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Manhole-cover Shaped Antenna Design for Underground Facilities Monitoring System

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Abstract

In this paper, system requirements to implement efficient underground IoT systems are overviewed, and novel manhole-cover shaped antenna is proposed. To verify its performance, the antenna prototype is designed for 900MHz-band operation, and it provides an omni-directional radiation pattern for reaching wide coverage.

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1. Introduction

In recent years, the internet of things (IoT) has shown rapid growth, and it dramatically changes our lives smarter than ever before. The IoT is based on a paradigm to inject all the physical devices into internet network infra structure. It means that we can easily get some data originated from the end devices, and generate more valuable information from post-processing procedure based on the huge amount of data. Recently, IoT services prevail in our daily lives in diverse area, such as smart home, home health, smart factory, and smart city. These services are mainly focused on how to improve convenience and guarantee more safety for all ^{1,2}.

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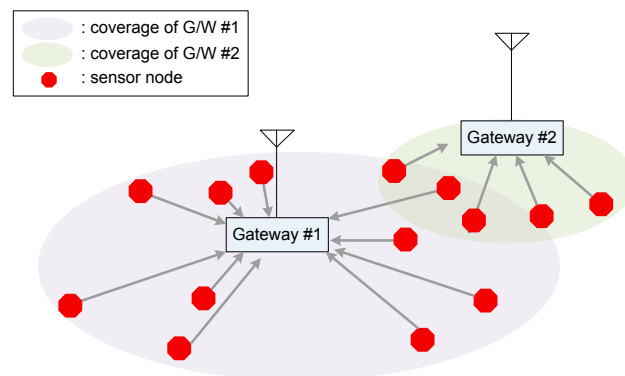
To achieve the concept of a smart IoT world, systematic convergence should be preceded by development in elementary technology, including wireless communications, platform, database, data processing algorithms, and so on. Among these research areas, we mainly focus on how to implement wireless communications system. Considering the system feature determines overall system costs, it is essential to carefully choose what type of wireless communication technology to be used.

In this paper, for efficient smart cities, overall system design and novel antenna design method for underground (UG)-IoT is presented. Section 2 deals with the comprehensive system analysis, particularly for underground facilities monitoring systems. Section 3 represents the newly proposed antenna design and measurement results, and Section 4 briefly gives a conclusion of this paper.

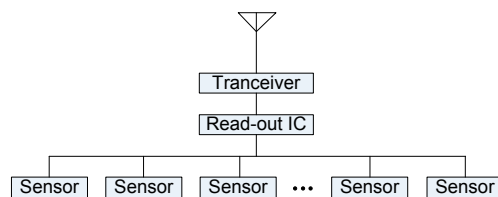
2. System Considerations for UG-IoT

Fig. 1(a) shows a general network topology for IoT sensor networks, composed of multiple sensor nodes and gateways. The system coverage determines how many sensor nodes each gateway can connect. Fig. 1(b) depicts a sensor node composition for sensor network. It consists of various sensors, read-out integrated circuits (IC), and RF transceivers. In the past few years, a variety of radio technology has shown for low power wide area (LPWA), including LoRaWAN, SigFox, Ingenu, LTE-M, and NB-IoT³. Compared to conventional wireless communications, it guarantees considerably long battery lifetime and wide coverage. It results that almost the on-the-ground physical devices are closely connected, and it contributes to rapid growth in IoT services development.

The sensor network can be classified into two categories corresponding to the location of data resource: an underground (UG)-IoT and above ground (AG)-IoT system. It means that UG-IoT system is based on underground sensors to gather data from all the underground things, such as humidity, temperature, and so on. According to the system category, the system designers should carefully determine how to distribute the composition blocks physically.



(a) network topology: sensor nodes and gateways



(b) composition of each sensor node

Fig. 1 Network topology and node composition for sensor network

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