재난발생 시 재난 취약 계층의 효과적인 대피를 위한 재난 대응 콘텐츠

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Disaster Response Content for Effective Evacuation of Disaster Vulnerable Classes in Case of Disaster

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[요 약]

　오늘날의 재난은 단일재난 형태가 아닌 이차, 삼차 재난을 가져오는 복합재난의 형태로 빈번히 발생하고 있지만, 재난취약계층을 대상으로 하는 서비스가 부족한 실정이다. 이에 본 논문에서는 재난 발생 시 일반인이 아닌 행동적·언어적 측면에서 상대적으로 대응 능력이 떨어지는 재난취약계층을 대상으로 하는 재난 대응 콘텐츠를 제안하였다. 구현 결과, 제안하는 킬러 콘텐츠는 재난취약계층의 현재 위치에서 주변의 대피 시설과 재난 지역을 확인할 수 있으며, 재난 지역 회피 알고리즘을 기반으로 재난지역을 우회하는 대피시설의 경로를 안내하는 것이 큰 장점이다. 제안하는 재난 대응 콘텐츠는 재난으로 인한 요구조자의 심리적 안정감에 의한 생존율 증가와 요구조자의 위치파악이 가능함에 따라 구조자의 수색범위가 명확화 될 것으로 사료된다.

[Abstract]

　Recently, disasters occur frequently in the form of complex disasters that lead to secondary disasters rather than single disasters, but there is a lack of services targeting vulnerable classes. In this paper, we propose the disaster response contents for disaster vulnerable classes with relatively low ability to respond in case of disaster. As a result of the implementation, the proposed contents can identify the nearby evacuation facilities and the disaster area at the present location of the disaster vulnerable class, and it is a great advantage to guide the route of the evacuation facility bypassing the disaster area based on the disaster area avoidance algorithm. The proposed disaster response content is expected to increase the survival rate due to the psychological stability of disaster vulnerable classes, and the rescuers will be able to clarify the search scope of disaster vulnerable classes.

Ⅰ. Introduction

Disasters are largely divided into natural disasters and social disasters. Natural disasters are caused by natural phenomena such as typhoons, floods, heavy rain, storms and earthquakes, and social disasters are classified into social disasters caused by human accidents such as fire, collapse, and explosion. Today, however, these disasters do not occur as a single, secondary disasters are manifesting in a complex way [1-3]. In other words, the impact of climate change due to global warming is causing disaster impacts throughout society, and social evolution is accelerating the impact of disasters due to social and human conflicts [4-6]. In particular, the general classes can be reacted promptly in the event of such a complex disaster, while disaster vulnerable classes, such as elderly, children, pregnant women, disabled people and foreigners, are in a relatively vulnerable position. Therefore, it is necessary to develop disaster response contents that can safely evacuate disaster vulnerable classes in the event of a disaster and to develop services targeting disaster vulnerable classes. In this paper, we propose disaster response contents focusing on the response of disaster vulnerable groups in the disaster management process of prevention, preparation, response and recovery. The composition of this paper is as follows. Section 2 describes the proposed disaster response contents, and Section 3 presents the necessity of the contents proposed through experiments and considerations. The conclusions and future work are described in Section 4.

Ⅱ. Proposed Disaster Response Content

The disaster response contents proposed in this paper is an application that is activated immediately in connection with the emergency broadcast service and guides the nearest evacuation facility at the current location of disaster vulnerable classes.

2-1 Related Technologies for Mobile Application

1) App Actions on Smart Devices

The proposed disaster response content should be automatically executed when the disaster vulnerable classes receives a certain pattern of emergency disaster characters, and this service should be executed in the background. By registering an app as a service to handle one or more user intentions in an android-based application [7], users can interact with the smart device through the app action feature.

2) Custom URL Scheme on Smart Devices

The custom URL schemes that run apps in mobile applications and browsers mean strings like "http://", "ftp://" and "market://" [8]. This is a common technology that allows you to run other external applications when you click a specific link on the web or app in the mobile environment. However, the app to be executed must be installed in advance, and if the app is not installed, exception processing should be implemented.

3) Map Display on Smart Devices

The open API for map display on smart devices is provided free of charge by Google, Naver, Kakao, and so on [9-12]. For the various functions, it is necessary to use the paid version through affiliation. In this paper, the map API of Naver and Kakao is applied to test the possibility of proposed contents.

