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Usability Analysis and Improvement Plan for Intelligent Speakers in the 4th Industrial Revolution Environment

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Abstract

Smart home in the 4th industrial revolution environment is where all devices in the home are connected to each other to provide the optimal living environment desired by the user. Artificial intelligence speakers are being used as a way to manage and control all devices used in this environment. The function of an artificial intelligence speaker ranges from simple music playback to serving as an interface that controls and manages all devices in a smart home space. In this study, we investigated and analyzed the usability of artificial intelligence speakers based on the current status of domestic and overseas markets and the survey contents of two organizations (Korea Consumer Agency and Korea Information and Communication Policy Institute (KISDI)). In addition, we investigated and analyzed the usability of artificial intelligence speakers. Based on the results of responses from users from two related organizations, major problems were derived, and major improvement measures, such as discovering new functions and improving voice recognition performance, were also described.

Keywords: *Smart devices, Artificial intelligence speakers, Smart home, Voice recognition, 4th industrial revolution.*

1. Introduction

IoT(Internet of Things) technology is an essential technology in the 4th Industrial Revolution environment, providing an environment where all devices are connected to the Internet and various information generated from each device can interact [1]. Using IoT, users have been able to access a variety of information that they had not been able to access before. The smart home field is playing a role in helping people live while creating an environment optimized for themselves through more convenient and simple methods. A smart home allows you to use and control various devices used at home through a user interface. This user interface has been changed into various forms over the years. To this day, where personal computers are dominant, a form using a mouse and graphics has been used, and with the advent of smartphones, another form, a touch method, has emerged. The touch method is a method in which the user clicks on the screen to use services within the

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smartphone. Most of the interfaces of smartphones used to date have adopted the touch method, but recently new voice-based methods are being used in parallel, and the proportion is gradually increasing.

Interest in the voice-based interface method is increasing in the smart home market, a representative field of the IoT market. Smart home is a convergence/complex environment that can monitor and control various home appliances, water, electricity, and gas usage using the IoT. In this smart home field, it has become possible to control and manage devices in the home in a more convenient way using voice rather than a touch-based interface using a smartphone. In this paper, we analyzed the current market status and usability of voice recognition-based artificial intelligence speakers that are transitioning to voice-based user interfaces in the smart home field. Lastly, problems and improvement plans for products currently in use are described.

2. Market Status

Research and development in the intelligent speaker market is centered around the United States and China, and these countries are leading the world in terms of market share. According to the 2020 report by 'Research and Market', a global market research firm, the market size for intelligent speakers is expected to grow at an average annual rate of 17.1% during the forecast period of 2020 to 2025 [2, 3]. Additionally, the largest market in the global market was the United States. The U.S. smart speaker market is predicted to be worth $7.098 billion in 2025 [2, 3]. The market by field of use of artificial intelligence speakers was in the following order: smart home, individual consumer, other, and smart office. The main reason driving the growth of the smart speaker market is the increasing number of smart home adopters.

In the United States, the smart speaker market is comprised of competition between three companies: Amazon, Google, and Apple. According to data as of June 2021 from 'Consumer Intelligence Research Partners', which investigated the relative market share of each company in the smart speaker market in the United States, Amazon Echo was 69% and Google Home was 25%. Apple HomePod has a market share of 5%, and Facebook Portal has a market share of 1%. According to another market report, since the fourth quarter of 2020, Apple's smart speakers have recorded triple-digit growth every quarter in the United States.

The speaker developed by Amazon.com and named Amazon Echo (or simply Echo), has a cylindrical appearance and is equipped with 7-piece beamforming [5]. Additionally, Amazon Echo is used in connection with Alexa [6, 7]. The main characteristic of Amazon.com is that it focuses on orders (commands) that increase intelligence when using speakers. Google Home, developed by Google, is specialized in connecting to Google services. HomePod developed by Apple focuses on connecting to Siri services. The main service functions of Amazon Echo and Google Home are similar [8]. Additionally, HomePod uses Siri software [9]. Meanwhile, the domestic intelligent speaker market is mainly led by ICT(Information Communication Technology) companies, including Kakao, Naver, SK Telecom, and KT [10].

