ISSN: 2688-9323

Design of Intelligent Manhole Cover Information Acquisition System in Internet of Things

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Abstract

This design relates to the intelligent manhole cover information collection system of Internet of Things. Comprises a composite manhole cover and a control unit, wherein the composite manhole cover is packaged with photoelectric devices embedded in the manhole cover to form a component capable of bearing load, providing power and transmitting signals, and mainly comprises a manhole cover base, a device layer, a supporting layer, a packaging layer and a well ring.The control unit is mainly composed of sensors, solar photovoltaic panels, communication antennas, RFID electronic tags, processors, power managers and wireless communication modules. A solar photovoltaic panel, an electric control box, a wireless transmission antenna and a manhole cover are integrated into a whole, which is used for transforming the existing existing pipe network into an intelligent pipe network, and replacing the manhole cover at an inspection well which needs to collect pipe network data.Sensors are set in the inspection wells, which are connected to the electric cabinet, and the collected data signals are processed and transmitted to the monitoring center through the Internet.

Keywords

Internet of Things; Manhole Cover; Information Collection System.

1. Preface

Urban underground pipe network is the infrastructure to maintain the normal operation of the city, and urban underground comprehensive pipelines include water supply, drainage, gas, heat, electricity, communication, etc. Although pipelines of different specialties have different media, they all need to monitor their operation conditions. Taking drainage pipelines as an example,It involves parameters such as velocity, discharge, water level, water quality, sedimentation depth, blockage and so on. In the past, traditional monitoring mainly relied on manual inspection, which was time-consuming and laborious. With the rapid development of Internet technology, intelligent monitoring of pipe network has been realized. Sensors are installed in inspection wells to collect monitoring signals, which are transmitted to the monitoring center through signal processing and transmission systems.There is an existing technology of collecting signals dispersedly, supplying power through cables, transmitting them through power carriers, and then transmitting them to the monitoring center through centralized processing. Data collected by sensors of various inspection wells in a small range are transmitted to the centralized control electric cabinet by cables, and then transmitted to the monitoring center through the network.This method can reduce the cost of transmission to the monitoring center, but cables need to be laid along the pipeline, which is suitable for newly built pipelines.

Many pipelines in the city have been built and used for many years, but the traditional pipe network cannot supply power and communicate. If these pipelines are changed into intelligent monitoring system, it is necessary to install sensors in the inspection wells for collecting data.

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The data cables are led out of the wells through threading pipes, and equipment poles are erected beside sidewalks, on which electric control boxes are installed, and the power is led from the nearby commercial power.It can also be powered by solar photovoltaic panels installed on poles. Because there are many urban underground pipe networks, the pipe networks laid under urban roads need to occupy a little underground space. Generally, drainage pipes are laid under the roadway, water supply, gas, cables and communication are laid under the sidewalk, and the sensor cable threading pipe needs to break the pavement or sidewalk.Equipment poles will also affect the urban landscape.

2. Design Content

The purpose of this design is to provide the intelligent manhole cover information collection system of Internet of Things, which is composed of composite manhole cover and control unit, integrating solar photovoltaic panel, electric control box, wireless transmission antenna and manhole cover into a whole, which is used to transform the existing existing pipe network into intelligent pipe network, replace this manhole cover at the inspection well where pipe network data needs to be collected, and set sensors in the inspection well.The sensor is connected to the electric cabinet, and the collected data signals are processed and transmitted to the monitoring center through the Internet. The intelligent pipe network has the advantages that the defects that the existing original pipeline transformation intelligent pipe network needs to break the road and install the threading pipe, and equipment poles need to be added on the ground are overcome; the intelligent well cover is matched with the intelligent sensor module, so that the data acquisition function of the intelligent pipe network can be conveniently and quickly realized;The integrated design method solves the problem that the traditional pipe network can't supply power and communicate, with simple installation and convenient maintenance.