2-2 Proposed Content

1) Concept of Proposed Content

The concept of disaster response content (DAApp; disaster action application) proposed in this paper is shown in Fig. 1. If the disaster vulnerable classes receives an emergency disaster letter, the DAApp is activated by app actions feature and displays the map with location of evacuation facilities based on the current location. In addition, disaster vulnerable classes can be provided with the nearest evacuation facility that avoids the disaster area.
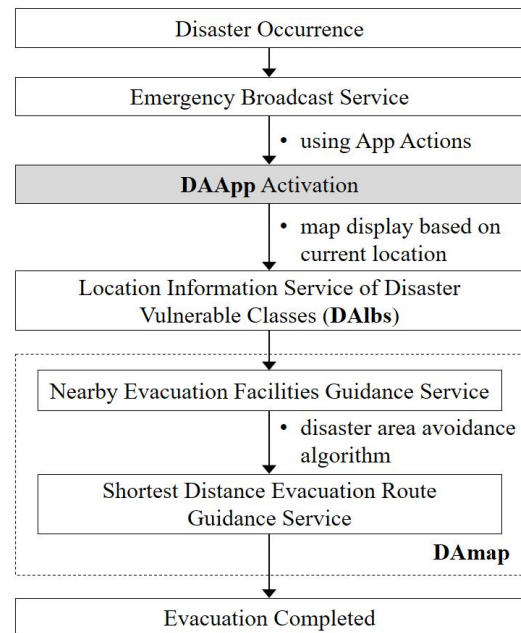

Fig. 1. The concept of the proposed disaster response content for the disaster vulnerable classes
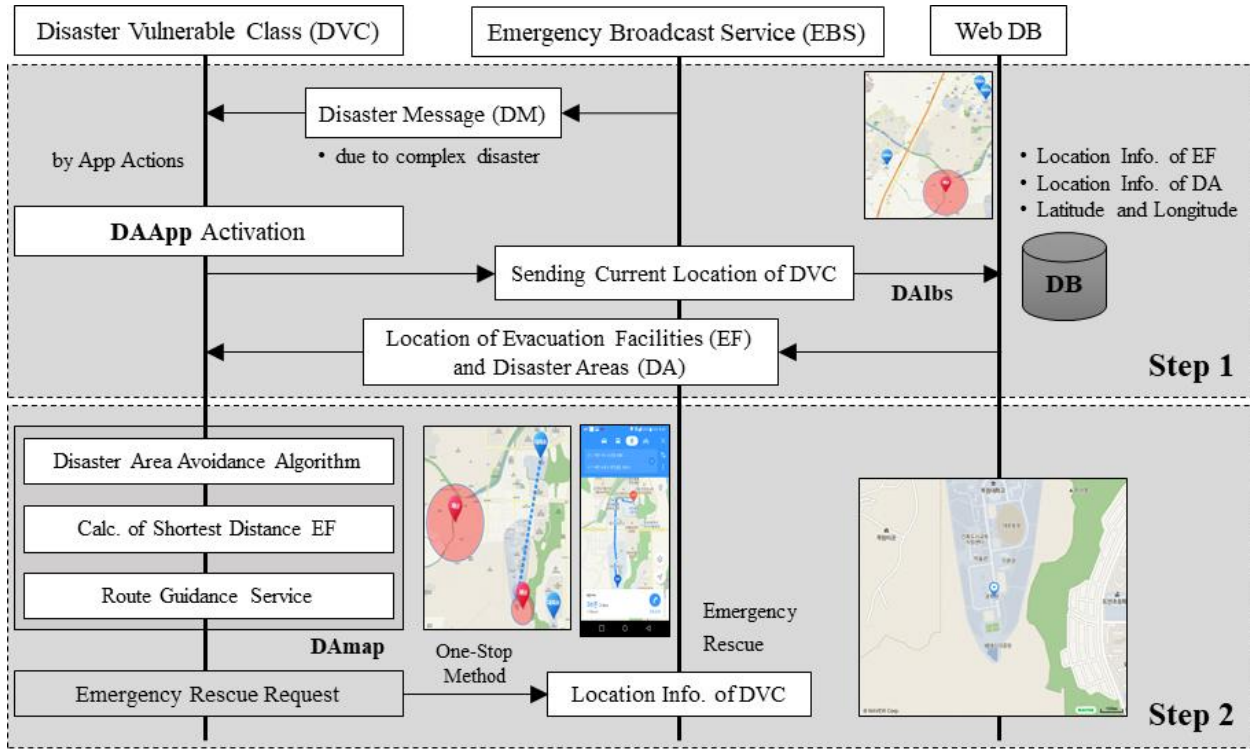
Fig. 2. The block diagram of the proposed disaster response content

