

MAG Ring: A Magnifier-like Partial Expander Designed for Seniors

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Abstract

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Since it was launched in the market, the smartphone has demonstrated a steady growth with the driving force of its excellent degree of freedom, which is incomparable to that of the feature phone. Thanks to this degree of freedom, a vast amount of contents could be consumed through smartphones, but it was accompanied by a certain degree of inconvenience caused by its limited screen size.

It has been a problem especially with the middle-aged and elderly people as they have less adaptability to the new technology than younger generations and also they have trouble using the contents freely with the small screen of the smartphone with their presbyopia. There have been researches on the methods of magnifying the screen, but the researches targeting at the middle-aged and elderly group was hard to be found.

Against this backdrop, the researcher decided that creating the environment of the smartphone device that suits the middle-aged and elderly people is needed to make them beneficiaries of the technological development as they have been excluded in the smartphone environment so far. And for doing

this, the research on the smartphone screen expanding method was conducted and it develops and suggests MAC Ring which got its motif from a magnifier and lets the user who has not seen it before know the use of method intuitively.

MAC Ring has the interface similar to the form of a magnifier, showing only the contents inside the round ring. MAC Ring works by being touched on the screen of the smartphone, and if it is rotated clockwise, the magnification increases, while if it is rotated anti-clockwise, the magnification decreases. If MAC Ring is eliminated from the screen, the screen gets back to the original status.

This thesis conducted an experiment targeting at 20 middle-aged people after making the prototype of MAC Ring, and drew a conclusion that it is a convenient and an economical tool in terms of the number of touches as well as a tool that gives fun to the users.

Keyword: MAG Ring, Partial Expander, Senior, Presbyopia, Appcessory

I. Introduction

Smartphones have been in increasing demand since it was introduced to the market, bringing a big change to the mobile equipment market. Unlike the existing feature phones though which users could only use the limited function and contents that are provided by the mobile phone manufacturers and communication services, these products gave the users a degree of freedom equivalent to the computer based on the multi-touch function on the screen and high degree of freedom.

With the limitations by functions disappearing, the needs of the users on the smartphones have become varied, which naturally made the performance of the smartphones improve rapidly to meet the needs. While the early smartphones were equipped with LCD screen of 3 inches and less than 1 GB of RAM, the main products of the smartphones recently released are mostly equipped with LED display bigger than 5 inches and more than 2GB of RAM. The improvement of performance made smartphones replace the functions of PCs considerably.

However, unlike the computer, the smartphone has inherent limitations ; the size of the screen. Even though it can output the amount of information as big as the computer, since it is the mobile device, the size of the screen is only about 5 inches and even for the biggest model, it is hard to find a model bigger than 6 inches.

The limited screen size of the smartphone has lowered the legibility,

which is especially an obstacle for the middle-aged and elderly population, who have the problem of low vision caused by the aging eye. In particular, according to the National Statistical Office of Korea, the ratio of the elderly population and the aging index are in a steady rise, and this tendency is expected to continue. With Korean society increasingly aging, the environment for the smartphone use focusing on middle-aged and elderly people needs to be created, as they take up a great proportion in the population.

