Automated Detection of Manhole Status and Prevention of Accidents Using PIR Sensors

S.PRIYADHARSINI, T.VARSHA

Department of Computer Science and Engineering

Velammal Engineering College, Chennai

ABSTRACT

Manholes are essential aspects of a city's infrastructure. Damaged manholes are posing a threat to commuters in city. Some of the damaged manholes can be seen on the busiest roads of the city. Many of them are not properly closed and can cause serious accidents. Fatal accidents caused due to open potholes are upsurging day by day. Passers by are at a high risk of facing hazards while crossing these manholes that are either damaged or kept open by the sanitation workers. This paper proposes a novel technique of affixing a passive infrared sensor at the pro-ring of the manhole chamber. WiiLSW are used to detect if the man-hole is open or closed. The PIR sensor is activated only if the man-hole is open. The sensor is attached to a security alarm circuit which is activated when a human intrigues the sensing area of the sensor, thus serves as a warning to those who seem to carelessly walk over the potholes and might save them from falling into the manhole. This alarm circuit also produces vibrations making it easy for deaf persons too. This whole set up can be implemented effectively using inexpensive equipment.

I. Introduction

In a recent survey conducted by National Crime Records Bureau 780 people have died on account of accidental fall into open manholes. Uncovered, unprotected open manholes have killed as many as 167 persons and injured five in 2018.

Besides being a threat to pedestrians, the uncovered manholes and pothole-riddled roads are posing serious threats to motorists. According to the Environmental Protection Agency, there are approximately 12 million sewer or storm water manholes across the nation. The surprising fact is that out of these nearly 12 million manholes, the Public Works Magazine estimates 80% need some level of maintenance or rehabilitation.

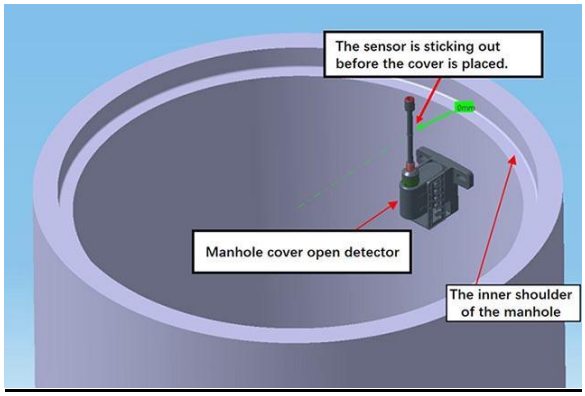
Measures are not being taken for closing such manholes and other death traps or barricading them. This is simply due to the lack of accountability, absence of safety consciousness and sheer

insensitivity to human tragedy. One of the major reasons for open potholes is the theft of the manhole covers leaving the manhole chambers open and unattended. Despite placing warning flags on the manhole covers, In floodwaters a person may not see the open drains and so risks falling in.

Falling into an open sewer can cause a myriad of dangers which may be as serious as suffocation to death. Toxic gases resulting from cleaning fluids and excrement may cause severe risks to those breathing them. The septic environment poses severe risk of infection to the victim if he or she happened to have any open cuts. Oxygen levels are very low especially in deeper sewers.

Sewer gas present inside is a complex combination of various organic and inorganic compounds which is the result of the breakdown of human waste in the absence of oxygen. Excessive inhalation of this gas may cause delirium, or even unconsciousness. For this reason it is considered to be an asphyxiant, and dangerous in enclosed spaces.

II. WiiLSW sensors

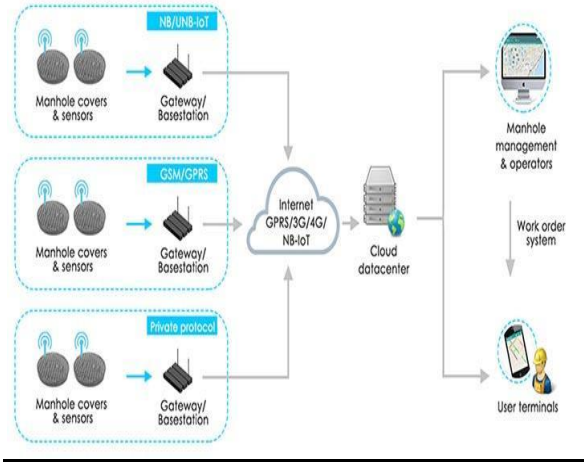


WiiLSW ,a positioning sensor in the WiiHey family designed to be extremely tamper resistant sealed and rugged for use in even unconventional environments.With the utilization of the off-shelf sensors,it is trying to be a zero-false alarm solution

Working

The sensor detects two statuses of the manhole cover-open or closed. During installation, the sensor is sticking out of the manhole surface, indicating the manhole is in "opened" status.After the manhole cover is placed on it, the sensor is bending over, knowing now the manhole is in "closed" status.

