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RESEARCH ARTICLE

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AI advisor platform for disaster response based on big data

Minho Lee[1] | **Libor Mesicek**[2] | **Kitae Bae**[3] | **Hoon Ko**[4]

[1]Department of New Media Business, Seoul Media Institute of Technology, Gangseo-Gu, South Korea

[2]Department of Economic and Management, Jan Evangelista Purkyne University, Usti nad Labem, Czech Republic

[3]Department of New Media Business, Seoul Media Institute of Technology, Gangseo-Gu, South Korea

[4]IT Research Institute, Chosun University, Dong-gu, South Korea

Correspondence
Hoon Ko, IT Research Institute, Chosun University, 309 Pilmun-daero, Dong-gu, Gwangju, South Korea.
Email: skoh21@chosun.ac.kr

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Abstract

In the past, the emergency responses to disasters such as fire outbreak accidents, accidents that require first aid were slow and not optimal. With human intellect, it was impractical to analyze vast amounts of data regarding the continuity of the numerous environmental changes and the correlation there may be with emergency responses based on past experiences with similar situations. Today, artificial intelligence is presented as a powerful tool to various organizations. Many have already made various attempts to apply this technology as an advisor for emergency response. This research expands on the practicality and effectiveness of utilizing AI as an advisory platform for disaster response based on the big-data, and also it designs an AI advisor platform for disaster response with big data-based algorithms. Finally AI advisor function are defined as part of the AI advisor platform, the voice recognition function, natural language processing function, big data coordination function.

KEYWORDS

analytic hierarchy process, big data, collaborative filtering, hierarchy structure, knowledge suggest system, multiple-advisor

1 | INTRODUCTION

Emergency responses must be fast and relevant to the situation. Otherwise, it delays the solving process and increases the risks of a disaster.[1] In the past, initial emergency responses to disasters were slow and not optimal. With human intellect, it was impractical to analyze vast amounts of data regarding the continuity of the numerous environmental changes and the correlation it may have with emergency responses based on past experiences with similar situations. Today, artificial intelligence is presented as a powerful tool to various organizations.[2] Many have already made various attempts to apply this technology as an advisor for emergency response. This research expands on the practicality and effectiveness of utilizing AI as an advisory platform for disaster response. Specifically, it is anticipated that an AI advisor system for emergency responses can be developed to increase the efficiency of the response. The proposed AI system begins with vast unstructured data put into AI algorithms as train data and undergoing experience-based analysis, so that the AI system can function as an expert that can deliver practical guides to various disastrous situations.[3,4] Aside from the introduction section, the article is composed of Sections 2–5. In Section 2, the background behind the purpose of this research is discussed, followed by Section 3, where the AI advisor is described in detail. Afterward, the design of the system is explored in Section 4, and Section 5 is concluded with the results of implementing the AI advisor system.

2 | RELATED WORK

In order to resolve the slow emergency response time, the following requirements are justified.

2.1 | Initial response

In order to shorten the response time and recommend practical responses, it is necessary to accommodate a systematically refined management of the diverse disaster responses.[5] Different emergency cases require different emergency responses. Due to the increased variety of types of disaster, there are numerous types of responses. A more systematically refined management of data can boost the speed of identifying the type of the situation and the urgency of the matter. It requires a natural language processing knowledge base and engine with emergency response ontology enabled and a deep-learning model designed to learn and recognize the context of the various situations must be designed.[6] The application of this model is crucial in making faster reliable judgments and procuring more "golden time".[7,8]

2.2 | Situation recognition

Aside from the initial response aspect of the proposed system, it is necessary to develop a platform with a model that can be continuously trained to improve its performance through response verification and machine learning based on the behavior of on-site response experts.[9,10] The requirements for the performance enhancement features are next the first is the deep learning algorithms structured with reinforcements so that it can continuously adapt to the diversity and maximize the rewards in the long term. And second is the template for the context of various emergency responses for enhanced identification of situations.[11]

2.3 | Interconnection of national disaster integration network operation centers

The wireless communication systems must be developed so that once the national disaster network is integrated it can be applied for immediate use in the future. Therefore, the system must enable a wireless voice recognition system that can support a PS-LTE system that utilize the domain knowledge of wireless communication systems.[6,12]

3 | AI ADVISOR

3.1 | The logical structure of the system

Figure 1 illustrates the logical structure of the proposed AI advisor system.[13,14] The structure incorporates a voice recognition system that consists of an abita core for voice recognition, an abita adapter for voice distribution and data management, and LMAATM for automated learning. The system also supports GUI, which makes the system more convenient for monitoring purposes. The training tool set for voice recognition systems includes an acoustic model and a wired telephone voice language model. Table 1 explains the logical structure of the system.