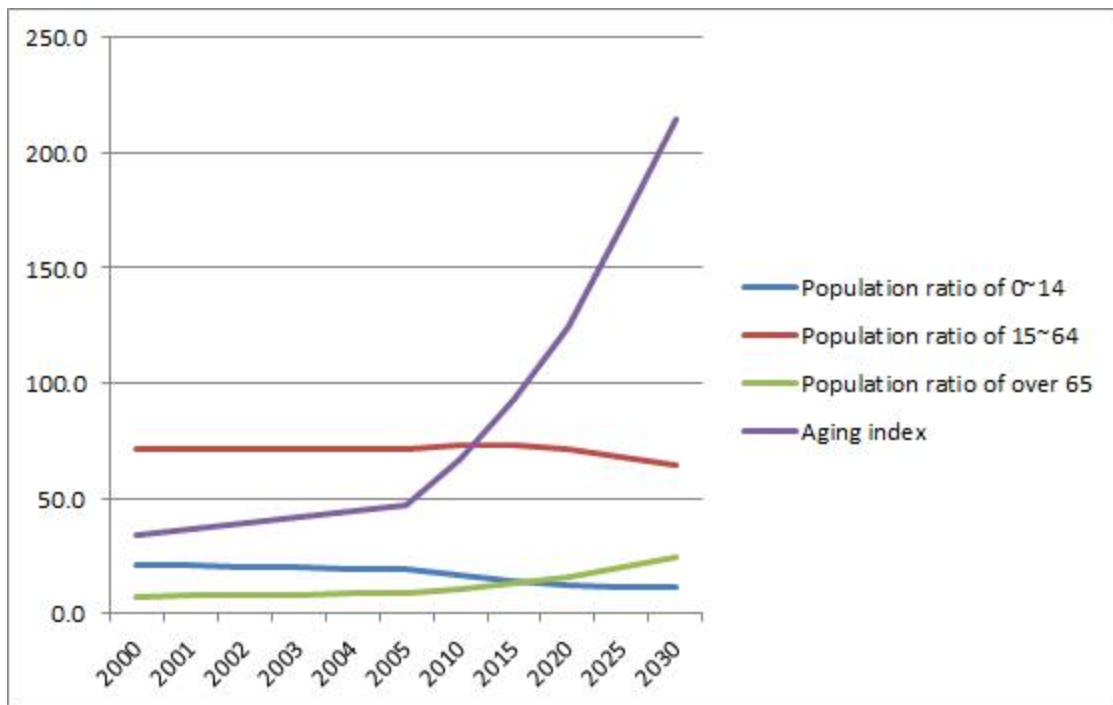


Figure 1. Population ratio and aging index of Korea
(National Statistical Office of Korea, 2015)

To overcome the limited screen size and enhance the legibility, the recent smartphones are basically equipped with the zoom in/out function, which was hard to find in the feature phones. Other than this, there are applications that provide the zoom /in out function in various ways. However, since their main purpose is to provide the zoom in/out function, it is still somewhat insufficient to provide the user experience for the middle-aged and elderly population.

Against this backdrop, this research suggested MCA Ring, a smartphone appcessory, to provide the zoom/in out function for the middle-aged and elderly people in a more intuitive way, verifying its effectiveness.

II. Related Works

1. Screen Expanding Function of Mobile Phones

1) Full Screen Expanding

Since the feature phone, a mainstream phone before the smartphone showed up in the market, had smaller size of screen with 1~3 inches, there existed an effort to enhance the legibility of the screen at that time already. The very basic technologies include the method that the user adjust the sizes with three stages of small-medium-large. Also, there is a method of using large display, which is now commonly being used for almost all the devices that have the text output functions including the smartphone.

Furthermore, in the smartphone, it is made possible to zoom in and out relatively freely through touch gesture based on the multi-touch function. According to the Touch Gesture Reference Guide by Craig Villamor, currently the touch gestures that are mainly used for operating the zoom in/out function are pinch/spread and double tap. Pinch/spread is a way in which the user slide the two fingers apart and together while touching on the screen, and the double tap is a way the user taps the screen two times swiftly. MAC Ring proposed by this research did not use these gestures and instead used rotate gesture for the screen zoom in/out, which has been normally used for turning the screen view. There is a difference in that the magnification of the screen goes up when

rotating clockwise, and it goes down when rotating anti-clockwise. Another difference is that it is not just limited to the touch gesture, being realized in the form of a separate appcessory, which got its motif from the magnifier.

2) Partial Screen Expanding

The mobile phone's expanding function in a general sense means the full screen expanding, but there has been an attempt to output magnifying only a certain portion of a screen.



