Map Application for People with Disabilities Using Smart Devices

Soo-Jin Lee, Yang-Won Lee

***Abstract*—Starting with an appearance of iPhone, various smart devices have been released in recent years and many smart devices applications that have been developed give users practicality and convenience. Especially map applications such as Naver map, Google map and Daum map provide convenience by offering geographic information related a daily life closely. But, physically challenged people who have problems such as hand tremor and amputation (hands, fingers, arm), and so on, have great difficulty in the use of the map application. In other words, it means that the map application doesn't ensure accessibility. In this study, we developed a map application that can be used by physically challenged people. It offers users gesture and voice in different ways and furnishes with necessary geographic information related people with disabilities.**

***Index Terms*—Disabled people, Accessibility, Map Application Using Smart Devices**

I. Introduction

DUE to appearance of various devices which enable the general public to approach much more information than the past, the importance of user interface, which closely affects interaction between human and computer-action, has been emphasized. Especially, the needs of interfaces which are specialized to the disabled people are usually suggested in various research [1][2] in that the disabled people are known as the weakest class in information industry can be easily isolated from information devices.

Thus far the disabled people who can't use the specific sense of their own physical organs haven't been adapt to newly introduced devices and this inadaptibility has caused new kinds of information divide that is differentiated to existed one depending on gap between the rich and the poor [3]. The rates of 30.2% which mean mobile informatization level of the people with the disabilities in comparison with the public can surely show it. Although there are several reasons for this phenomenon such as burden of communication expense, unawareness about the use, absence of necessity, but it is main reason that the disabled people feel difficulties on using devices because of physical limitation [4]. If digital divide by physical limitation is deepened, it can cause the serious gaps between social classes [5].

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To resolve these problems of digital divide and to guarantee the disabled people equal rights against the non-disabled, many efforts on mobile accessibility are on with governments and organization. First of all, as a leader of web accessibility, W3C (World Wide Web Consortium) that highlighted the importance of web accessibility also suggests mobile accessibility guidelines [6] to which developers should consider whenever they develop mobile application. In case of Republic of Korea, Accessibility Guidelines 2.0(KWCAG 2.0) [7] and Mobile application accessibility guideline [8] were proposed and they have been applied as mandatory regulation with which venders should comply when they develop web applications since 2013. Other countries including U.S., Australia, Canada, the United Kingdom are on same situation, establishing disability discrimination act and ensuring accessibility for the disabled.

Meanwhile several technical materials to advance mobile accessibility of the people with disables have been suggested except the governmental efforts which are denoted so far. As representative example, Android which is mostly adapted operation system by smart devices with iOS also provides alternative methods that can replace general user interfaces as a way to improve mobile accessibility for the disabled. Various APIs such as Text-to-speech, Haptic Feedback, Gesture Navigation, Trackball and Directional-pad Navigation are usable to implement alternative user interfaces [9]. In case of iOS, similar methods are supported via 'Accessibility API' [10]. Also, in case of academic aspect, various studies applied existing technology are constantly suggested. As representative example, [1] suggested interface methods of smart phone, applying eye tracking method for people who are disabled with hand or are busy both hands that touch interface cannot be used and [2] suggested control system for the disabled people by using voice recognition instead of pressing button.

In spite of these endeavors, however, they are just a first step of changes and, in various field, they are not reflected yet. As a typical example, Daum and Naver map applications known as mostly used map application in Korea are evaluated as inappropriate applications to the disabled in evaluation of accessibility amongst most used Android applications in South Korea App Store [11] and also didn't reflect 15 article suggested as mobile application accessibility guideline by Ministry of Public Administration and Security in 2011. Particularly, the regulation for guaranteeing accessibility in map application is quite important because map application is frequently used in real life and has thick user layer. That is, research to improve accessibility of map application is needed.

In this study, therefore, hybrid application in which Android gesture and text-to-speech API are conflated with

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web map service is developed to improve accessibility of existing mobile map applications. As the application realized in this study provides simple interface by one panel and two buttons to accept users' gesture and voice as alternative interface, it makes the people with disability such as hand tremor, paralysis or amputation be able to use map application as normal people do. This paper is composed as follows. Firstly, types of map interfaces which can be easily used from normal person to the disabled people are searched in chapter 2. After that, in chapter 3, the features and structure of map application suggested by this paper is reported. Lastly, a review about the map application is stated through availability test of chapter 4 and conclusion of chapter 5.