2) Details of Proposed Content

The detailed contents of the proposed contents are shown in Fig. 2, and the implementation flow of the proposed content is divided into two stages. The first stage sends and receives location information of disaster vulnerable class (DVC), evacuation facilities (EF) and disaster area (DA) between the DAApp and Web DB. In the event of a disaster, the DVC will receive emergency disaster messages. At this time, the DAApp installed in the smart device of DVC is activated, and the current location of DVC (DAlbs) is transferred to the Web DB. Then, the DVC receives the location information of the evacuation facility and the current disaster area from the Web DB.

The second stage is the actual step of DVC evacuation, the DVC is guided to the nearest evacuation facility from the current location. Here, the evacuation route is applied to the disaster area avoiding algorithm described in Section 2-3, and the DVCs that are difficult to evacuate can also request one-stop emergency rescue.

2−3 Disaster Area Avoidance Algorithm

Effective disaster area avoidance should identify the distance between EF and DA based on DVC location. That is, as shown in Formula 1 and Fig. 3, whether or not the path through the DA can

be determined by determining the angle corresponding to the inner product of the triangle composition. Table 2 shows the code for calculating the angle θ in Fig. 3.

$$\theta = acos\left(\frac{AB^2 + AC^2 - BC^2}{2 \times \overrightarrow{AC} \times \overrightarrow{AB}} \right). \tag{1}$$
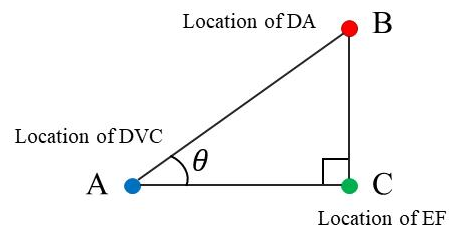

Fig. 3. Position relationship between DVC, DA and EF

Table. 1. Code for calculating the angle θ of Formula 1

variable	content
LoEF	location of evacuation facilities
D1	distance between DVC and EF
D2	distance between EF and DA
D3	distance between DVC and DA
float angle = (float) (acos((D3×D3 + LoEF.D1 × LoEF.D1 - D2×D2) / (2 × D3 × LoEF.D1)) × 180 / PI);	

In Fig. 3, if the internal angle θ of $\overline{AB}$ and $\overline{AC}$ is less than 90 degrees, it will pass through the disaster area. The analysis of the case where the angle θ is 90 degrees or more and the case where the angle is less than 90 degrees is shown in Fig. 5. The intersection point can be calculated by drawing a line at a right angle the DA on the line $\overline{AC}$. Given the straight line $a_1 x + b_1 y + c_1 = 0$ and $a_2 x + b_2 y + c_2 = 0$, the intersection point (P_x, P_y) in Fig. 4 can be obtained from Formula 2. Therefore, if the angle θ is less than 90 degrees, it means that the evacuation path passes through DA.

$$(P_x, P_y) = \left(\frac{b_1 c_2 - b_2 c_1}{a_1 b_2 - a_2 b_1}, -\frac{a_1}{b_1} \times \frac{b_1 c_2 - b_2 c_1}{a_1 b_2 - a_2 b_1} - \frac{c1}{b_1} \right). \quad (2)$$