Figure 2. Method of magnifying a portion of display (Lai, 2004)

In 2004, Cheng-Shing Lai and Cong Wu in America applied for a patent of the feature phone software that has the function of magnifying a certain portion around the selected area. This software is similar to the design proposed

by this research in that it partially magnify all the contents that are included in the selected area including images as well as the text. However, its expanding functions are somewhat limited because it can only magnify the certain selected icon by the user as shown in the picture 2. This seems to result from the fact that the interface of the feature phones is more simple than that of the smart phones.

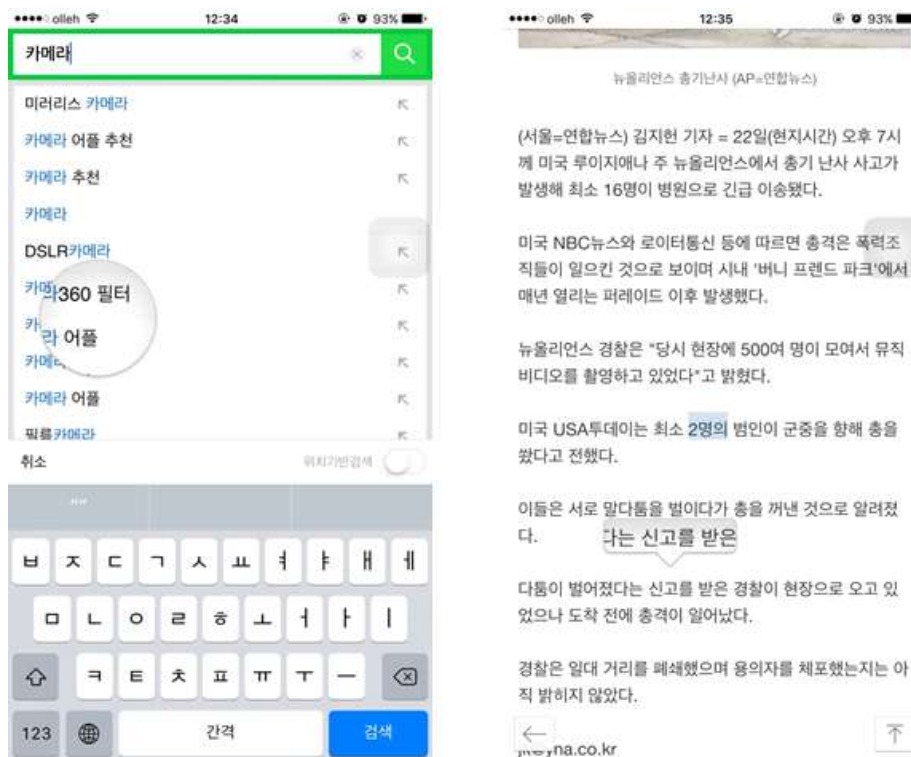


Figure 3. Partial magnifying method provided by iOS

The smartphone manufacturers these days provide the expanding function in various ways. In iOS, an operating system of the Apple smartphone,

when the users touches on the text or the text box, the circle or rectangle shaped magnification window comes up at the top of the selected portion and the hidden portion of the text covered by fingers is magnified. This function has similarity with MAC ring in that it displays the screen partially magnified, but the purpose of it is to solve the problem of blind spot of the screen caused by fingers. Since its magnification is low and the target is limited to text, it has functional limitations compared to MAC Ring, which outputs magnifying all the contents of the selected area all together.



Figure 4. Partial magnifying method provided by Google Chrome browser

In the Chrome browser basically provided by the android operating system of Google, when the user touches on the adjacent multiple hyperlinks with one finger at the same time, the selected portion becomes partially magnified. This function puts more emphasis on magnifying than the function of iOS does, but still magnifying is an additional gesture, and its main purpose is to have the users to touch the hyperlinks that they aimed at accurately one more time to prevent them from entering the page that they did not intend. Also, since it is designed to operate only in the situation mentioned earlier, it is different from MAC Ring in which the partial magnifying function works on a regular basis whenever the users want.

