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An Overview on the Manhole Edge Computing

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ABSTRACT- One of the most important basic platforms in a smart city for preventing recurrent manhole cover accidents is an intelligent manhole cover management system. Manhole cover removal, loss, and injury endangers people's safety, which is contrary to the aim of smart cities. This article describes an intelligent manhole cover management system (IMCS) for smart cities that is based on edge computing. Each manhole cover has its own radio frequency identification tag with tilt and vibration sensors, and communication is done through a narrow-band Internet of things. Meanwhile, based on the collected data, edge computing servers communicate with appropriate management employees through mobile devices. The effectiveness of the proposed IMCS was shown in a demonstration application in Hangzhou's Xiasha District. It halved the repair time, possibly improving the safety of both humans and manhole covers.

KEYWORDS- IOT, GSM, Mobile device, Power Supply, Vehicle.

I.INTRODUCTION

A variety of subterranean systems, such as electric power, drainage, and network systems, need a number of holes in the pavement for management purposes. However, these manholes result in situations where people and cars fall into holes, causing loss, displacement, and harm to society, thereby defeating the aim of smart cities. Accidents involving manholes occur as a result of open holes that are not monitored in real time. As a result, government authorities should check manholes on a regular basis to determine their condition. However, because of the huge number of manholes to be covered, this will need the use of a significant quantity of human resources. It is also unable to maintain real-time performance. In the suburbs, using this examination approach will take more than a day, two, or even months. Because there is no surveillance, there is an issue with manhole covers being stolen. Because these coverings are so light, they are readily stolen [1].

As a result, an intelligent manhole cover management system is required, which should have the following features:

- Self-perception: Every cover should be able to self-monitor, for example, when there is damage, tilt, or displacement. The cover should also have self-monitoring capabilities [2].
- Active real-time alert: It should sound an alarm anytime it detects tilting, damage, or displacement.
- Real-time response: The system should respond to the alert in real time, and people should be scheduled accordingly.
- Low management expenses: The costs of bandwidth, human resources, and energy resources should all be wisely minimized.
- Minimal repair time: To minimize the risk of people falling into the bridge, the average repair time after any tilt, damage, or displacement should be as short as feasible.

Figure 1 depicts the characteristics that a smart ICMS should have. The intelligent manhole cover management system (ICMS), which is based on edge-computing technology, has been suggested to fulfill these criteria. Every manhole cover will contain a unique adio frequency identification (RFID) tag, as well as vibration and tilt sensors, for self-monitoring [3]. Because of its poor efficiency, all manholes utilize narrow band IoT technology to serve the function of internet connection.. The server's goal is to handle real-time information on manhole covers, such as status and location data. Observing abnormalities, concerned people are informed for the purpose of carrying out the objective of the schedule of repairing tasks [4]. In a research conducted in Hangzhou, China, it was discovered that the time between the alarm buzzing and the server's response was less than 15 seconds. The IMCS system has the capability of minimizing human resources resulting from unnecessary frequent inspections [5]. Thus the major benefactions of paper are:

- Using the IMCS, an edge-computing technology, to effectively control all manhole covers with the greatest level of safety and lowest cost.
- To fulfill the function of communication, the proposed IMCS uses a narrow-based IoT method [6].

- It has been shown that the suggested structure is very efficient.

A manhole cover with an RFID tag is illustrated in figure 3 to create a smart manhole cover. It has a few advantages:

- It is equipped with a number of sensors, including vibration, tilt, and position sensors. This enables the detection of any rotation, movement, or vibration sensors in real time [7]. As a result, any movement on the cover may be readily detected, which is the most important aspect.
- A 3.6 V lithium battery is attached to provide power and is capable of providing power for three to five years.
- It has a narrow band-based IoT module integrated in. Thus, by using narrow based IoT, all manhole covers are capable of connecting with the server, and the benefits of narrow based IoT are combined with IMCS, such as reduced power consumption, lower transceiver complexity, better coverage, and lower chip cost. It can support the connecting of a large number of manhole covers across the city.
- A demolition alarm will sound once the RFID is disassembled, allowing it to transmit its own report and analysis.

Figure 3: Manhole's cover with RFID

A hand-held equipment is used to ensure that all manhole covers are operational and in good working order. This portable gadget will check all of the covers on a regular basis for 5 to 15 seconds, and it may also be set up manually. This period has been fixed at 10 seconds in this article. If a manhole cover is discovered to be offline at any moment, the server locates it and dispatches the necessary people to investigate. There may be a variety of causes for the cover's offline state, such as a lack of power sources, in which case staff will replace the batteries. Another cause may be network issues that prevent communication with the manhole covers; fixing the network would resolve the issue [8].