Architecture



The sensor supports LPWAN IoT communications technologies, such as GPRS, NB-IoT, GPRS, etc. They combine high transmission ranges of up to several kilometers in urban environments, with low power consumption. Data are transmitted to cloud data center for processing and fusion. Eventually, operators could view every manhole status from a cloud-based GIS dashboard.

III. PROPOSED IDEA

WiiHey's Manhole cover Open Detector is used initially, the realtime manhole status data is transmitted from the sensor to the cloud database via(LPWAN)Low Power Wide Area Network.This integration provides a web based GIS dashboard platform to monitor and plan the maintenance of the assets.

IV. Passive Infrared Sensor

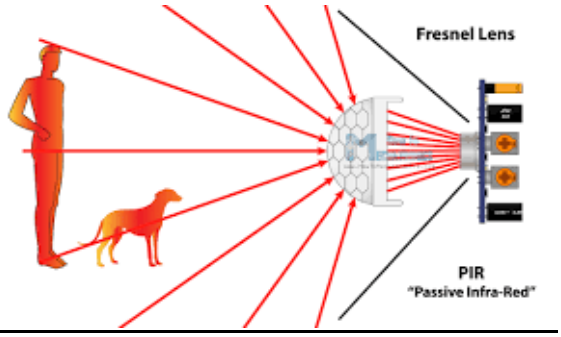
The ultimate purpose of PIR sensor is to sense motion. This sensor is used to detect whether a human has moved in or out of the sensors range.

This sensor detects a human being moving around within approximately 10m from the sensor.

It is used to discover the entry and exit of an individual within the specified sensor area. These are small, cheap, easy to use, consume low power and do not wear out very easily.

These pyroelectric sensors are can detect levels of infrared radiation. It measures the temperature, the hotter something is, the more radiation is emitted. It passively detects the infrared radiation coming from the human body in the surrounding area. The detected radiations are then converted into an electrical charge, which is proportional to the detected level of the radiation.

Working of PIR Sensors



PIR sensor consists of a specially designed cover named Fresnel lens, which focuses the infrared signals onto the pyroelectric sensor. It consists of two slots which are made up of a special material sensitive to IR. Both slots detect the same amount of IR.

When the sensor detects the motion of a warm body like human or an animal one half of the PIR sensor is interrupted at first, which causes a positive differential change between the two halves. Similarly when the body leaves the sensing area, the reverse process takes place. In this case a negative differential change is created.

As the motion is detected, the output pin will go high to 3.3V. This electrical signal can be used to activate an alert system or buzzer or alarm sound.

The PIR sensor can be fixed at the pro-ring of the manhole chamber. So that it can detect the motion of humans moving nearby or very close to the manhole. If the motion of a human or an animal is detected very close to the manhole chamber, such that the motion intrigues the sensing area of the sensor, then the sensor is activated electrical pulses are generated which is fed into the inverter circuit and the alarm system is activated.

This alarm serves as a warning to those who seem to carelessly walk over the potholes and might save them from falling into the manhole. Even if a human or an animal has fallen into the pothole accidentally, the sensor detects the presence of the person due to infrared radiation emitted by the hot body and the alarm system is activated . In this way, unfortunate accidents due to fall into potholes can be prevented.