The stylus pen for the tablet PC proposed by Ken Hinckley also has the screen partial magnifying function. When the user touches on the screen of the tablet PC with two fingers grasping the stylus pen, a circle window comes up and the selected portion in it becomes enlarged and output. It is similar to MAC Ring in that it displays the magnified screen in the circled window and it is based on the touch method, but it is different as it used the existing pinch/spread method for its method of adjusting the magnification and the medium for interaction is the stylus pen whose main purpose is drawing.

2. Appcessory

Appcessory is a compound word of App and Accessory, which has been defined by Koen Holtmen as "the smartphone accessory that provide useful

functions for the users operated with a certain application". It has the characteristics of physical hardware (accessory) and the software (app), which is specially designed for the best use of the hardware, being provided together. The representative example of the appcessory is the stylus pen, and the wearable devices such as smart watches can be regarded as a form of appcessory in a wider category.

According to Eugene Investment and Securities, the market size of the smartphone accessory in Korea was 244.5 billion won in 2010 and has been growing annually. This tendency is likely to continue in the future. Also, if accessories for general purpose and the tablet PC are included, the market size is expected to reach 2 trillion won.

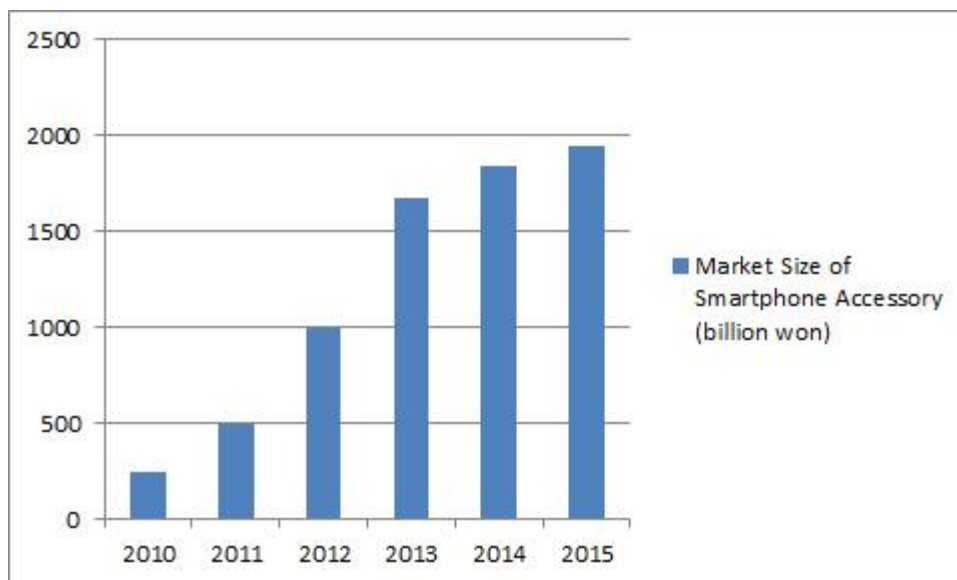


Figure 5. Market Size of Smartphone Accessory in Korea (Park, 2013)

The research by Young-Long Lee classified the smartphone accessories roughly into 6 categories as follows: accessory for the business use, accessory for home, accessory for vehicles and travel, accessory for sounds, accessory for sports and health care, and accessory for games.

3. Presbyopia

Presbyopia refer to a condition in which people have trouble seeing the object nearby as the near point gets farther with weakened accommodation force. It is a normal phenomenon that develops as eyes age in the aging process, which is not regarded as a disease. Generally, when this phenomenon develops and reaches the point in which the accommodation force of the lens drops under 4D, we call it presbyopia(Ryu, 2000). Accommodation means the overall refractive power of the eye changes with the change in the thickness of the lens to put focus on the retina and maintains it (Ciuffreda, 1998, Dubbelman, 2005, Hofstetter, 1965).