3.2 | Language knowledge builder flowchart

The builder tool extracts text data from documents to construct a new dictionary of disaster-related terms by applying new meaning into the extracted terms.[15,16] The builder is designed so that the new dictionary of terms, created from the data-building tool, can be examined by language-knowledge inspectors before being inserted into the big data systems[17] in Figure 2. Table 2 defines the manual to each situation.

4 | DESIGN

4.1 | Interface design

The voice recognition servers are designed so that the servers can be requested through either real-time interfaces or client requests in stand-alone mode and intersystem interfaces are designed to use TCP/IP methods and RestAPIs to receive interfaces with web-type clients.[18]

4.2 | Design of morpheme analyzing module

A sentence preprocessor for the morpheme analyzer refers to the process of finding a sentence in the text received from the speech recognition system and processing the sentence into special characters and exceptions.[19,20] A morpheme is defined as a minimally meaningful unit

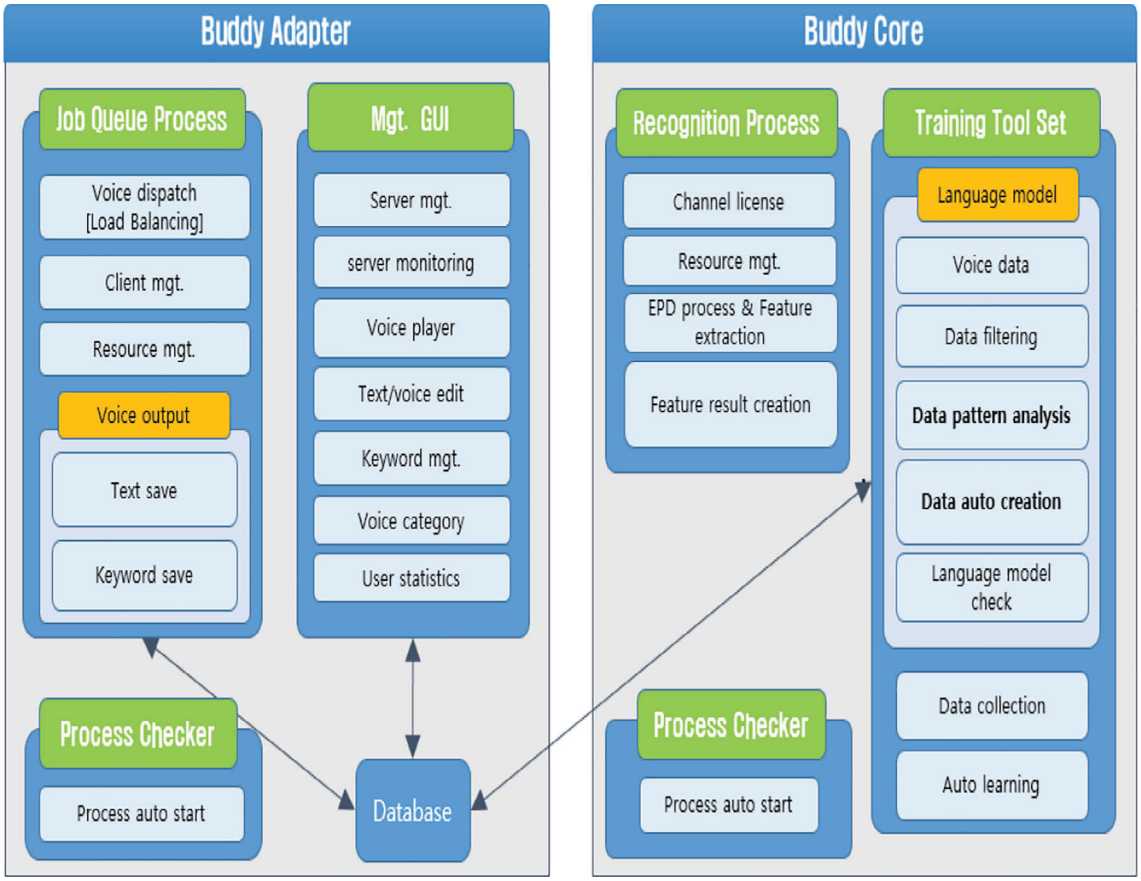

FIGURE 1 System logical structure

TABLE 1 The logical structure of the system

Name	Contents
The acoustic model	In order to ensure a high recognition rate of wired voice data, an acoustic model trained with around 3000 h of sound data of actual disaster sound, noise, and visualization is included in the training tool set
The language model	Extracts voice characteristics used in the navigation engine through analysis of voice after processing. Around 200 h worth of wired telephone voice converted into shorthand data and around 1000 domain-related keywords are trained into the model. The model trains by processing the applied data through this model to be filtered until only relevant data is left. The remainder is then refined to create a domain-specific enhanced model

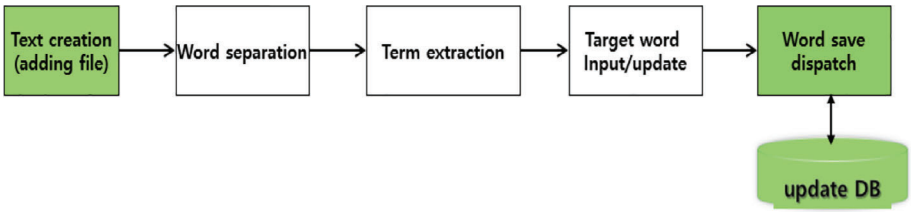

FIGURE 2 System processing step

TABLE 2 Language knowledge builder flowchart

Name	Contents
Load document	A module that loads relevant document files for keyword extraction.
Document text tokenization	A module that splits the text of the document into list of words.
Term extraction	A module that derives morphemes from words and lists the same terms by parts or combinations of parts to display the number of duplicate words and visualize them so that new terms can be created.
Entering and modifying relevant terms	A module for entering or modifying the terms (representative synonyms) in the list of terms.
