which detect the leakage and movement of water pipes. Then, the IoT-based underground risk assessment system surrounding water pipes will be proposed. The system consists of early detection tools for underground events and correspondence services, by analyzing leakage and movement data collected from PSU. These methods must be continuous and reliable, and cover certain block area ranging a few kilometers, for properly applying to regional water supply changes.

Keywords: water pipes, leakage, risk, assessment, subsidence, sinkhole

1 Introduction

A sinkhole is a hole or cavity in the ground that forms when water dissolves surface rock. In general, this surface rock is limestone, which is easily eroded by the...
groundwater flow. However, recent sinkholes are far from this reason. They occur with related to some artificial reasons such as careless construction for underground structures and damage or aging of underground pipelines. Recent sinkhole accidents occur due to less care during construction of underground structures such as regional water pipes, sewer line, subway tunnel and ground excavation for building construction. It means, as more underground construction undergoes, there is more chances that sinkholes open. About 40 cases of recent urban sinkholes were investigated that have occurred in South Korea since 1990’s, and found out that the number of accidents dramatically increased from 2010 in which underground construction works in urban areas has grown.

Sinkholes (road side subsidence) sometimes happen when construction goes wrong, or because of aging and leakage of underground pipes. For aged underground pipes, they must be replaced. Local government continues replacement project of aged pipelines annually, especially sewer lines. With related to construction, more tight monitoring for ground movement must go with during construction. If there is suspicious ground settlement, site manager should do closer investigation immediately, then make a change of construction process and reinforce the ground as soon as possible. For this, proper regulation must be made in order to mandate contractors to actively remove any ground hazard.

IoT(Internet of Things) based underground risk assessment system surrounding water pipes enables an advanced monitoring and prediction for unexpected underground hazards such as abrupt road-side subsidence and urban sinkholes(road side subsidence) due to a leak in water pipes

2 Development of PSU

PSU (Pipe Safety Unit) is a combination of leak detection sensor, gyroscope and accelerometer sensor unit. PSU can be a leak detection and location of the water supply pipe movement. PSU is divided into the sensor unit and the communication unit. The sensor unit of PSU composes of stainless steel material of the outer casing and the piezoelectric element, a gyroscope sensor, an accelerometer sensor and sensor controller which filters sound leakage and positional displacement information. Cable for connecting the sensor and the communication also is manufactured using a material of water-resistant. The sensor controller provides a function to filter the non-effective leak sound noise.

Fig.1. PSU installation diagram
3 Underground assessment system surrounding water pipes

Underground risk assessment system surrounding water pipes predicts the occurrence of subsidence caused by the leakage and movement of water pipes. It consists of PSU (leak detection, gyroscope and accelerometer sensor) and PSU management and analysis technology. An analytical algorithm for analyzing the signal of leak detection and displacement is under development. It can be interpreted as a change of the position of leak location and channel using the analysis techniques. <Figure 1> is a case study of the water pipe assessment system. With this system it is possible to monitor the problems of the water pipes. And the administrator might proceed the maintenance work.

![Fig. 2. Water pipe underground assessment system](image)

The assessment algorithm will be developed based on the field simulation of leakage tests for water supply pipe lines.

Possible sinkholes (road side subsidence) area is evaluated to more than allowable leak and where the position variation has occurred as determined by the simulation.

4 Conclusion

A technology for predicting sinkhole opening (road side subsidence) is under development. Final goal for the research program is to provide SRI (Sinkhole Risk Index) by monitoring tunnel, underground water pipes and sewer pipelines, and urban ground water flow. The research focuses on real-time underground monitoring based on IoT platform to build Big-Data, and then analyze the Big-Data to see the sinkhole hazard.
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References