Normally, presbyopia start after 45 years old, but this varies depending on person, and it starts earlier in the order of far-sighted eyes, normal eyes, and near-sighted eyes (Duke-Elder, 1970). That is, people with far-sightedness experience aging eye earlier than the average, while people with near-sightedness experience it later than the average. Also, the near point gets farther, the near-distance vision is blurred, the pupil gets contracted, and people feel drowsy when reading.(Borish, 1970)

With these symptoms, people who experience presbyopia have many problems in their every day life than people with normal vision, especially having trouble reading small letters. Since the letters of the smartphone tend to be small as it has to output a lot of information on a screen with limited size, people with presbyopia do not feel comfortable looking into the smartphone screens, which is becoming an obstacle for the use of smartphones by middle-aged and elderly people.

III. Prototyping

1. MAG Ring

1) Appcessory Design

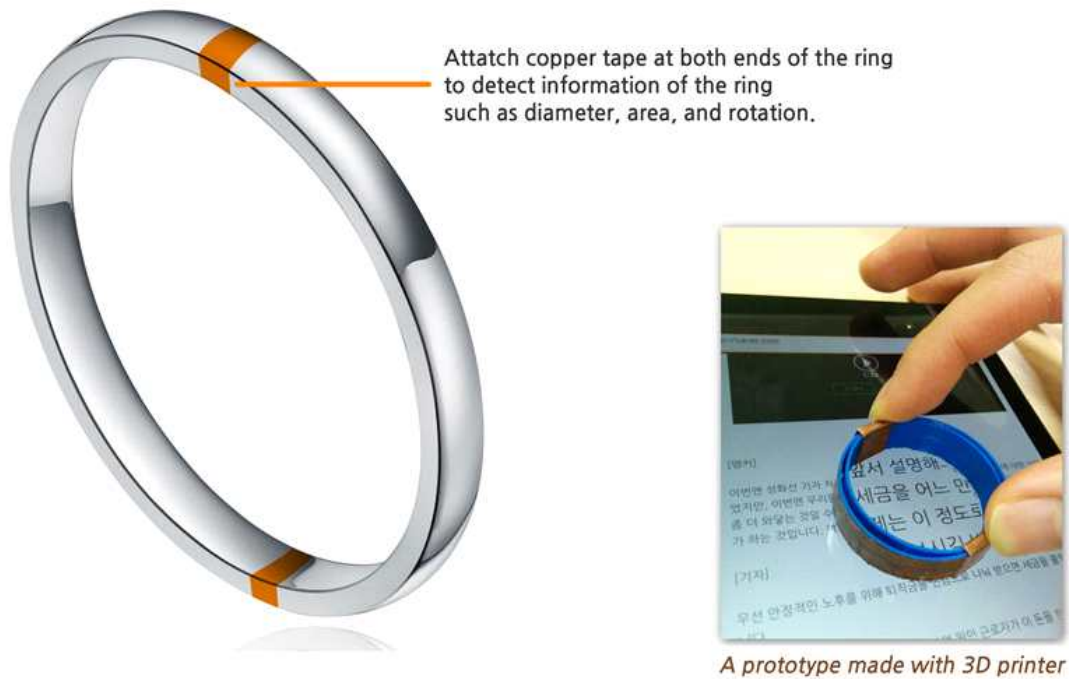


Figure 6. Concept design and the first prototype of MAG Ring

When the MAC Ring touches on the screen, only the inside area of the ring magnifies, and the user can check the whole contents outside of the ring

while looking at the magnified portion. If MAC Ring is eliminated from the screen, the screen gets back to normal. The picture 6 is the concept design of MAC Ring and the prototype that has been produced later.