Save and export terms	A module that saves and export the list of extracted terms as an excel file.

that loses its meaning if broken down any further, such as a simple word's root, a single word or survey, a prefix, or a suffix. It is essentially a module that breaks a sentence and puts it into a Hangeul morpheme analyzer.[20] As the first step of the natural language processing system, the Han-gul morpheme analyzer recognizes each morphemes that can be broken down according to how the word is spaced out and restores split morphemes into their original form (word) should the broken pieces show irregular form, abbreviation, or needs to be eliminated. The morpheme analyzer begins from processing a document → document preprocessor → word analysis → form(meaning)-tagging → result.

4.3 | Parser design

The parsing system is a system that enables a computer to analyze the patterns on how human beings read its structure and understand a sentence through syntax analysis. Syntax analysis is the process of analyzing the structure of a sentence by systematizing the syntactic structure. Through this, the results from the morpheme analyzer are designed to achieve more accurate results.

4.4 | Intention analyzer design

The intention analyzer uses keyword-based parsing to analyze the form of accident, the severity according to the type of the accident that is then further analyzed according to its severity grade. It is designed to match and analyze the syntax pattern of the accident to an already existing pattern for further analysis.

4.5 | Big data linkage collection service design

As it references in Table 3, the big data linkage collection service is a module that collects database, file, web data, and web service data. It is designed so that the service collects and saves disaster-related data on the storage platform under a system Figure 3.

4.6 | Big data storage structure design

The big data storage structure requires RDB, NoSQL, File, and Web data storage to store the various data collected, and is designed to store both structured and unstructured data.

4.7 | Big data visualization design

After the data collection, storage, utilization and sharing stage, the system is designed so that it can handle, analyze and provide visualization for an exponential data paradigm due to IT technology advancements and broader mobile environments (Table 4).

4.8 | Intelligent advisor flow diagram

As it shows Figure 4, the AI advisor module consists of a preprocessor module and disaster response recommendation module.