This design is realized by the following technology: the intelligent manhole cover includes a composite manhole cover 10 and a control unit 20. The composite manhole cover 10 is packaged with photoelectric devices embedded in the manhole cover as a whole, which constitutes a component that bears weight, provides power and transmits signals, and mainly consists of a manhole cover base 1, a device layer 2, a support layer 3, a packaging layer 4 and a well ring 5.The control unit 20 is mainly composed of a sensor 11, a solar photovoltaic panel 12, a communication antenna 13, an RFID electronic tag 14, a processor 15, a power manager 16 and a wireless communication module 17.

There is a square groove in the middle of the manhole cover base 1. The bottom of the groove is a device layer 2 for installing photoelectric devices which cannot be shielded by light and electromagnetic signals. The upper part of the device layer 2 is a supporting layer 3 for protecting photoelectric devices. The upper part of the supporting layer 3 is a packaging layer 4. The top surface of the packaging layer 4 is flush with the top surface of the manhole cover base 1, and the top surface is provided with anti-skid stripes.The manhole cover base 1 is hinged with the well ring 5 by a hinge shaft 6.

The support layer 3 is made of high-strength compression-resistant transparent material. The encapsulation layer 4 is a plastic fluid material, which is a solid transparent waterproof layer formed after curing. A solar photovoltaic panel 12, a communication antenna 13 and an RFID electronic tag 14 are installed in the device layer 2.

The processor 15, the power manager 16 and the wireless communication module 17 are installed in an electric cabinet 18, which is fixed at the bottom of the manhole cover base 1.

The manhole cover base 1 is made of cast iron or resin composite material.

The support layer 3 is PVB laminated glass, which is composed of two layers of high-strength tempered glass sandwiched by a polyvinyl butyral PVB film.

The encapsulation layer 4 is made of transparent cement or transparent resin.

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The sensor 11 is installed in the inspection well and connected with the processor 15 through cables. The signals detected by the sensor 11 are subjected to A/D conversion and data processing. After data processing, the signals are modulated by the wireless communication module 17 and transmitted to the network through the communication antenna 13.

The electric energy output by the solar photovoltaic panel 12 is charged and discharged by the power manager 16 to provide power for the processor 15 and the wireless communication module 17.

The protection level of device layer 2 and electric cabinet 18 is IP67.

The above components constitute a manhole cover which is powered by solar energy and used for the intelligent acquisition and control system of underground pipe network.

