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A Study on the Interconnection between National Disaster Management System and Private Disaster Prevention IT Technology through Application

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국가재난관리 시스템과 민간 방재IT기술의 지능정보기술 적용 사례고찰을 통한 상호 연계에 관한 연구

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Abstract In order to strengthen the disaster prevention phase and the management of social disasters, we will examine the plan of To-Be disaster management system interconnected by using intelligent information technologies such as IoT, Cloud, Big Data, Mobile and AI. The disaster management system can be upgraded by constructing an intelligent infrastructure based on Big Data analysis of the disaster signals before and after the disasters generated by private mobile and IoT. Big Data of disaster Signals can be customized to users in a timely manner through AI methodologies of supervised and unsupervised learning and reinforcement training. In the long term, it is expected that not only will the capacity of disaster response be improved, but the management ability centering on prevention will be enhanced as well.

Key Words : Disaster Management System, Intelligent Information Technology, ICBMA Disaster Prevention Technology, Disaster Prevention IT Technology, Smart IT Technology

요 약 재난예방단계와 사회재난분야의 관리강화를 위해 지능정보기술(ICBMA, IoT, Cloud, Big Data, Mobile, AI) 활용하여 상호 연계한 To-Be 재난관리시스템 제안을 고찰하고자 한다. 민간Moble, IoT등에서 생성되는 재난발생 전후시기에 재난징후의 Big Data와 분석 결과로 초지능 인프라를 구축함으로써 현재 재난관리 시스템을 고도화할 수가 있다. 재난징후의 Big Data를 AI의 지도, 비지도 강화훈련 학습으로 사용자에게 적시에 맞춤식 제공이 가능하고 장기적으로 재난대처 능력이 향상될 뿐 만 아니라 예방단계 중심의 관리 능력이 높아질 것으로 예상된다.

주제어 : 재난관리시스템, 지능정보기술, 재난예방기술, 재난예방 IT기술, 스마트 IT기술

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1. Introduction

Disaster management can be divided into four stages: prevention, preparedness, response and recovery activities. In order to build the information system of disaster-related work at each stage, the prevention and preparation stages are applied at simulation techniques for disaster prediction. The response stage deals with technology for information delivery system, emergency response activities, and disaster damage analysis. In the recovery stage, techniques for damage assessment can be applied. The nation is developing and using the information systems for disaster management as a four-step disaster management system[1,2].

As the information and telecommunications environment is shifted to digital convergence, all the materials such as voice, data, public broadcasting, mobile communication, and the Internet are integrated into one. Regardless of access network or terminal device, it is evolving toward providing service anytime and anywhere[1,2]. The ICT environment is evolving toward intelligent information technology that is becoming interconnected and intelligent between human, object, product and services based on widely used ICBMA (IoT, Cloud, Big Data and Mobile, AI)[1].

In this paper, we will examine the plan of To-Be disaster management system in connection with disaster management system and civil intelligence information technology through the case studies of national disaster management system and civil disaster prevention IT technology.

2. Current Status and Proposal of Disaster Management Systems

2.1 Current Status and Problems of Disaster Management System

The disaster management system is mostly operated based on GIS and is continued to develop gradually, which operates as an integrated system that collects location-based data, predicts, responds and recovery. It establishes standardization by exchanging information on human and physical resources between local governments and neighboring countries[1,2]. As shown in Fig. 1, the disaster management system focuses mainly on the four stages of disaster management such as preparedness, response, recovery in natural disaster areas. It is relatively insufficient in the field of social disasters, which is mainly about emergency disasters, and the prevention and preparedness phases are less coped than the response and recovery phases. It provides a one-way service to users by using a network or terminal device for information communication environments such as voice, data integration, broadcasting communication and the Internet. It is also insufficient for the application of private smart disaster IT information technology. There is still a limit on providing customized analysis information and coping with disaster prevention stages that users can easily access.