For this kind of appcessory, detecting the location of the appcessory that is put on the smartphone screen is the most important issue. This research used a method of attaching the conductive material to give the effect of touching with human fingers. This method has the limitation that the appcessory can be used only when it is touched on the screen, but it has the strengths that it is relatively simple and highly accurate, and can be used semi-permanently since it does not need power supply.

2) The Principle of Operating the Appcessory

The principle of MAC Ring is as follows. First, the display that used the eletrostatic touch panel detects the portion that the conductive material, which is located at both ends of the MAC Ring, touches on. And based on the location of the two points, the diameter of MAC Ring is calculated, an area of circle is made, and then it is extracted. The screen that is currently being output is magnified with the basic magnification, the selected area is cut, and then it is output in the extracted area.

The change of the magnification has been made possible. After detecting the angle by which the ring rotates, mapping is conducted with the magnification value. The beginning angle is 0 degree, and when it is rotated clockwise, it becomes positive degree increasing the magnification, while it becomes negative degree decreasing the magnification when it is rotated

anti-clockwise. The picture 7 shows the schematization of these steps.

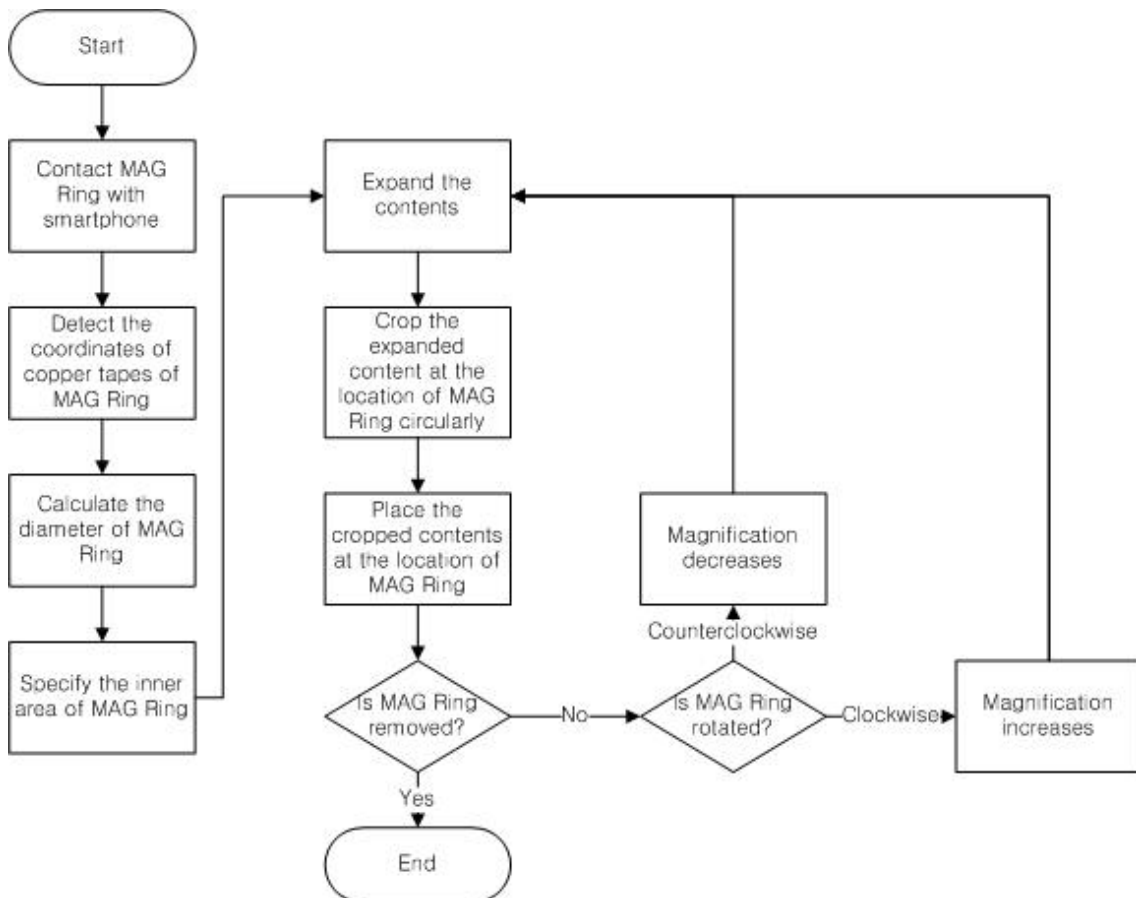


Figure 7. System flow of MAG Ring

Also, circular shape and the method of magnifying the inner area is the same form as the magnifier, a traditional magnifying tool. And for the method of changing the magnification, it used the same method as the jog shuttle, a device that enables the users to guess the method of use more intuitively by providing the familiar interface for the users. Therefore, it is expected that the