Network of Internet and NB – Iota

The network is a critical component in the effective deployment of the IMCS. It is critical that the server maintains appropriate connection with the manhole cover. Managers are in charge of keeping track of all the covers, and the server is in charge of scheduling the repair tasks for the appropriate people. The network serves all of the purposes listed. The large number of connections between the manhole covers and the server is a key need for communication. A city has millions of manholes, therefore the network should be able to handle a large number. In order to save manpower, the cover should be able to function for as long as feasible without human involvement. The IoT based on narrow-band should be capable of meeting communication requirements from the server to the manhole covers. The managers utilize both the internet and the LAN to keep track of the status of all manhole covers. The management server and terminal are linked via LAN in the management center, allowing administrators to quickly monitor the status of each and every manhole cover. The internet is utilized to monitor status outside of the control center. The general packet radio service and the internet are used to schedule the repair work. The message of repair tasks is given to employees through APP management and text messages sent over the phone [9].

A. Management System Based on Edge Computing

The data regarding the manhole cover may be acquired using the two methods described above. However, in the event of an emergency, it is critical that it take the necessary action within the time limit. If a manhole cover is taken, the RFID tag will transmit the dynamic location information to the server. The management system's job here is to provide real-time information about the thief's whereabouts so that it may be apprehended. Analysis and catching will be simpler if you respond in real time. The method is intended to provide power that is elastic in computation and storage at a lower cost. However, this is not capable of delivering a real-time reaction, while edge computing can. In the article, an IMCS based on edge computing is presented. Figure 4 depicts the main components of ICMS technology [10].

The IMCS parts based on edge-computing technologies are described in the following sections:

- Unique Identification - Each manhole cover should be assigned a unique identification (ID) number so that they may be distinguished properly. Each cover should include latitude and longitude information to help locate the faulty manhole cover.
- Manhole cover status - The cover should be in the online state by default, but it may be rotated, tilted, offline, or relocated in the event of an abnormal occurrence.

- Location mapping - All manholes are visualized by being plotted on a city map. Different colors are used for different states to differentiate them. It becomes simpler to identify all of the faulty manhole covers this way.
- Texting: After the abnormal condition is transmitted to the server, text messages should be sent to the appropriate people. To speed up the repair process, the text will include a unique ID, location information, and problems (11).

Figure 4 depicts the current state of research in edge computing and smart cities, demonstrating the exponential growth in the number of publications in both areas. Apart from the trend in research papers, data show that the proportion of people living in cities was 29 percent in 1950, 50 percent in 2008, respectively, and is projected to reach 65 percent in 2040. Every week, around 1.3 million individuals relocate to cities. There have been three megacities in 1975, but there are now 21 megacities with populations of more than 10 million people. In addition, the number of megacities is projected to grow by one in Africa, two in Latin America, and five in Asia by 2025. Furthermore, cities use 60 percent to 80 percent of global energy and produce half of all ghgs.

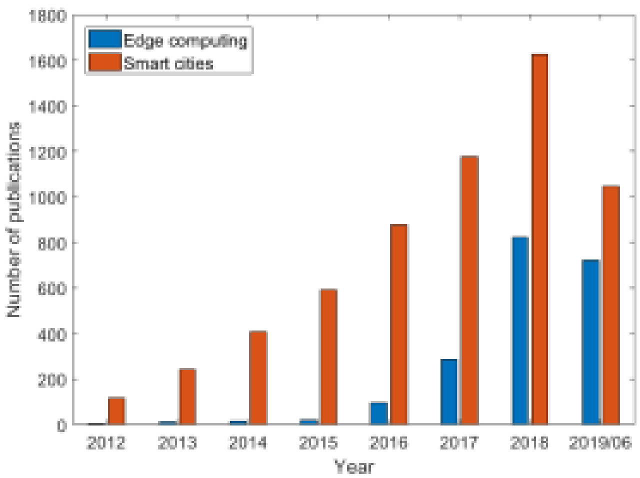

Figure 2: Number of published articles on edge computing and smart cities

Figure 3 depicts a high-level overview of edge computing-enabled Internet of Things (IoT)-based smart city settings. These IoT-based smart surroundings make use of linked smart IoT devices and sensors to help people live better lives. Apart from that, since it is linked with a range of technologies and ideas in literature, IoT may be defined in a variety of ways. The majority of IoT definitions are based on research initiatives. The authors discovered the following common and often recurring characteristics across various IoT definitions:

Existence of a worldwide network architecture capable of providing a unique addressing scheme, seamless integration, and connection amongst heterogeneous IoT nodes.