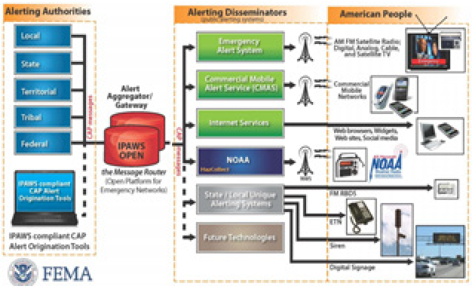

Fig. 1. As-is Disaster Management System Example) IPAWS Architecture in USA

2.2 Proposal of To-Be Disaster Management System

Since 2010, the ICBMA of the 4^{th} Industrial Revolution era has been making rapid change on daily life and business such as smart factory, smart city and autonomous vehicle by smart IT information technology using intelligent information. Civil disaster management technology is also getting developed by applying the intelligent information technology. The national disaster management system will also propose an improvement plan of the To-be disaster management system as shown in Fig. 2. Hyper-connected intelligent infrastructure is constucted and generated big data based on signs of disaster and those analysis results before & after the disasters through the privately-run IT devices. This kind of infrastructure can enhance and improve the preparation and response stage of the current disaster management system.

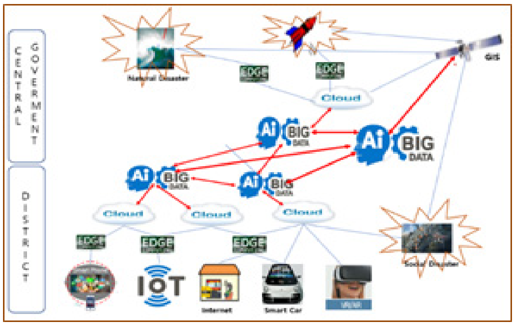

Fig. 2. Architecture of To-be Disaster Management System Architecture

Subsequently, Big Data of disaster Signs clean up and classifies data with Edge + Cloud Computing according to its purpose at the right time. Then, the refined and classified information can be shared with each other to prevent disasters through the results of supervised and unsupervised learning or reinforcement training by AI.

Finally, it is possible to recommend appropriate disaster prevention education in advance by AR / VR technique using big data and AI analysis results, for those who are exposed to the possibility of specific disasters.

This can enhance coping capabilities at the disaster prevention stage and provide users with customized disaster prevention information in a timely manner.

3. Case Studies and Discussion

3.1 National Disaster Management Information System Case

1) Disaster management, which is organized by FEMA(Federal Emergency Management Agency)in America, systematically responds and manages disasters with the NIMS as a national disaster management system. Based on the NIMS information system, core technologies are used for connection and integration with the relevant DBs, such as geographic information, population, real-time disaster information, and registration information for recovery and rescue. NIMS operates five componentsas shown in Table 1 [3].

The Integrated Public Alert and Warning Systems (IPAWS) program in conjunction with NIMS is a rapid disaster forecast and alert delivery that protects the life and property of the American people, as shown in Fig. 1.

It is on reinforcement that federal, state, and local governments are using a variety of means

Table 1. 5 components of NIMS

Component	Content
Preparedness	Incident Response Integrated management planning, organization, equipment, etc
Communication and Information Management	Emergency management and incident response activities are based on information management and organic communication
Resource Management	Standardized resource management inputs, shares and traces such as personnel, equipment, teams, materials
Command and Management	The command and management elements are based on a flexible and standardized incident management
Management and Maintenance	Provide technology through management such as monitoring according to national disaster man' system

of communication to provide integrated disaster-related services to their communities.

Also it is a main purpose that is built and managed an integrated interconnection system for disaster warning. And it is provided effective alerting services and resilience of IPAWS infrastructure etc. IPAWS is based on EAS establishes delivery system as representative alarm delivery medium and is in use a various alarm delivery media such as alarm service (CMAS), which is based on commercial mobile phone, internet service and special alarm system. It uses a common alerting protocol called CAP (Common Alerting Protocol), which is delivered using the same CAP message format regardless of the disaster alerting agency[4,5].

2) Japan's Disaster management is coping with public-private cooperative governance based on experiences that have been experienced through large-scale typhoons and earthquakes. Japanese government has been establishing the Disaster Prevention 4.0 Future Initiative Project, which emphasizes overcoming the limitations of the government-led response. It provides a comprehensive disaster prevention information system that integrates disaster information throughout the country such as increasing accessibility of organizations and individuals to a reliable disaster information.

