A Preliminary Study on the Facility Maintenance Technology Classification System for the Application of Internet of Things

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1. Introduction

With the growing number of casualties due to the dilapidation of national infrastructures and relevant safety accidents in recent years, diverse researches are being conducted to convert the passive facility maintenance system into a proactive maintenance system using sophisticated information technologies. Of such major technologies for the aforementioned purpose, the Internet of things technology is required to be utilized. Internet of things (IoT) refers to the intelligent networking technology and environment by which the things around us are connected with one another via wired and wireless networks, closely gather and share information with one another, and interact with one another. In addition, IoT is a future Internet technology by which the things in the real world and the virtual world are interconnected via networks to enable communication anywhere, anytime between humans and things and between things [1]. If IoT is constructed, its influence will spread extensively not only in all business areas but also in people's daily lives, thanks to the development and diffusion of wireless networks, communication modules and sensors, and smart-device technologies[2].

This study sought to present diverse technologies using IoT and the corresponding technology classification system so as to convert the current system into a system designed to diagnose the statuses of facilities through a variety of equipment, and to enable the timely repair and reinforcement thereof based on an intelligent status evaluation system.

2. Domestic and Overseas Trends

The global IoT markets were estimated at USD200 billion in 2013 and are expected to rise and to reach USD1 trillion in 2020, with a 26.2% average annual growth rate. The South Korean IoT markets were estimated at KRW2.3 trillion in 2013 and are expected to reach KRW17.1 trillion in 2020, with a 33.33% average annual growth rate. As overseas examples, Cincinnati in the U.S. developed a garbage management system through which it monitored the domestic garbage volume, thereby reducing its garbage emissions by 17% and increasing the recycling thereof by 49%.Barcelona in Spain installed sensors in street lamps by which to automatically adjust the lighting luminance thereof, thereby saving energy by 30% annually.In Germany, Benz and BMW developed devices capable of sensing the vehicle parking location, door closing, and fuel status, and of remotely controlling motor vehicles.Brazil operated an intelligent center by which it analyzed virtual data and forecasted heavy rainfall, thereby advancing its response time by 30% and reducing deaths by 10%. In South Korea, LG Electronics and Samsung Electronics developed sensors designed to measure the amount of physicalactivity, and successfully commercialized them. IT Health Co. developed a smartphone-based urination and bowel evacuation management system [3].

A look at the related global policy trends will reveal that in 2012, seven standardization institutions and 267 firms in South Korea, USA, Japan, and China established oneM2M(one machine to machine), by which they are pursing the standardization of a common platform to ensure IoT compatibility between diverse industries, such as the automobile, medicine, home, electronics, and electric-power industries.EU devised 14 action plans for IoT in 2009, and since 2010, it has pushed to establish IoT governance, to monitor the protection of personal information, to define the risk factors, and to establish private-sector partnerships and international cooperation. A look at the global industrial trends in the IT category will reveal that Google acquired Nest (home automation solution firm); ARM, a mobile low-threshold strategy process firm, acquired Sensinode (IoT SW firm); ORACLE acquired Bluekai (social data analysis firm); and IBM acquired Cloudant (data management analysis firm). Still, the Japanese firm NEC and the American firm AT&T forged alliances. As such, many mergers and alliances are being forged to secure IoT technologies.Against such background, diverse researches and projects on the use of IoT technologies to create new growth engines are progressing globally [3].

3. Deriving a Technology Classification System by Maintaining National Infrastructures

The work of maintaining national infrastructures is classified into inspecting facilities in the field, managing networks for managing the inspection results, and evaluating the statuses of facilities and repairing and reinforcing them if needed. In this study, to derive an IoT-based technology classification system applicable in the maintenance of national infrastructures, experts from the government-run research institutes engaging in research on facility maintenance were surveyed, and accordingly, the technologies were classified.