TABLE 3 Big data linkage collection service design

Name	Contents
Distributed indexer server	It is a collection module for DB data, XML/JSON data, and a module used to configure the time(frequency) of the collection.
Data linkage collection management service	It is a data linkage, collection and management module, such as public data connection, fire disaster data collection and management, and service operation management.

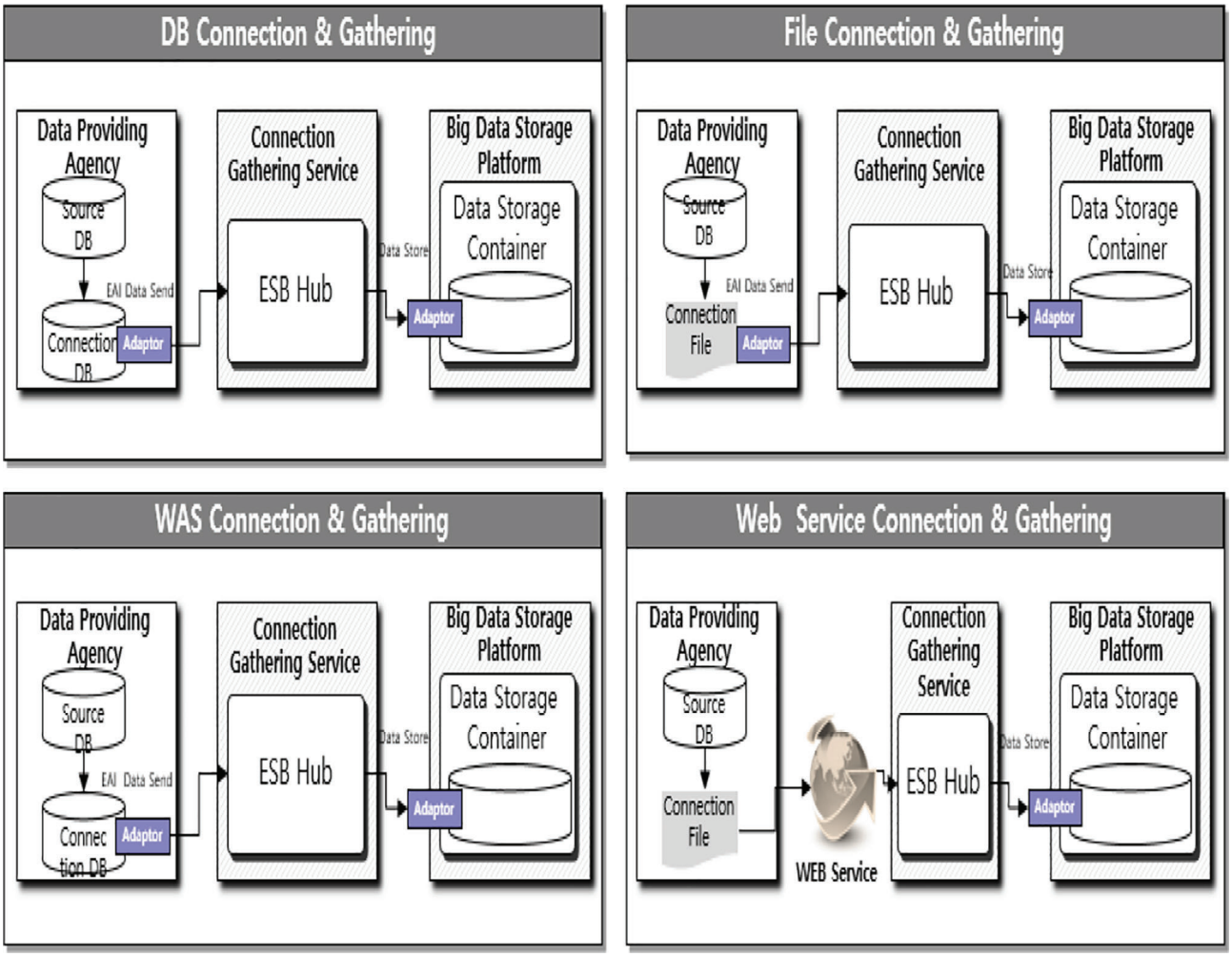

FIGURE 3 Linkage collection service configuration

TABLE 4 Data

Name	Sortation	Number of cases
Response manual by disaster type	Response manual	500 cases
On-site wireless voice connection	Wireless voice connection	10,000 cases
On-site wired communications	Voices from wired connection	10,000 cases
National public POI data	Address data	100,000 cases
Key journal data	Journals, and so forth	300,000 cases (over the past 2 years)