The J-Alert (Japan Emergency Alert System) was established to deliver emergency information to residents, which quickly uses communication satellites and local disaster prevention wireless. The advantage is that it can deliver information such as large-scale disasters, ballistic missiles, and attacks that need emergency response directly and quickly to the people[5]. J-Alert is a satellite-based system as shown in Fig. 3, which allows authorities to quickly alert citizens and guide indoor and outdoor evacuation through speakers, television, radio, email and broadcast systems across the country[6-9].

3) Disaster management in Germany is managed by BBK(Federal Bureau of Investigation) and it's system is based on the Copernicus program operated by Europe as a whole.

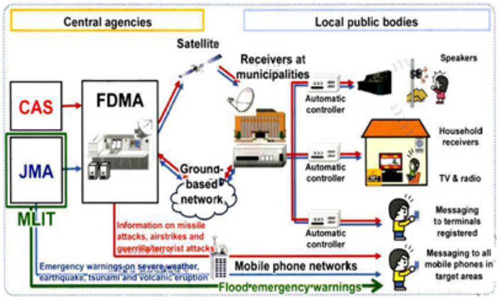

Fig. 3. J-Alert Configuration Diagram

This is an infrastructure program that observes the land, the ocean, the atmosphere, and the climate.

It uses its own satellite for emergency management services. Emergency Management Service (EMS), a core service function, shows all stages of crisis management through satellite image analysis and understands the progress with information on buildings and traffic conditions[10]. By providing an analysis of potential threats, it helps a lot in risk management and decision making. The modular warning system, as a means of spreading disaster, has been based on GIS since 2013. A Warn-App of NINA in the mobile phone is quickly provided specific action information to protect citizens in various crisis situations[11].

3.2 Cases of disaster management using intelligent information technology

3.2.1 Case of social disaster

1) In case of a fire accident, a fire detection device (detecting flame, smoke, temperature etc.), as shown in Fig. 4, is installed to detect a fire. Fire is detected by connecting the device or control room / center based on IoT technology. The usage of monitoring system that sends fire alarms is increasing. Seoul City installed 243 intelligent fire detection systems in the

traditional market in Gangdong-gu and the information is automatically delivered to the Seoul Comprehensive Disaster Prevention Center and store owners when heat or smoke is detected for more than 5 seconds [12].

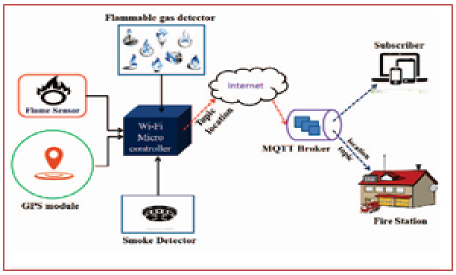

Fig. 4. Fire detection alarm monitoring system

2) Explosion accidents are mostly gas leakage accidents. IoT devices are installed in specific spaces to monitor and analyze signs before gas leakage(facility corrosion etc.) or after gas leakage(gas concentration exceeding etc.). Those devices predict explosion and provide autonomous control method. The closed space safety management system collects environmental information with internal residual gas measurement device and delivers the information to the control center through wireless communication and wired(wireless) network. This system notifies the dangerous worksite based on the information DB of the risky area[12].

3) In the collapse event, ground displacement system technology was developed to accurately analyze the condition of ground facilities such as tunnels in real time. By measuring the displacement of the ground facility and changing the shape information, it was possible to analyze the condition of the facility in real time and to identify the dangerous state to prepare for the collapse[12].

4) The environmental pollution accident is a monitoring device installed in rivers nationwide by establishing a remote monitoring system of river water quality to monitor the pollution discharge situation in real time at the control center. Management measurement indicators such as pH and COD are automatically measured and emissions of water pollutants are reduced[13].

3.2.2 Case of natural disaster

1) Flood damage is being introduced in such a way as to identify blocked channels due to heavy rain, to share and spread the information on the location of the damage. the Urban Flood project in the EU, which is carried out, locate pressure sensors and flow sensors on the bank and provide a flood early warning system and a real-time risk management system by analyzing the data[12].