3. Utility analysis of intelligent speakers

The analysis of the usability of intelligent speakers covered in this chapter was based on the survey results of the Korea Consumer Agency [11-13] and the Korea Information and Communication Policy Institute (KISDI) [14]. The Information and Communication Policy Research Institute has been conducting research on intelligent speakers through a broadcast media use behavior survey since 2018. On the other hand, the Korea Consumer Protection Agency conducted an online survey regarding the use of voice recognition speakers in 2019 and 2021. Key findings from the survey include:

First, the results of the Korea Consumer Agency's survey on whether artificial intelligence speakers are being used are shown in Table 1 below. On the other hand, KISDI's survey results are shown in Table 2. The results of both research organizations show that the use of artificial intelligence speakers is increasing.

Table 1. User ratio by consumer protection agency

	2019	2021
Ratio(%)	19	25

Table 2. User ration by KISDI

	2018	2021
Ratio(%)	3.1	14.7

The results of a survey conducted by the Korea Consumer Agency on the functions mainly used while using voice recognition speakers are shown in Table 3 below, and the results for each content are the results after allowing duplicate responses. Most of the main uses were search functions such as weather, music, and VOD(Video On Demand).

Table 3. Utilization functions by consumer protection agency

	Major utilization function	Ratio(%)
2021	Weather, fine dust search	52
	Music search, playback	46
	TV control	43
	VOD Search	20
	Find the remote control	20

On the other hand, the results of the survey on the usage functions of KISDI, another research organization, are shown in Table 4 below [15]. According to the survey, the most used function was music playback, followed by TV program playback, information search, time check and alarm, and control of electronic devices in the household. Tables 3 and 4 show that the main uses of smart speakers are listening to music, watching TV programs, and searching for information. In reality, the control functions of various devices in smart homes are at a minimal level.

Table 4. Utilization functions by KISDI

	Major utilization function	Ratio(%)
2021	Play music	22.9
	Play TV program	19.1
	Internet Information search	14.2
	Time check and alarm	13.3
	Control of electronic devices within the household	13.3
	Run app through smartphone linkage	7.4
	Product purchase and payment	0.7

Meanwhile, in a survey on the frequency of use of artificial intelligence speakers conducted by KISDI in

2021, the rate of use 5-6 days a week was found to be 31.5%. Detailed information is shown in Table 5 below. On the other hand, according to the survey results of the Korea Consumer Protection Agency in 2021, 50% of respondents said they use it more than 3 days a week, which is a decrease of about 3% compared to 53% in 2019.

Table 5. Frequency of use of KISDI

Frequency of use	Ratio(%)
everyday	22.5
5-6 days a week	9.0
3-4 days a week	10,7
1-2 days a week	18.7
1-3 days per month	17.4
1-2 days every 2-3 months	21.6

The results of a survey conducted by the Korea Consumer Protection Agency on the level of satisfaction with speakers by element are shown in Table 6 below, showing two main characteristics. One is that 51% of respondents are satisfied with the external aspects such as design and size, while the level of satisfaction with the technical accuracy and speed of the speaker is less than 40%.

Table 6. Speaker satisfaction rate

Factors	Ratio(%)
Design	51
Size	51
Sound quality	49
Command response speed	39
Command correctness	33
Command support, execution	32

Consumers' overall satisfaction with artificial intelligence speakers over the past three years has been gradually decreasing as shown in Table 7 below. This decline in satisfaction is expected to have a negative impact on the activation of IoT control functions, which can be said to play a central role in speakers.

Table 7. Satisfaction rate decline by year

2019	2020	2021
47	44	42

4. Problems and improvement plans

Table 8 shows the main results regarding the reasons for overall dissatisfaction with artificial intelligence speakers. The problems shown in Table 8 can be broadly summarized into two. First, performance problems include problems with the accuracy of recognizing voice commands, natural conversations, and misrecognition of external noises other than those of the user. Second, the problem with the service functions provided to users is that the functions that can be used using artificial intelligence speakers are limited.