4.8.1 | Preprocessor module

The voice recognition interface is developed as a client/server with the voice processing system with the application of TCP/IP socket. The voice recognition interface contains that the voice recognition interface is designed to operate as a client (REST based), As the combined Processing, it designed to incorporate packets for better network message transmission performance and ease and in the feature extraction, the extracts characteristics from the collected disaster level data and classification dataset. This is carried out by converting raw data into cases are extracted as a component of the input data to calculate and apply the TF∗iDF value.

4.8.2 | Disaster response recommendation module

There are a function, utilizes scikit-learn, optimizing supervised learning and creating a learning model in disaster response recommendation module. In the function, it creates a disaster safety learning model based on a supervised learning method based on the known qualities of the disaster.

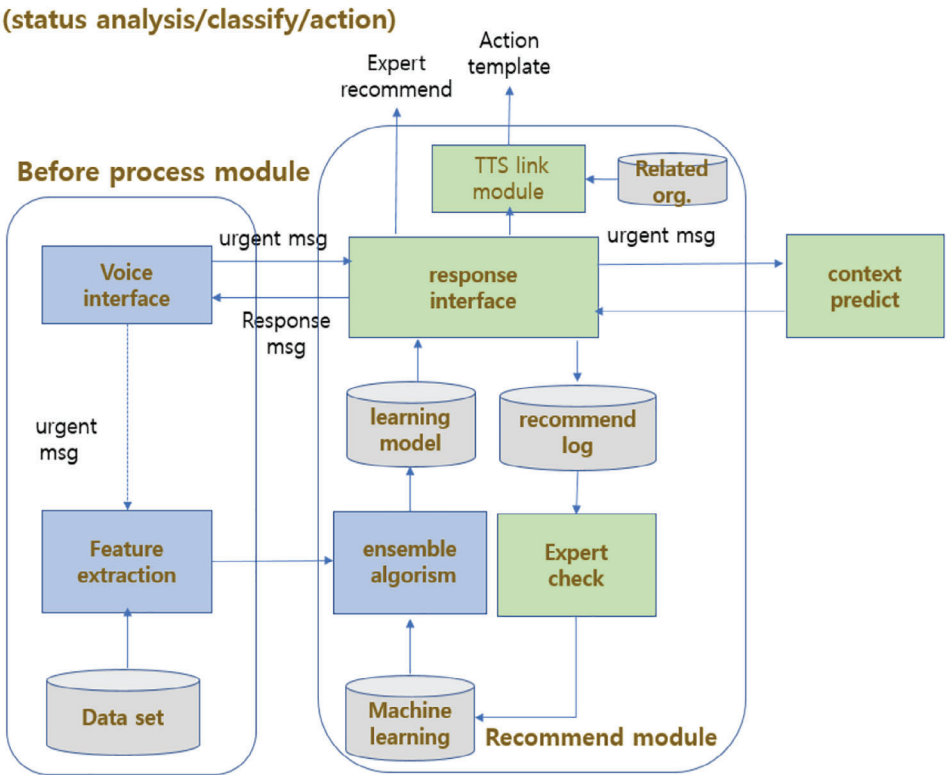

FIGURE 4 AI advisor flowchart

Next utilizes scikit-Learn to develop a supervised learning method that incorporates the ensemble algorithm, then it undergoes supervised learning for optimizing precision and recall rate in the optimizing supervised learning. Finally, as the creating a learning model, a disaster safety learning model coordinated by kNN, Naive Bayes, and ensemble-based support vector machine classifier.

5 | ANALYSIS

5.1 | Big data analysis and visualization

Big data analysis techniques were refined and improved to fit large-scale data processing for analysis and visualization after statistics and computer engineering, especially machine learning, data mining, text mining, opinion mining, and social web analysis (Table 5).

5.2 | Analysis of fire outbreak categories and recommending situation-specific responses

Table 6 shows the action guidelines for fire outbreak reporter.