Fig. 5. My Shake Execution Screen

2) The earthquake damage is going to prevent itself. the result of the earthquake information analysis is transmitted quickly to the citizens and the infrastructure of the risk area using IoT technology. My Shake, as shown in Fig. 5, recently developed in the United States, is an application that is provided to citizens on a smartphone for real-time information such as earthquake magnitude and epicenter when an earthquake occurs. It can be judged by AI technology whether vibration is caused by life or earthquake[12].

3) Tsunami / storm damage has been developed to forecast storms and tidal waves and to predict tsunami flooding and complex disasters in coastal areas during storm invasion. It is possible to calculate atmospheric pressure

by using weather forecast, set storm occurrence information by combining with tidal information, and provide data of storm tide forecast result through analysis and visualization[14].

4) Green algae damage occurs because the algae grow in large quantities above a certain temperature. Thermal Line Sensing (TLS) technology maximizes the detection of temperature changes inside the water with a compact sensor on the line that has fallen into the water. Data measured from multipoint temperature monitoring sensors are sent to the control center and analyzed to predict green algae[15].

3.3 Results of Comparative Analysis

3.3.1 Comparison of Disaster Management System and Disaster Intelligent Information Technology

Based on the contents of the national disaster management system (3.1) and civil disaster prevention smart IT technology by disaster type (3.2) described above, the current ICT technology and ICBMA-centered smart IT technology utilization status and comparison are shown in Tables 2, 3 below.

Table 2. Comparison of Smart IT Technology of Nation Disaster Management System

EMS	Disaster preparedness, response, recovery phase				Disaster prevention, preparedness phase			
	GIS	Broad cast	Wired /less	Inter net	Mob ile	IoT	Big Data	AI
IPAWS (USA)	◎	◎	◎	◎		X	X	X
J-Alert (Japan)	◎	◎	◎	◎		X	X	X
MoWAS (German)	◎	◎	◎	◎	○	△	X	X

◎: High utilization, ○: Moderate utilization, △: Utilization Initial State, X: Almost no utilization

Table 3. Comparison of Smart IT of Private Disaster Prevention Technology

Disaster Classification & Type		D - prepared, respon',recov'				D - prevention, prepared phase			
		GIS	Broad cast	Wir ed/ less	Inter net	Mob ile	IoT	Big Data	AI
Soc ial Disas ter	Fire	○	◎	◎	○	◎	◎	△	X
	Explosion	△	◎	◎	○	◎	◎	○	X
	Collapse	○	◎	◎	◎	◎	◎	○	X
	Pollution	○	◎	◎	◎	◎	◎	○	X
Natural Disast'	Flood	◎	◎	◎	◎	◎	◎	◎	X
	Earthquake	◎	◎	◎	◎	◎	◎	◎	△
	Tsunami	◎	◎	◎	◎	◎	◎	◎	X
	Greenalgae	◎	◎	◎	◎	◎	◎	◎	X

3.3.2 Implications of Intelligent Information Technology Utilization Comparison

1) The national disaster management system, as shown in Table 2, operates mainly on broadcasting, wired and wireless communication, and the Internet based on GIS. It mainly focuses on disaster preparedness and recovery. Emergency alert system (EMS), the US IPAWS, Japan J-Alert, and Germany MoWAS are serving their own people. It is being developed from the user's point of view and recently began to use the disaster application of personal mobile.

2) Private disaster prevention IT technologies, as shown in Table 3, are adopting intelligent information technologies with a focus on mobile, IoT and Big Data, and are actively being developed in the field of social disasters. Big Data, which has been detected and accumulated through the IoT, is expected to utilize Cloud AI and AR / VR. Private disaster prevention technologies are developing and spreading toward disaster prevention and monitoring rather than disaster preparedness and response.

3) The national disaster management system, which is continuously operating an analytical information system based on the data accumulated in the GIS, needs to utilize the disaster signal detection data by interconnecting them. It is expected that complementary

measures will be needed to enhance disaster prevention and capacity.

4) The followings were the insignificant applications of Big Data and AI technology to the national disaster management system. In the social disaster field, it is difficult to collect data. The field is not equipped with a collection system because those data are generated by private information technology equipment. On the other hand, in the natural disaster field, Big Data was collected and accumulated from natural disasters such as storm and flood damage, earthquake, etc. Since AI's deep learning model appeared in 2016, it began to develop learning models and algorithms in specific disaster management fields from 2018. However, the application for the national disaster management system will soon be realized.