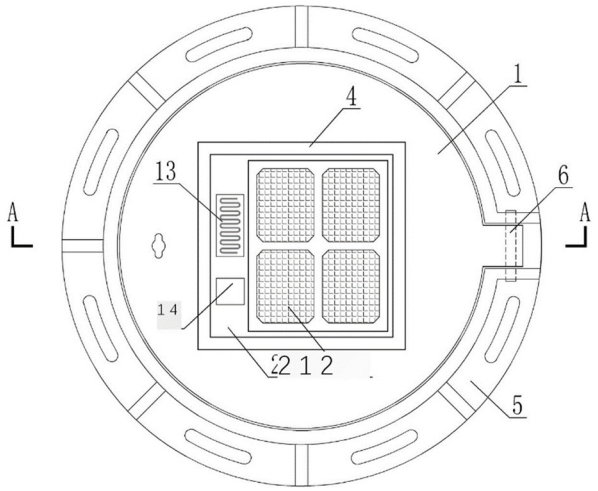

Fig 1. The design plan

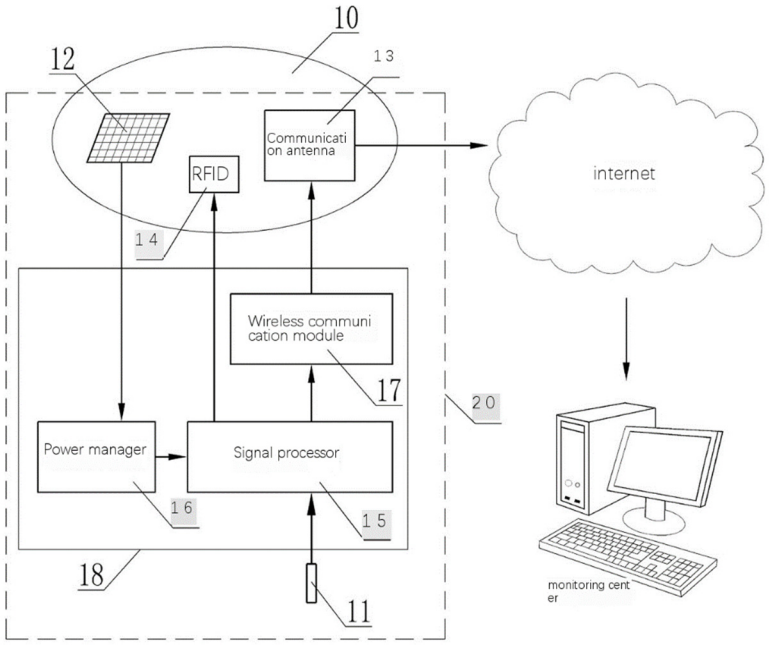

Fig 2. Schematic diagram of control unit

In the drawing: 1- manhole cover base, 2- device layer, 3- support layer, 4- package layer, 5- well ring, 6- hinge shaft, 10- composite manhole cover, 11- sensor, 12- solar photovoltaic panel, 13- communication antenna, 14- RFID electronic tag, 15- processor, and 16- power management

ISSN: 2688-9323

3. Specific Implementation Mode

For the sake of better understanding of the design by those skilled in the art, the design will be further explained with reference to figs. 1-2, and the contents mentioned in the embodiments are not a limitation of the design.

This design is a manhole cover for intelligent pipe network, which includes a composite manhole cover 10 and a control unit 20. The composite manhole cover 10 is packaged with photoelectric devices embedded in the manhole cover as a whole, forming a component that bears weight, provides power and transmits signals, and mainly consists of a manhole cover base 1, a device layer 2, a support layer 3, a packaging layer 4 and a well ring 6.The control unit 20 is mainly composed of a sensor 11, a solar photovoltaic panel 12, a communication antenna 13, an RFID electronic tag 14, a processor 15, a power manager 16 and a wireless communication module 17.

The manhole cover base 1 is made of cast iron or resin composite material. Ductile iron has good moldability, high strength, toughness and wear resistance, and is widely used in manhole cover manufacturing. The resin composite material is a fiber reinforced material based on organic polymer, which has no recycling value and good anti-theft property.At present, it is also widely used in the manufacture of manhole covers, and composite materials can be used when there are anti-theft requirements. When manufacturing the manhole cover base 1, there is a square groove in the middle of the manhole cover base 1, which is divided into two layers. The bottom of the groove is the device layer 2, and the groove of the device layer 2 is smaller than the grooves of the upper support layer 3 and the packaging layer 4, forming a platform, which is convenient for placing the support layer 3.See fig. 1 for the plan view of this design. the plane shape of the manhole cover is round. the manhole cover base 1 is hinged with the well ring 5 by using the hinge shaft 6, and the well ring 5 is built on the inspection well. the manhole cover can be turned up and opened without moving through the hinge shaft 6, which can achieve a good anti-theft effect. Fig. 1 is a top plan view with the top surface of the manhole cover looking down, and the square in the middle shows the uppermost packaging layer 4.When the manhole cover base 1 is manufactured, the top surface is provided with anti-skid lines (not shown in Figure 1), which are used for anti-skid when vehicles and pedestrians pass through.

The device layer 2 is used for mounting optoelectronic devices that cannot be shielded by light and electromagnetic signals. A solar photovoltaic panel 12 is installed in the device layer 2 to provide power for the intelligent monitoring system. A communication antenna 13 is also installed in the device layer 2, which can not be shielded by the well cover material and improve the efficiency of wireless signal transmission. An RFID electronic tag 14 is also installed in the device layer 2,RFID electronic tag is a non-contact automatic identification technology, which can automatically identify target objects and obtain relevant data through radio frequency signals. In urban roads or industrial parks with many pipelines, inspectors can quickly identify the types of inspection wells through hand-held equipment, and even read monitoring data.Optoelectronic marks can also be installed in the device layer 2, which are marked in different colors or shapes to identify the attributes of underground pipelines. For example, LED is used to make luminous bodies with the words "water supply", "rain water" and "gas". Through the supporting layer 3 and the packaging layer 4, the words can be identified, and different colors of light can be emitted at night to display the words, which is convenient for night inspection and identification.The depth of the device layer 2 should meet the installation requirements of optoelectronic devices, and the optoelectronic devices will not contact the supporting layer 3. The photoelectric device is adhered to the bottom of the device layer 2 with sealing glue, the cable lead of the device is led out from the threading hole at the bottom of the device layer 2 to the outside of the manhole cover base 1, and the lead and the threading hole are sealed with sealant.