Of the three major areas, first, the technologies in the diagnosis area were classified into key network technologies for the management of national infrastructures, IoT-based remote diagnosis technologies for national infrastructures, and diagnosis device automation technologies for national infrastructures. The network maintenance technologies were classified into IoT-based data standardization and convergence technologies for managing infrastructures, IoT- and the 3D information building modeling convergence-technology-based smart management technologies for national infrastructures, and IoT-based proactive disaster sensing and monitoring technologies. The repair and reinforcement technologies were classified into IoT-based maintenance optimization technologies for managing assets, unmanning technologies for the facility repair and reinforcement system, and artificial-intelligence technologies for repair and reinforcement.Specifically, the diagnosis area was classified into three detailed technologies and 12 further segmented technologies, the network maintenance area was classified into three detailed technologies and 13 further segmented technologies, and the repair and reinforcement area was classified into three detailed technologies and 11 further segmented technologies.All these can be seen in the diagram in Figure 1.

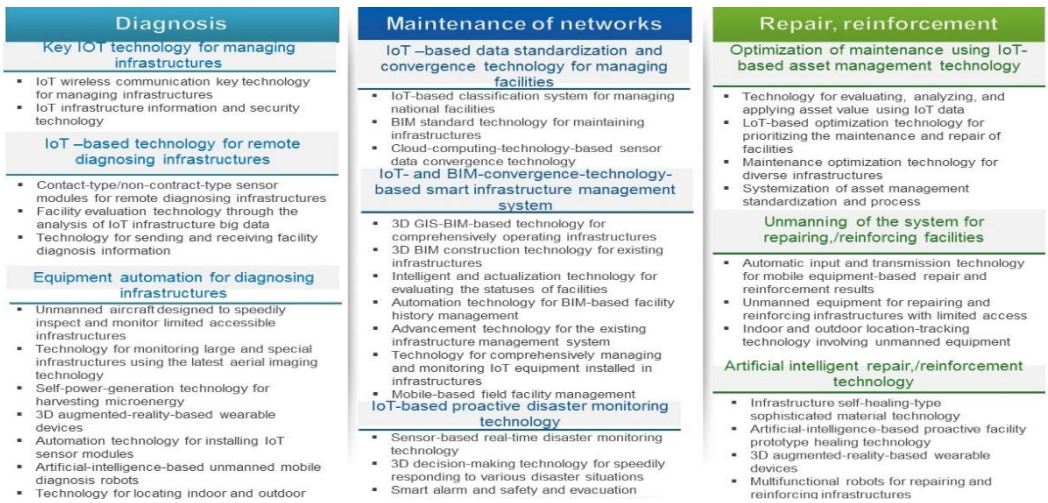

Figure 1. Schematic diagram of the IoT-based technology classification system for facility maintenance.

The selected technologies to be put to use over the next five years include the IoT-based remote diagnosis technology for facilities, the equipment automation technology for diagnosing infrastructures, the IoT-based data standardization and convergence technology for managing facilities, the IoT- and BIM-convergence-technology-based infrastructure smart management system, and the IoT-based maintenance optimization technology using the asset management technology.Furthermore, the selected technologies to be put to use over the next ten years include the IoT-based advanced diagnosis technology for facilities, the IoT-based proactive disaster monitoring technology, the unmanning technology for facility repair and reinforcement, and the artificial-intelligence repair and reinforcement technology.

4. Conclusion

This study defined three IoT-based areas for maintaining national infrastructures, and presented the corresponding technology classification system. If all the technologies presented herein are realized, the statuses of infrastructures can be monitored, the automation and unmanning of the inspection thereof can be ensured, dangerous infrastructures and infrastructures to which access is limited can be speedily repaired and reinforced, and an integrated operation of GIS-BIM-based infrastructures can be achieved. The proposed system can also be utilized in facility maintenance, in devising optimized maintenance plans based on asset value evaluation, and in the work of inspecting and measuring field facilities using mobile devices, etc., and as the platform for national disaster control systems.The findings of this study will be utilized as basic data in applying IoT technologies to national-infrastructuremaintenance.

5. References

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