(a) $\theta \geq 90$
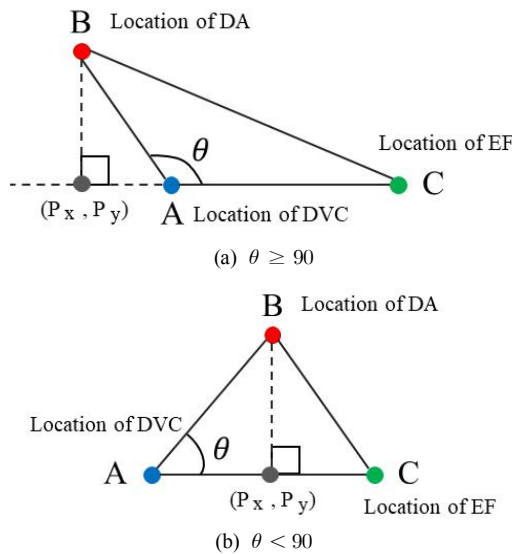

(b) $\theta < 90$

Fig. 4. Intersection of a right angle between DVC and EF for DA avoidance

Table. 2. Code for calculating an Intersection (P_x, P_y) of Formula 2

variable	content
LoEF	location of evacuation facilities
LoDVC	location of DVC
LoDA	location of DA
ILat	latitude of intersection
ILong	longitude of intersection

```
double m1 = (LoEF.Lat - LoDVC.Lat) / (LoEF.Long - LoVC.Long);
double b1 = LoDVC.Lat - m1 × LoDVC.Long;
double m2 = -1 / m1;
double b2 = LoDA.Lat - m2 × LoDA.Long;
double ILong = (b2-b1) / (m1-m2);   // Px
double ILat = m1 × ILong + b1;      // Py
```
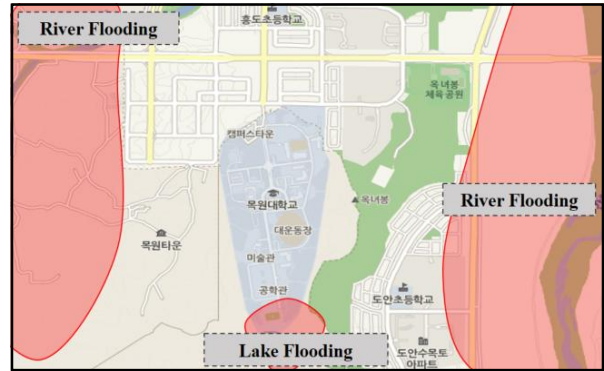

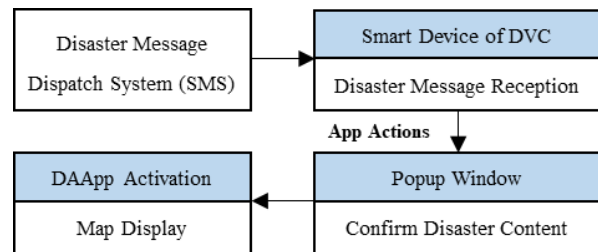**Fig. 5.** Declaration of disaster areas for testing based on virtual scenarios

Fig. 6. DAApp activation process with app actions

Ⅲ. Experiment and Discussion

In this Section, a virtual scenario is set up to test the performance of the implemented DAApp, and the implementation details are described step by step.

3-1 Virtual Disaster Situation based on Scenario

The virtual disaster situation setting is as follows. If a flood disaster occurs as shown in Fig. 5, the disaster response manager sends emergency evacuation message to the DVC.

· Disaster type : **heavy rain**
· Disaster occurrence date and time : 2018.11.22., 13:15
· Disaster location : **rivers and lakes flooding** near "OOO"
· Disaster message : [Disaster caused by heavy rain] Please evacuate urgently.