ISSN: 2688-9323

See fig. 2 for the sectional view of this design. from fig. 2, it can be seen that the upper part of the device layer 2 is a support layer 3 for protecting optoelectronic devices. After the photoelectric devices of device layer 2 are installed, support layer 3 is installed on the upper part of device layer 2, which is made of PVB laminated glass and is composed of two layers of high-strength tempered glass sandwiched by a polyvinyl butyral PVB film.The side length of the support layer 3 is slightly smaller than that of the upper square groove and larger than that of the lower device layer 2. The side edges and bottom edges of the support layer 3 are coated with sealant and adhered to the upper part of the device layer 2 to seal the photoelectric device in the device layer 2. The upper part of the support layer 3 is an encapsulation layer 4 which is a plastic fluid material and a solid transparent waterproof layer formed after curing.The encapsulation layer 4 can be made of transparent cement, which is a special cement, a new building material with light transmission performance, and a compound composed of optical fiber and fine grinding cement, and the transparent cement is solidified into a solid state by hydration reaction with water. The light transmittance of transparent cement is affected by the amount of cement, and the light transmittance is low. The encapsulation layer 4 can also be made of transparent resin, Transparent resin is a solid transparent body formed by using polymer materials and adding fixed-line agents. In order to increase the strength of manhole cover, a certain amount of glass fiber can be added into transparent resin. Transparent resin has high light transmittance, and it is preferable to make the encapsulation layer 4. Pour an encapsulation layer 4 on that upper part of the fix support layer 3, wherein the top surface of the encapsulation layer 4 is flush with the top surface of the manhole cover base 1; Before the encapsulation layer 4 is solidified into a solid state, a mold with the same pattern as the top surface of the manhole cover base 1 is pressed on the encapsulation layer 4, and after solidification, an anti-slip pattern consistent with the manhole cover base 1 is formed.

A solar photovoltaic panel 12, a communication antenna 13 and an RFID electronic tag 14 are packaged in the composite manhole cover 10, and a processor 15, a power manager 16 and a wireless communication module 17 are installed in an electric cabinet 18 which is installed at the bottom of the manhole cover base 1 and fixed by stainless steel bolts. At least one sensor 11 is arranged in the inspection well,There can also be multiple sensors, and different sensors can be set according to the needs of the pipe network. For example, sewage pipelines can be equipped with sensors such as flow rate, flow rate, water depth and water quality. Sensor 11 is connected with processor 15 through cable, the signal detected by sensor 11 is subjected to A/D conversion and data processing, and the signal after data processing is modulated by wireless communication module 17.The signal transmitted by the communication antenna 13 is uploaded to the network, and the signal is transmitted to the monitoring center through the Internet, and the monitoring center analyzes and processes the data to obtain the operation status of the pipeline. The electric energy output by the solar photovoltaic panel 12 is charged and discharged by the power manager 16 to provide power for the processor 15 and the wireless communication module 17.The storage battery can be selected from lithium battery, nickel-cadmium battery and lead storage battery, and lithium battery is preferred.

The protection level of device layer 2 and electric cabinet 18 is set according to IP67, which can prevent mud, sand and dust from entering. Under normal temperature and pressure, when the shell is temporarily immersed in 1m deep water, it will not cause harmful effects.

According to the monitoring requirements of different pipelines, different sensors 11 are set, the monitoring signals are processed by the processor 15, and the wireless communication module 17 transmits the signals to the monitoring center through the Internet, to realize an intelligent monitoring system for underground pipe network powered by solar energy.

ISSN: 2688-9323

Acknowledgments

Supported by Liaoning University of Science and Technology 2021 College Students Innovation and Entrepreneurship Training Program.

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