Senior Project Proposal

Intelligent Manhole Cover system

by

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1. Abstract

Smart manhole cover systems are a very important platform for citizen safety and weather data collection. Lost or damaged manhole covers often pose a huge threat to the safety of citizens, and in a smart city manhole covers can also help collect a lot of data. The goal of this project is to create a smart manhole cover that comes with a number of functions. Each manhole cover is equipped with a GPS module that can accurately locate if the cover is missing. Each manhole cover has a humidity sensor that opens the drainage hole for drainage in case of rain. The manhole covers are also equipped with a waste detection sensor that alerts the relevant personnel when there is too much waste in the well. The sensors also monitor the temperature, humidity and rainfall of the ground and feed back to the data centre for interaction with the management, improving the accuracy of the weather data and reducing the maintenance time of the manhole covers.

2. Introduction

Manhole covers are a very important part of the urban drainage system, connecting the sewer to the ground. In the past few years, there have been many incidents of damage to people's property due to loss, damage or construction of manhole covers. Ensuring the integrity of manhole covers is essential to provide a great deal of safety for pedestrians and vehicles on the road, as well as ensuring the proper functioning of the municipal drainage system.

As part of a smart city, manhole covers should do more than just that. A smart city is a collection of intelligent systems and end-to-end services, and the data and information needed for the intelligent systems can also be obtained from the manhole covers. As the most widespread infrastructure, manhole covers can be found in every corner of the city. Integrating the data sensors required by smart systems into manhole covers allows for extensive coverage, while at the same time greatly controlling the cost of production and hiding the sensors to keep the city looking good.

The current big data platforms have been able to access this type of terminal sensors and to integrate this part of the data very effectively, giving meteorological analysis and municipal construction units to make good planning and implementation. Through the observation and analysis of these big data platforms, intelligent manhole covers are very likely to be realized on the basis of these data platforms and have a very wide application value.

3. Problem statement

Today, many cities have introduced the concept of smart cities and many have started to develop big data platforms to collect information and contribute to the lives of their citizens in large and small ways. But at present, big data is often related to the functions of government departments rather than directly to the lives of citizens. For example, the big data platform displayed on the big screen at the Wenzhou Civic Centre generally shows the number of citizens doing business, rather than other data that is more relevant to their lives. If we are to truly realise a smart city, big data should not be restricted to government functions alone. There are still problems with the personal safety of citizens' property due to missing manhole covers or construction work, and in some places waterlogging due to blocked sewers still cannot be repaired in time. These problems may seem to have little to do with smart cities, but with the widespread use of big data and end products in smart cities, these problems can often be solved in a timely manner.

Refining these issues, they can be used as drivers for this project to address.

1. How to solve the problem of lost or shifted manhole covers?

2. Whether the smart manhole cover should always open the drainage hole?

3. How to detect if the drain is blocked?

4. How to integrate the smart manhole cover with a big data platform?

4. Objective

The ultimate goal of this project is to connect the entire smart manhole cover to the big data system developed by the municipality. It is possible to achieve real-time monitoring of data such as ambient temperature and humidity, and to show on the big data platform whether there are missing or offset manhole covers and to monitor whether there are blockages in the sewers.

The sub-objectives of this project are as follows:

1. smart manhole cover development based on Arduino microcontroller.

2. the smart manhole cover should have a GPS positioning function.

3. the smart manhole cover should be able to monitor the external humidity and open the drainage hole when it needs to be opened.

4. The smart manhole cover should be able to detect a range of weather data such as temperature and humidity.

5. The smart manhole cover should be able to detect if there is a blockage in the sewer that prevents drainage.

6. The data collected by the smart manhole cover should be available on a PC or mobile phone terminal and the problem should be able to be reported.

7. The smart manhole cover should automatically send an alarm message if it is damaged or lost.

If these functions can be realized, then it can greatly protect the property and life of the citizens. It can also provide a lot of support to the big data system of the smart city and facilitate the government to serve the citizens better. At the same time, this project can be used as a template for many similar smart city projects, such as intelligent waste bins. These products can form a huge smart city system and inspire the development of subsequent smart city systems.

5. Preliminary Literature Review

There have been a few projects that have started research on items such as smart manhole covers, but much of that research has been conducted on data collection, such as information on water levels, pressure, temperature, etc. Little has been seen on determining whether sewers are congested or not, and many of the articles are more concerned with how to connect to or develop big data platforms. For example：

RFID technology was proposed for communication between a reader and tags based on radio waves, making it possible to automatically track and locate or identify objects, such as animals and people without the need for a line-of-sight method. An RFID reader has two modes, fixed and static. RFID tags are intelligent barcodes, which allows them to be easily tracked. RFID tags communicate wirelessly with the reader. An RFID system can easily meet the