5) Among the architectures proposed in Figure 2, the proposals and application methods for the national disaster management system are as follows. Since it is in the stage of developing models and algorithms for storm and flood damage, earthquake and tsunami, it is suggested to be expanded to other natural disasters while being applied those to the national disaster management system. In the social disaster field, we define a classification of data collection items in Mobile and IoT devices, and review the database structure, and then propose the design of the architecture using Cloud. It is necessary to apply it to specific social disaster items with urgency, ripple effect and importance, etc.

4. Conclusion

The national disaster management system is mainly operated in the disaster preparedness, response, and recovery stages centered on natural disaster management. On the other hand, the application of intelligent information technology to civil disaster prevention technologies is being developed with the focus on disaster prevention and preparation. Especially, they are actively developed and utilized not only for natural disasters but also for social disasters.

The national disaster management system manages the vast accumulation of data and analytical information continuously collected by GIS. It is necessary to establish a super-intelligent infrastructure that utilizes disaster signal detection data of private disaster management technologies in conjunction with each other. Disaster management system will be built up on national data and social disaster management.

The disaster management system can also be upgraded to the current management system by constructing a super-intelligent infrastructure like the one proposed in this paper in Figure 2. Based on this Big Data, supervised, unsupervised learning and reinforcement training of AI can provide customized information in a timely manner and appropriate disaster prevention education can be conducted by AR / VR technique. In the long run, it is necessary for users to change disaster prevention management system.

The disaster prevention technology utilizing intelligent information technology in the 4th Industrial Revolution era is growing as one of the civilian industry. As the case mentioned above, it presents a solution to prevent and prepare for disaster with intelligent convergence service. Recently, it is a good opportunity to develop the disaster prevention IT technology industry in the position of the leading country that Korea introduced for the first time as 5G. It is expected that long-term research review is necessary to build a disaster management system or platform by linking and converging with the private smart IT technology on the national disaster management system.

REFERENCES

[1] J. P. Kim. (2019). A Study on smart IT technology application to national disaster management system. *The 9th International Conference on Convergence Technology*, 539-540.

[2] O. O. Lee. (2015). *Introduction to Emergency Management*. Sang Neung Publisher, 358-372.

[3] B. G. Lee. (2018). A Study on the Disaster Safety Management of Local Governments in Smart Society. *Wonju Korean Research Institute for Local Administration*, 81-113.

[4] S. J. Choi. (2015). A Study of Operation Plan for Efficient Public Warning. *KCC*, 12-13.

[5] Ipaws components. https://www.fema.gov/ipaws components

[6] S. H. Park. (2015). Research on improvement of evacuation guidance system, based on evacuation simulation. *National Disaster Management Research Institute*, 32-33.

[7] *MIC*. https://www.soumu.go.jp/johotsusintokei/whitepaper/ja/h28/html/nc269240.html

[8] *UTM*. https://people.utm.my/noreliza/foundation of river and basin integrated communication frics tokyo japan/

[9] *Wikipedia*. https://en.wikipedia.org/wiki/J-Alert

[10] *Corpenicus EMS*. https://emergency.copernicus.eu/mapping/ems/what-copernicus

[11] *KOREA CC*. https://m.blog.naver.com/kcc1335/220884055370

[12] S. I. Myong. (2018). IoT Based Disaster Mitigation and Monitoring Technologies. *Electronic and Telecommunications Trends*, 103-108. DOI:10.22648/ETRI.2018.J.330110

[13] J. G. An et al. (2010). Status of Pollutants Through Clean SYS (Smoke Stack Tele Monitoring System). *Korean Society for Atmospheric Environment*, 235.

[14] J. G. Kim et al. (2013). Development of Hydrologic Hydrodynamic Flood Coupling Model (1). *National Disaster Management Research Institute*, 11-1312184-000048-01

[15] O. H. Oh et al. (2016). Water purification apparatus having multistage model. *KIPO*, 10-2016-0020644

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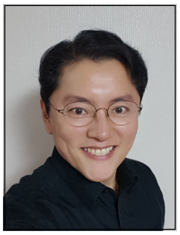

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