II. Technique Element

A. Gesture

Smart devices appeared recently almost possess features of touch screen and this makes advantages of existing interface methodology such as gesture to be accentuated. Users can handle machines easily and intuitively by using the gestures as substitutional interfaces of clicking and typing to execute programs or to transmit commands [12], thereby, efficiency of task and availability of devices could be increased. Thus far, gesture interfaces have been provided in various aspects such as web and mobile environments.

Gesture interfaces are also playing a key role in map applications that is closely related with convenience of social life. In case of Google maps application, as supporting gestures like Fig1, it helps users easily access map interfaces like zoom-in, zoom-out, rotate and so on. On the other hand, another parts of inner interfaces of the map application that consist of several buttons and boxes can cause problems to the people who have disadvantages related with fingers or hands as map can't guarantee accessibility. Especially, the interfaces applied to smart phones or other devices of which size is too small to use is hard to be handled by people who can't move their hand or finger delicately.

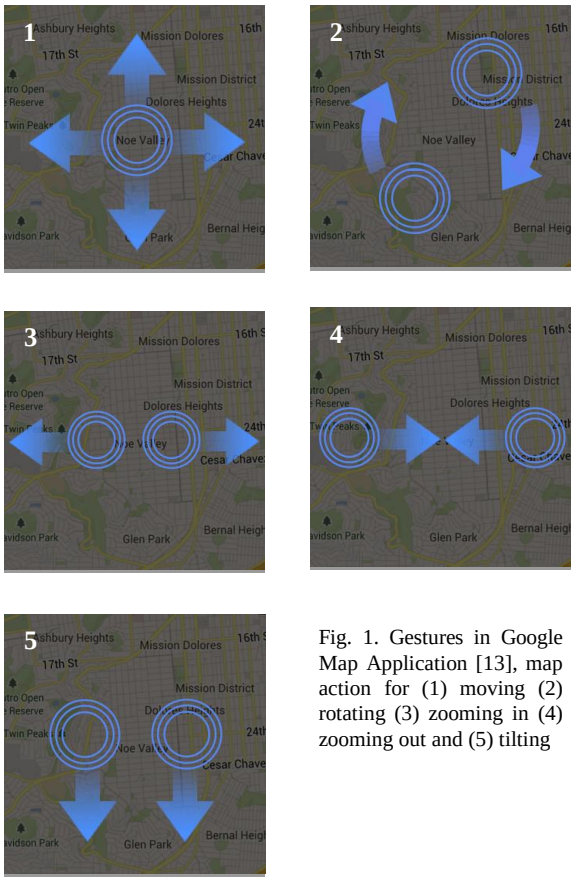

Fig. 1. Gestures in Google Map Application [13], map action for (1) moving (2) rotating (3) zooming in (4) zooming out and (5) tilting

Thus to complement the flaw of existing map application, the gestures which usually used to be utilized in specific parts of map control are appeared as main controller for map application. The feature of the gestures in this research is that they can be registered and used directly by users on map application. By doing this, users can apply familiar interfaces to map and realize more intuitive interface on mobile map application. In this paper, Android gesture API mentioned in introduction is selected as a method to realize gesture interfaces in map application.

The principle of gesture recognition in android API is by scoring a similarity between registered gesture and inserted gesture. When users make gesture lists after registering gestures, no matter how complicate it is, all of them can be scored and selected.

B. Voice

Voice recognition is a method that can control devices, handle process or execute methods by recognizing humans' voice and it is one of methods which usually has spotlighted. This interface is widely utilized in various fields, categorized as the four types depending on its purpose. According to each feature, it possesses differentiated strength [14] as specified in Table 1.

TABLE I
4 TYPES AND ADVANTAGES OF VOICE RECOGNITION [14]

Types of voice recognition	Advantages of voice recognition
1. Controlling device loaded a lot of functions.	It provides users with convenience by easily using devices without additional study and training.
2. Inputting data (when you are moving and working)	It raises productivity and safety about performing task in situation that hands and foots aren't free.
3. Providing personalized service in medical care, education, security and so on	It can catch identity, mentality, health condition, language ability through voice.
4. Processing real time information	It can input data rapidly because input speed of it is fast than typing.