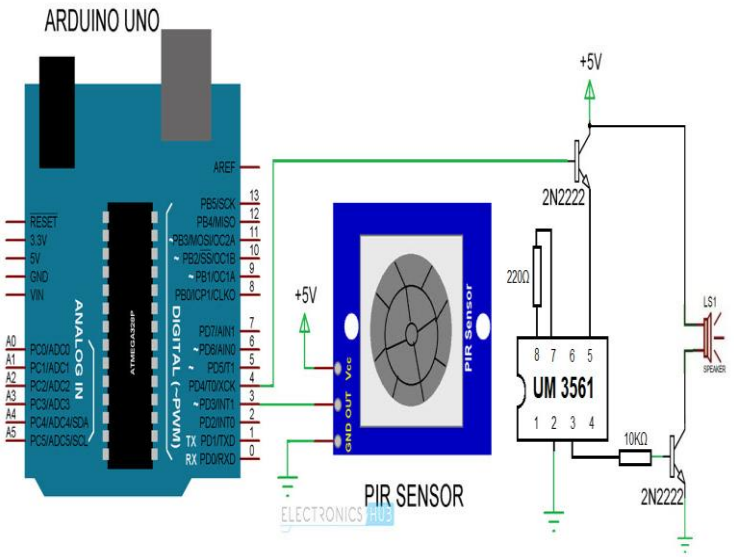
This whole set up can be implemented using inexpensive equipment which consume low power. These equipments do not wear out and are easy to handle making the process easier for maintenance.

V. PIR Sensor based Security Alarm Circuit Design

The PIR sensor is connected to the alarm system. The designed system consists of Arduino, PIR sensor, UM3561 IC, Speaker, transistor and a couple of resistors. The UM3516 IC is a Siren generator IC. It has 8 pins. First and sixth pins are the Sound effect selection Pins.

Pin 5 is connected to +5V through an NPN Transistor. 220KΩ resistor is connected to the seventh pin of the UM 3561 IC and the other end is connected to the eighth pin of the IC. Output is taken from the third pin of the IC and it is connected to a speaker through a resistor and transistor. The base of the transistor is connected to the output of the IC through a resistor of 10KΩ. Emitter pin is connected to the ground while one end of the speaker is connected to the collector, while the other end is connected to +5V. Output of the PIR sensor is connected to the Pin 3 of Arduino.

Working of PIR sensor based security alarm



1. The connections are made as per the circuit diagram.

2. The PIR sensor is powered and it detects the IR rays emitted from humans within the sensing area.

3. This PIR sensor has a range of 5 meters. This distance can be varied.

4. When the presence of a human is detected, the PIR sensor outputs a logic HIGH value i.e. voltage of 3.5V to 5V to Arduino's Pin 3.

5. As soon as the Arduino detects logic HIGH on Pin 3, it makes the Pin 4 HIGH for a duration of 10S. During this time, the Siren IC UM3561 is activated as its Pin 5 provided with +5V.

6. This siren generator has an oscillator internally, to produce the sound and the oscillator is tuned to a certain frequency and using a 220KΩ resistor.

7. The oscillations are sent to the address counter. The address counter then sends the data to the ROM.

8. ROM then sends the alarm tone on the output pin 3.

9. The output is given to the NPN transistor to amplify the siren.

10. The base of the transistor gets voltage from output pin of the siren generator.

11. Transistor starts conducting when it gets the cutoff voltage at the base and the speaker is negative pin and is connected to the ground.

12. Thus sound produced can be heard from the speaker when human is likely to cross the manhole at a much closer distance.

13. It also produces a great vibration making it easy to give away a warning for deaf persons too.

VI. Conclusion

The combination of the WiiLSW sensor along with PIR sensor for preventing accidents due to careless handling of manhole can be greatly reduced.

WiiHey's Manhole cover Open Detector permitting low power consumption optimises the usage over any remote location.The PIR uses the infrared radiations which is a electromagnetic radiation that can be easily created using commercially available devices.It produces vibration which will alert even a deaf person when they accidently come near the vicinity of an opened manhole.

VII. References

[1] https://ieeexplore.ieee.org/document/1033761

[2] http://www.wiihey.com/en/applications/manhole-cover-monitoring.html

[3] http://www.embeddedworks.net/sens377.html

[4] https://www.elprocus.com/pir-sensor-circuit-with-working/

[5] https://howtomechatronics.com/tutorials/arduino/how-pir-sensor-works-and-how-to-use-it-with-arduino/

[6] http://www.glolab.com/pirparts/infrared.html

[7] https://www.nap.edu/read/4782/chapter/7#35

[8] https://howtomechatronics.com/tutorials/arduino/how-pir-sensor-works-and-how-to-use-it-with-arduino/