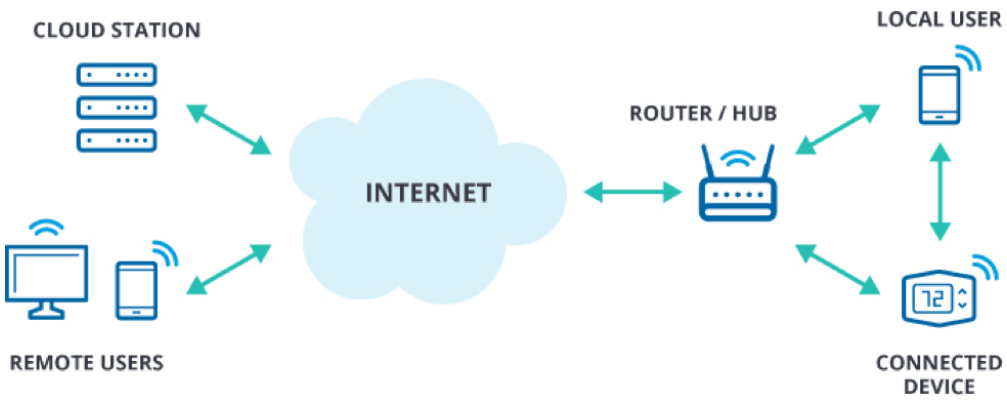
self-perception requirement and provide a user with information about an object's type, location, and condition.[3]

The RFID technology mentioned is also used to distinguish each manhole cover and connect it to the big data platform, but there is no good description of how the cover itself is made and what functions it is intended to perform.

6. Methodology

The core of this project is the development of a smart manhole cover product, so we should start with the hardware of the smart manhole cover itself. The platform chosen is the Arduino microcontroller platform. Before developing the smart manhole cover, you should learn to be familiar with the Arduino interface and modules and learn how to program and import the Arduino program.

After learning about the Arduino approach, it is time to start implementing the functionality, assembling the modules, programming them and importing them into Arduino.



Before the Arduino can communicate with the Big Data system it is necessary to build a model, refine the data transfer model between the Arduino and the system and determine the form of transfer and collection.

The development of the big data platform can start with a data collection platform as the basis for data collation, and then the platform can be built in the form of big data, with the final feedback presented in the form of a web page or software visualization.

The use of multiple Arduino modules is an effective aid to the development of smart manhole covers. The different modules are responsible for different content making the Arduino more efficient to manage and easier to troubleshoot in case of problems, making daily maintenance easier. However, there may be a cost increase.

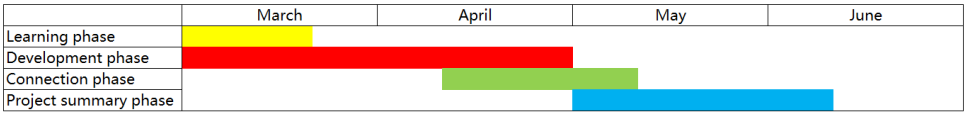
Timetable：

March 1~mid-March: Learning Arduino.

March 1 ~ Early May: Develop smart manhole covers and big data platform.

Mid-April ~ Early May: Development of a connected big data platform and test.

Early May ~ June: Project summary.



Team assignments

Learning Arduino phase:

1-2 people to learn the hardware knowledge of Arduino related modules, 1-2 people to learn the programming knowledge of Arduino related modules.

Development phase:

2-3 people to develop the Arduino part, 1-2 people to develop the big data platform.

Connection phase:

2-3 people are responsible for the connection between the manhole cover and the big data platform, 1-2 people are responsible for the acceptance and bug submission of the tests.

Project summary phase:

All project team members summaries the project, write a paper and give a presentation.

7. Costing

Well cover section:

Arduino and its sensor module ￥800

Motor and other drive components ￥200

Data platform:

Ali cloud server ￥40

Arduino and its sensor module	￥800
Motor and other drive components	￥200
Ali cloud server	￥40
Total	￥1040

8. References

1. Guo, X., Liu, B., & Wang, L. (2019, June). Design and implementation of intelligent manhole cover monitoring system based on NB-IoT. In *2019 International Conference on Robots & Intelligent System (ICRIS)* (pp. 207-210). IEEE.

2. Jeong, S., & Chappell, W. J. (2010). A city-wide smart wireless sewer sensor network using parasitic slot array antennas. *IEEE Antennas and Wireless Propagation Letters*, *9*, 760-763.

3. Jia, G., Han, G., Rao, H., & Shu, L. (2017). Edge computing-based intelligent manhole cover management system for smart cities. *IEEE Internet of Things Journal*, *5*(3), 1648-1656.

4. Praveena, B. A., Shetty, B. P., Kalasi, M. S. S., Yadav, S. S., Prasad, M., Sujith, M. N., ... & Mallikarjun, L. (2021, January). Design and Development of Smart Manhole. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1013, No. 1, p. 012006). IOP Publishing.