- Addressable, readable, locatable, identifiable, and autonomous IoT nodes are required.
- There are a variety of technologies that must be carefully considered.
- The association of services with objects emphasizes the object-dependent character of the service.
- Human-machine interactions that are intelligent.

Computing is a trying to cut computing model defined by geo-distributed operation, context awareness, mobility support, and low latency. It moves computer resources including processing power, data, and apps from the cloud to the network edge, enabling a variety of real-time smart city services. Cloudlet, fog computing, and mobile edge computing are three new technologies that have recently been utilized in the literature to bring the compelling characteristics of cloud computing to the edge. Edge computing, for example, lowers network bandwidth consumption by reducing data transfer from end users to the distant cloud.

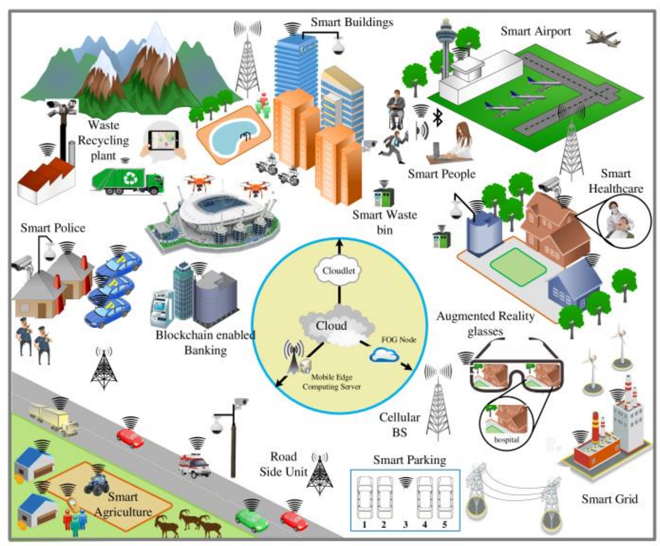

Figure 3: An Overview of Edge Computing Enabled Smart City

II. DISCUSSION

This paper discusses about the A number of holes in the pavement are required for the administration of a range of subsurface systems, including electric power, drainage, and network systems. However, these manholes cause people and vehicles to fall into holes, resulting in loss, displacement, and damage to society, thereby undermining the purpose of smart cities. Manhole accidents happen as a consequence of open holes that aren't monitored in real time. As a consequence, government officials should conduct frequent inspections of manholes to assess their condition. However, due to the large number of manholes to be covered, a considerable amount of human resources will be required. It's also unable to keep up with real-time demands. Using this testing method in the suburbs will take more than a day, two, or even months. There is a problem with manhole covers being stolen since there is no surveillance. These covers are easily stolen since they are so light. The network is a critical component in the effective deployment of the IMCS. It is critical that the server maintains appropriate connection with the manhole cover. Managers are in charge of keeping track of all the covers, and the server is in charge of scheduling the repair tasks for the appropriate people. The network serves all of the purposes listed. The large number of connections between the manhole covers and the server is a key need for communication. The data regarding the manhole cover may be acquired using the two methods described above. However, in the event of an emergency, it is critical that it take the necessary action within the time limit. If a manhole cover is taken, the RFID tag will transmit the dynamic location information to the server. The management system's job here is to provide real-time information about the thief's whereabouts so that it may be apprehended. Analysis and catching will be simpler if you respond in real time. The data regarding the manhole cover may be acquired using the two methods described above. However, in the event of an emergency, it is critical that it take the necessary action within the time limit. If a manhole cover is taken, the RFID tag will transmit the dynamic location information to the server. The management system's job here is to provide real-time information about the thief's whereabouts so that it may be apprehended. Analysis and catching will be simpler if you respond in real time.

III. CONCLUSION

Edge computing is a prominent computing paradigm for providing immediate computation and storage to smart cities. Cloud computing is often utilized to provide smart device computing and storage features. However, cloud computing's inherent delays have opened the path for the process of transferring processing and storage resources from a central, remote location to the network's periphery. On the other hand, real-time smart city technology and instant analytic services are required. Edge computing is required for apps to enable for these real-time operations. Edge computing in smart cities, on the other hand, poses significant difficulties. In this poll, the acceptability of edge computing was high. Smart cities are the subject of much study. To that aim, we first examined the evolution of edge computing, focusing on the gradual growth of computer technology in the direction of Edge Computing. Furthermore, the technology involved as well as the benefits of different computing paradigms are discussed. Second, there has been significant recent improvement. A thorough examination is carried out using different evaluation criteria.

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