Voice recognition is adequate not only to the people with the disability but also to the people who want convenience on using electronic devices. So far, diverse electronic devices like a desktop, tablet, television, vehicle navigation choose the voice recognition as substituted interface. Moreover, as iOS and Android which lead trends of smart devices provide libraries which support voice recognition function such as 'Voice Over' and 'Speech', they suggest the way for realizing applications to help the disabled people easily.

However, most mobile or web applications adopting the voice recognition method as user interface deal with function of voice recognition as the tool limited to typing and searching and it is hard to find examples of voice recognition for the people who have inconvenience to use smart devices.

Thus, in this paper, voice recognition function of Android

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Speech-to-text is selected as method to realize alternative interfaces for the disabled people. Almost feature of voice recognition API is similar with gesture API except that voice recognition which doesn't need to register original data as comparison target. What user said is transformed to text depending on its similarity. Then, as user can get list of answer words they can use them to search locations or to command map. Almost functions of the application in this paper are linked with specific words so user can utilize the voice as interface by interconversion between specific voice and specific text.

III. Implementation of System

A. System Architecture

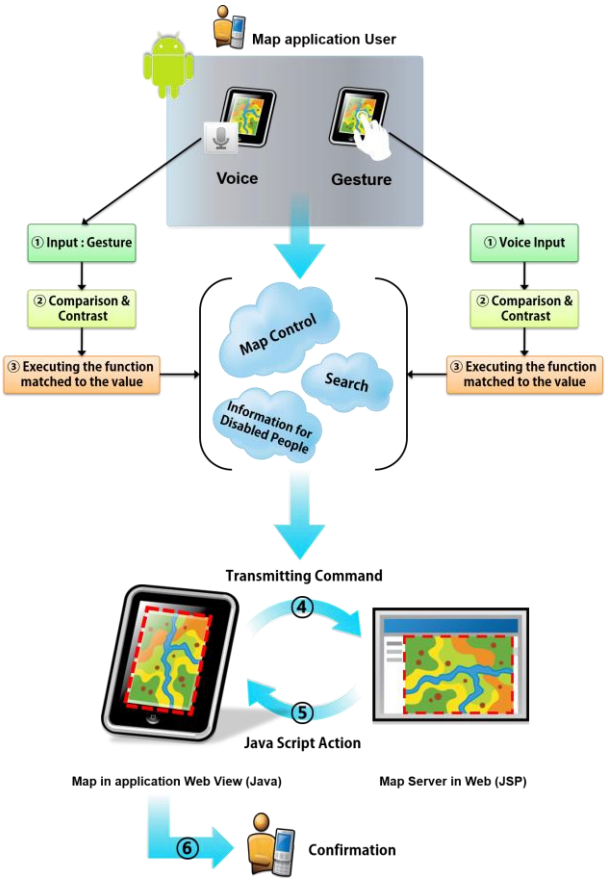

Fig. 2. Flow Chart of System Operation

As denoted in previous chapter, the application which implemented in this research provides two alternative interfaces which consist of gesture and voice recognition to offer easier interfaces in existing map application for the disabled people. And the application is produced as the form of hybrid which is composed of web and mobile elements. In this chapter, operational features of the application are specified according to its composition. Main features can be categorized into 2 parts.

The initial point of the application consists of the gesture and voice API as mobile elements and the its operational procedure is same with ①, ②, ③, ④ of figure 3. The user of this application should insert their gesture or voice to execute application and then the application deduces the word-set or function name ordered through extracting data feature. And it transmits a proper function to web-view. Hereby, the proper function can be executed and these processes are carried out by mobile elements.

On the other hands, there are the web compositions for handling map service as depicted in ⑤, ⑥ of figure 3. As the function name extracted in previous procedure is transmitted to web elements, Javascript functions which realized on web layer can be executed to handle map service. As the functions related with map handling is implemented not on mobile but on web layer, the advantage of hybrid application which improves reusability of source code is maximized. Apart from basic map functions, Additional functions which can search address and facilities for the disabled are realized by using Naver Search API and information about library for the disabled and so on. If user calls this extra functions, the application show coordinates and additional information about specific location on map after parsing information from other API or database.