TABLE 5 Big data analysis and visualization

Analysis technique	Content of analysis
Data mining	- conducted pattern recognition on big data.
	- conducted statistics and AI techniques to decipher correlation between data and insightful information.
Text mining	- conducted text-processing (information search, extraction, systemization, analysis) for new insightful data from text-based data
Opinion mining (sentiment analysis)	- used to extract the opinion form within text data (whether the opinion was positive, negative or neutral).
Social web analysis	- monitoring nlp extractions from social media to predict future issues.

TABLE 6 Fire outbreak category analysis according to fire classification

Fire outbreak category		
fire outbreak in high building	house fire	fire in underground facility
fire in accommodation facility	vehicle on fire	fire in education facility
in-flight fire	environmental pollution	gas leak
buried accident	chemical substance accident	building collapse
terror bomb threat	car accident	radiation leakage

- Induce human evacuation (broadcast facts of the situation)
- Restrict hazardous areas
- (If fire extinguishers are present) provide guidance on initial fire suppression
- (Remove risk factors) cut off electricity, execute gas leakage prevention measures, and eliminate any other hazards.
- Open emergency exits.
- Inspect fire fighting apparatuses.
- Tunnel (vehicle) fire: if the fire cannot be extinguished, turn off the vehicle engine and escape.
- Forest fires: move to a safe place and spray water on buildings if there are any dangerous substances, such as gas leakage.
- (In case of a leakage accident) check on gas valves for any leakage
- Checking the operation status of fire doors, ventilation equipment, fire hydrants, SPs, and so forth and informing them to take action
- (If the reporter is safe) move obstacles or parked vehicles, and so forth for fast entry of fire trucks to fight off the fire

5.3 | Analyzing the first aid categories and recommending contextual responses

Table 7 defines the first aid emergency reporter action manual.

- Check the health status of the reporter.
- Know exactly what happened.
- Check the health status of the patient.
- Check the safety of the reporter and the patient's current status.
- Conduct injury severity check.
- Check the caller's information.
- Check the availability of ambulances.
- Identify transportable hospitals → Notify hospital paramedics.
- Ensure the availability of all vehicles.
- File a final situation report.

5.4 | Analysis of rescue-type emergency categories and recommendation of emergency responses according to category

Table 8 is for a categories that a situation can be categorized after analysis and classification, and next is the rescue-related action manual.

TABLE 7 Emergency category analysis according to fire classification

Emergency category		
seizure	cardiac arrest	cardiac arrest
dyspnea	neurological damage	assault/sexual assault
puncture/penetration, gunshot wound	animal bite wound	blockage in respiratory tract
burn	mental/behavioral disorder/suicide	injury from falling off
car accident	pregnancy/delivery/abortion	addiction

TABLE 8 Rescue category analysis registering to fire classification

Rescue category		
car accident	fire accident	mechanical accident
mountain climbing accident	drowning accident	in-flight accident
train accident	typhoon/ heavy rain	gas leak
buried accident	chemical substance accident	building collapse
environmental pollution accident	falling accident	

- Check the safety of the reporter
- Restrict irrational actions and leaving safe zone
- Check the location of the accident
- Identify the number of people and request rescue
- Identify the possibility of additional urgent situations
- Confirm caller information
- Check fire truck availability
- Identify available hospitals (night/holiday)-> Notify hospital paramedics
- Check personnel number of the dispatch team and equipment condition
- Monitor the availability of each vehicle (water supply, refueling) required for the rescue
- File a final status report

6 | CONCLUSION

This study designed an AI advisor platform for disaster response with big data-based algorithms. As part of the AI advisor platform, the voice recognition function, natural language processing function, big data coordination function, and the final AI advisor function were defined. First, the design and the interface of the real-time voice recognition function were defined. Then the postprocessing module design and open source verification were handled. In the natural language processing section, the design of the language knowledge tool was introduced. Specifically, a morpheme analyzing technique was introduced followed by a parser and intent analyzer as part of the design. Afterward, the design of the big data linkage collection service and visualization was introduced. Finally, as part of the AI advisor function, based on the preprocessor models, an emergency response recommendation module was developed. As a result of this study, rapid response can be expected in various disaster situations, and in the future, the research is expected to expand and apply for special disasters, aside from general disasters.

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ORCID

Hoon Ko https://orcid.org/0000-0002-4604-1735

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