users can magnify the screen of the smartphones naturally and gain information smoothly from the magnified contents by guessing how to use MAC Ring through the information learned before.

2. User Scenario

The MAC Ring user scenario proposed by this research is as follows.

The users whose eye sight is worsened with presbyopia have a hard time using smartphones that provide a lot of information. The users get to access the web page that does not have mobile version while they surf the Internet through smartphones. The mobile version web site reduced the inconvenience by providing the font sizes that are apt for the smartphone, but the PC version web site gives inconvenience as the users need to magnify and look for the part that they want to see every single time.

However, if the zoom accessory of the smartphone in the form of a magnifier is used, the users can see the part they want to see by magnifying it with just one touch of the accessory, and can check how the other parts outside of the accessory is constituted. The users can gain a lot of information in a shorter period of time by using the accessory. The table 1 is the result of comparing the touch gesture zoom and MAC Ring based on the user scenario.

	Touch Gesture Zoom	MAG Ring
Expanding Range	Full Screen	Inside of the Ring
Strength	It is built in smartphones.	Users can recognize where he/she is watching in the display. It is easy to manipulate.
Weakness	Users cannot see the composition of a screen. Relatively big number of touches.	It is provided as a separate accessory.

Table 1. Comparison of touch gesture zoom and MAG Ring

IV. Experiment

1. Experiment Condition

An experiment was conducted to verify that MAC Ring provides more intuitive and efficient user experience compared to the full screen zoom in the method using the existing touch gesture zoom.