B. Main Functions

The main purpose of this application is to supplement interfaces which have the gap of convenience between normal and the disabled person. Therefore the functions provided by the mobile application should be similar with existing map applications except methods of additional interfaces. All of these functions are combined with each gesture or voice and additional gesture by users. The type of functions can be divided into two category, map functions and search functions.

TABLE II
Comparison of Functionality between Produced Map and Generic Map Applications

Basic Functions comparative table	Function implemented	Map App made in study		Google Maps App		Naver Map App	
		Gesture	Voice	Gesture	Voice	Gesture	Voice
Zoom in/out	zoomin (1 level by 1 level)	○	○	○	X	○	X
	zoomout (1 level by 1 level)	○	○	○	X	○	X
	zoomin3 (3 level by 3 level)	○	○	X	X	X	X
	zoomout3 (3 level by 3 level)	○	○	X	X	X	X
Movement	↑	○	○	○	X	○	X
	↓	○	○	○	X	○	X
	→	○	○	○	X	○	X
	←	○	○	○	X	○	X
	↖	○	○	○	X	○	X
	↘	○	○	○	X	○	X
	↙	○	○	○	X	○	X
	↗	○	○	○	X	○	X
Search	Search for location	X	○	X	○	X	○
	Search for local Information such as famous restaurants	X	○	X	X	X	X

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Fig. 3. The interface of the map application for the disabled people

In case of map functions, there are ‘zoom-in’, ‘zoom-out’, ‘moving’, ‘favorite location’, ‘other maps’ and etc. ‘other maps’ is function for change of map which provided from map service and explanations of other functions are skipped as it is reflected on functions label well.

In sequence, search functions are composed of ‘Naver Search’, ‘Facility Search’ and are only allowed for voice recognition interface. Each function is implemented by external API and extra data. When users choose voice interface, they can insert search-word through voice recognition and search-words is reflected as address or name of location user want to find.

IV. Availability Test

The upper-left picture of figure 3 represents main-screen which user can face firstly when they execute application. Main-screen consists of map, three buttons (each of button for using gestures as interface, for using voice as interface and for registering gestures) and both of buttons reflect specific color (gray one for the gesture and red one for the voice) and are intentionally designed to be bigger than normal buttons for the disabled people to use easily. Users can execute the map application as numbers on Figure 3. Procedures of execution consist of registering gestures and executing functions by gestures and voice. When users try to register gestures, they can initially check gesture list which is already registered and then can register the gestures through gesture windows as drawn in ① of figure 3. In case of using the gesture and voice as user interface, it is simpler than registering gestures as depicted in ②, ③ of figure 3. If users select one of button on main-screen users can input the gesture or voice to execute functions of map. In case of gesture, user can draw the gesture as using throughout whole screen and in case of voice, what users say can be transform as text through speaker. Then, as I mentioned in previous chapter, proper commands can be transmitted to web-view to execute Javascript functions. The lower-right pictures in fig 3 are representative examples of the result of executing the application and it represents the result of map changing and searching library for the blind people through alternative interfaces.

V. Conclusion

In this study, we developed map application for people with disabilities based on Android API. To increase device usability and work efficiency of people who have inconvenience by with upper limb disability on controlling or handling of map application, we provide users with the gesture and the voice that the existing map application serves

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in different ways. In conclusion, the map application can help people with upper limb disability like amputation, hand tremor and paralysis because various functions such as searching, zooming in/out, moving place, giving information and so on is only controlled by the gesture button and the voice button. Also, it can give speed and convenience to people because there is no need to click several buttons or to type. Research in the future need to be studied and developed map application satisfied mobile application accessibility guideline. Especially the field of geographic information service should consider their own standards through the research about part of functions and user interfaces like symbols or presentations of map, arrangements of buttons, design and so on. Moreover, when application guaranteed accessibility is developed, the disabled people should be in development and verification process. In case of information for the disabled people, they need to be open information in the form of open API so that developers and users can utilize data easily.

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