3-2 Disaster Message Reception and App Activation

When the DVC receive disaster message, the DAApp is automatically activated by the app actions feature described in Section 2-1. The DAApp activation process using app actions is shown in Fig. 6, and the implementation result in the DAApp is shown in Fig. 7(a).
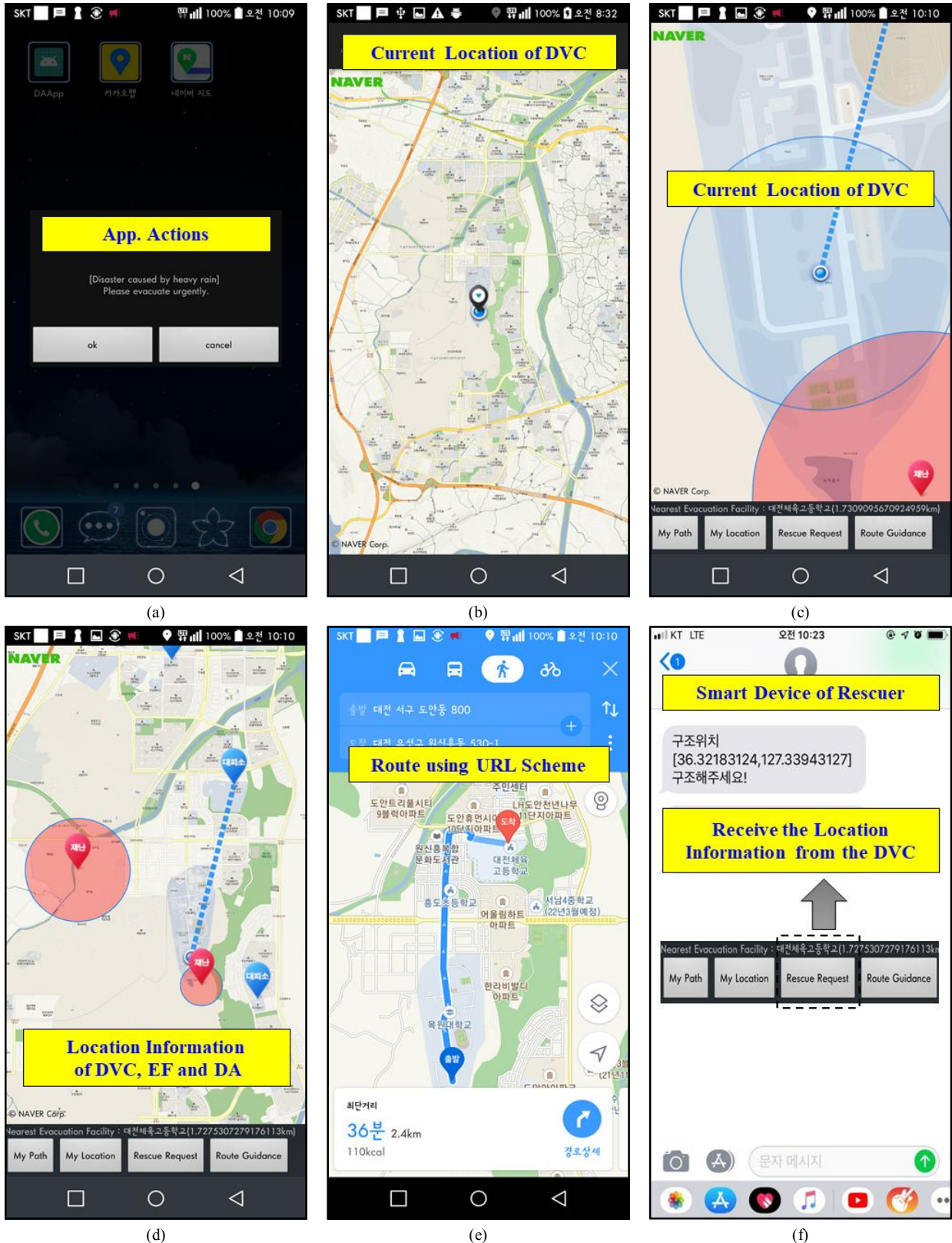
Fig. 7. Implementation results; (a) app actions; (b) current location of DVC; (c) result screen when clicking 'My Location' button; (d) result screen when clicking 'My Path' button; (e) result screen when clicking 'Route Guidance' button; (f) result screen when clicking 'Rescue Request' button

Table. 3. DAApp table structure in Web DB

field	type	primary	content
id	varchar	not null	DVC, EF and DA
lat	double	not null	latitude
long	double	not null	longitude
type	int	null	DVC(0), EF(1), DA(2)
time	datetime	null	current location transfer time of DVC
range	int	null	disaster scope

3-3 Transfer Current Location of DVC to Web DB

When the procedure in Section 3-2 is completed, the DVC transmits the current location and time to Web DB, and receives location information of EF and DA. The table structure of the Web dB is shown in Table 3, and the DVC can check the surrounding EF and DA based on the current position

3-4 Evacuation Route Guidance

The DVC can confirm the nearest EF with the DA avoidance algorithm described in Section 2-3 as shown in Fig. 7(c), and the route guidance is shown in Fig. 7(d) and Fig. 7(e).

3-5 Emergency Rescue Request

The DVC can request emergency rescue in case of inconvenience or difficulty in evacuation, and the DVC transmits the current location information to rescuer as shown in Fig. 7(f).

IV. Conclusion

In this paper, we propose and implement disaster response contents that enable disaster vulnerable classes to evacuate safely when a disaster occurs. The proposed content is focused on response time in disaster management process of prevention, preparation, response and recovery, and it is service technology targeting disaster vulnerable classes who are not ordinary people.

In particular, the implemented killer application has a great advantage that the disaster vulnerable classes can identify the evacuation facility and the disaster area around the current location, and guide the route to evacuate immediately. As a result of the implementation, it was confirmed that it is effective for the emergency evacuation of vulnerable disaster classes. The proposed content is expected to be highly scalable to various natural and social disasters such as water disaster, earthquake, fire, collapse of multi-cluster facilities.

Acknowledgment

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