Table 8. Contents of main complaint

Main Content	Details of Complaint	2019	2021
Voice recognition	When the pronunciation is incorrect and fast, recognition rate is lowered.	44	47
Natural conversation	User first tries to talk to the speaker to get the result. The reverse is impossible.	33	33
External noise errors	Malfunctions by mistakenly recognizing external noise as the user's voice	35	31
Function	Available functions are limited.	27	31

Among the contents of the usability analysis related to the use of intelligent speakers so far, meaningful contents that suggest the direction of improvement are as follows. First, when combining the user ratio and usage frequency, the user ratio increased in 2021, but the usage frequency decreased. Although the number of users who own speakers is increasing every year, this can be seen as a sign that there is a lack of positive aspects that can encourage owners to use them frequently. These positive aspects indicate the need for improvement in technology and service functions.

Second, what we can implicitly know through the user ratio and purchase form content is that the number of users is continuously increasing, but the form in which users purchase speakers is introduced through free gifts, etc., rather than the proportion of users purchasing speakers out of direct necessity. It can be seen that they are increasing. As a result, it can be assumed that the purpose of using the artificial intelligence speaker is not clear, which may reduce the need for use and increase the likelihood that a simple search function will be used. In addition, looking at the user ratio and yearly satisfaction decline trend data, the satisfaction rate for using artificial intelligence speakers is decreasing even though the number of users continues to increase by year. This phenomenon can be said to be the most striking feature of the negative aspect.

Summarizing these phenomena, we can conclude that although the number of speaker users has increased each year, they are not purchasing them directly because they have a clear purchase purpose, and as a result, the frequency of use is decreasing and satisfaction with speakers is decreasing. In addition, as the direct purchase rate has decreased, the functions that can be used using speakers are simply at the search level, and the ultimate function, IoT control, is underdeveloped. Considering these points, it can be seen that it is similar to the problems pointed out in Table 8.

Based on the contents described above, efforts to improve the future of artificial intelligence speakers should be made in two major directions. The first is efforts to improve technology and user convenience. First, the technology includes improving the recognition rate for voice recognition and improving response time to voice commands. Regarding improving user convenience, the goal is to provide a common platform for artificial intelligence speakers. By providing different environments for each manufacturer, user convenience is weakened. Consumers who want to purchase a refrigerator must first decide which company's AI speaker to choose. Home appliance manufacturers also have to choose which platform to install among Amazon, Google, and Apple when producing refrigerators. These problems may be solved in the future if related companies develop new standard technologies.

Second is to strengthen service functions. In order for a voice recognition-based speaker to serve as a core interface in a smart home environment, it must have functions beyond simple search. It would be difficult for these functions to play a central role in smart homes if speaker manufacturers provide some functions for the purpose of providing prizes. Therefore, it is necessary to increase the frequency of speaker use and strengthen

the diversity of speaker functions so that the direct purchase rate can increase as needed. To this end, feasible service scenarios in a smart home environment are discovered and provided. As an example of a scenario that can be considered in relation to going out in a smart home, when a user living in an apartment needs to go outside, all windows, fire-related facilities such as water and gas are controlled, and the function to call the elevator is provided. It provides commands through voice in the process of actually going out by specifying the floor you need to go to. If these life-friendly service scenarios are discovered and provided in a smart home environment, the usability of artificial intelligence speakers will increase.

5. Conclusions

Artificial intelligence speakers are a representative device of the IoT that can play a new role in the user interface. Most of these artificial intelligence speakers are being researched, developed, and used by large American companies such as Google, Apple, and Amazon. In this study, the usability of artificial speakers was investigated and analyzed. The survey data was based on survey results from two domestic institutions. Based on this, we analyzed the usability aspects of domestic users and identified problems. Lastly, improvement measures for this were described. Problems with artificial intelligence speakers largely came from technical and service aspects. From a technical perspective, the accuracy of voice recognition is not clearly improving. Additionally, in terms of services, the functions available to users are limited. Additions and improvements in functions in terms of services can be achieved through software efforts, and results will be achieved in the short term rather than technical improvements. On the other hand, improving technical problems will require more long-term planning and time. Through this, the role of artificial intelligence speakers will gradually increase in the smart home area in the Internet of Things era.

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