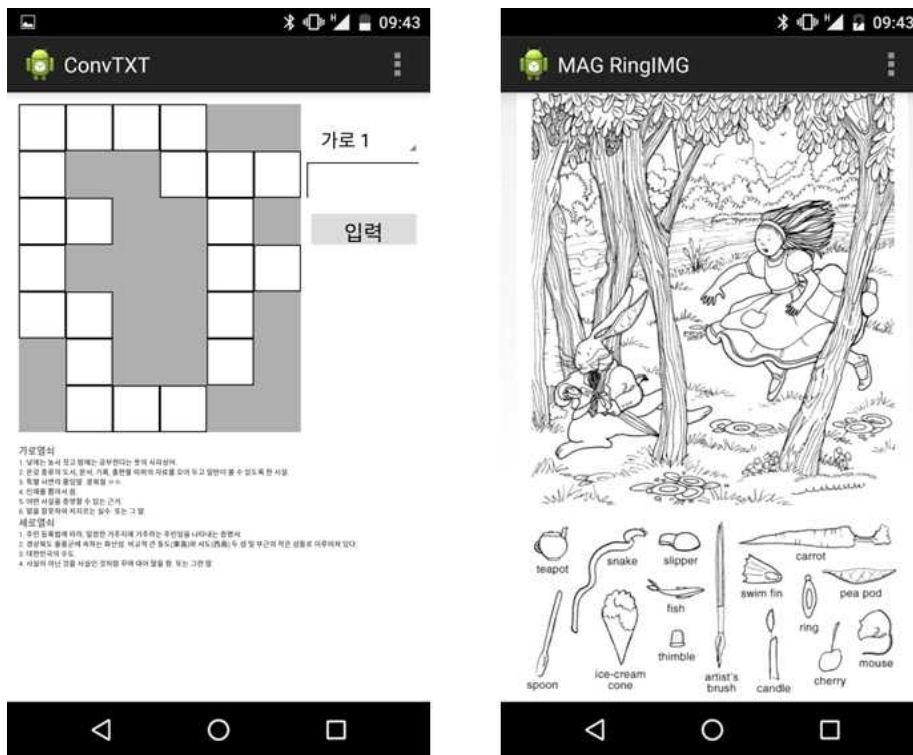


Figure 8. Two types of contents for the experiment

The experiment was conducted divided by two groups, one that uses the full screen expanding function using the touch gesture zoom and the other that uses MAC Ring. Each subjects belonged to only one group since it was hard to adjust the difficulty level of the two question sets. It was conducted through two stages with the smartphones that are equipped with the applications made for the experiment. In the first stage, the letter recognition ability has been measured through the crossword puzzle. In the second stage, the picture recognition ability has been measured through finding the hidden pictures.

Picture 8 is the questions for the crossword puzzle and finding hidden pictures that have been actually used in the experiment. Also, we gave the MAC Ring group one minute of using MAC Ring before the experiment to have them learn the interface. To correct the differences in learning the method of use of MAC Ring in the middle of the experiment, we divided the subjects into two groups and conducted the letter recognition experiment for one group first, while the other group conducted the picture recognition experiment first. There was no time limit for each stage, and the stage ended when more than 2/3 of the questions were solved.

The target of the research was the middle-aged group with 20 people aged 50 or older (10 males and 10 females) who have trouble reading the smartphone screen due to presbyopia. The collected information from the experiment is the number of touches and correct answers. After the experiment, the quantitative evaluation through questionnaires and the qualitative evaluation through interviews were conducted together. We gave the touch gesture zoom group time to use MAC Ring after the experiment to get the feedback about MAC Ring also from them in the questionnaire and the interview.

Table 2 is the questions in the questionnaire, and for the three questions at the bottom, we had them respond through 5-point Likert scale. The first question is to measure the subjects' proficiency of the smartphones, the second to measure the convenience of MAC Ring, the third to measure fun and the interest degree of interaction, and the last is to measure the preference toward MAC Ring and its practicality.

Questions
How long do you use your smartphone a day?
It was convenient to use MAG Ring.
It was fun to use MAG Ring.
I would like to use MAG Ring.

Table 2. List of questions asked in the questionnaire

2. Experiment Result

For the question "How long do you use your smartphone a day?" to see the subjects' proficiency of the smartphone use, 14 people with 70% responded that they use the smartphones 1~2 hours a day, and there was no big difference in the answers of the rest 6. Therefore, this research carried out the result analysis in the assumption that all the subjects have the same smartphone proficiency.

1) Quantitative Data

The result of the number of touches is as shown in Table 3. We can see that the number of touches declined when using MAC Ring than using the touch gesture zoom. The result of conducting the independent t-test shows that p-value with significance level of $\alpha = 0.05$ was 0.002 in the text environment and 0.000 in the picture environment, showing statistically significant differences and confirming that MAC Ring is more efficient than the existing touch gesture method. Especially it decreased dramatically in the picture environment, which seems to be the result of the difference in the characteristics of the text and the pictures. That is, when reading text, there is a direction and people do not read the parts that they have read again, but in the case of pictures, people tend to see the random parts irregularly.

	MAG Ring	Touch Gesture
Text	$\mu = 14.1$ ($\sigma = 2.77$)	$\mu = 19.9$ ($\sigma = 4.09$)
Picture	$\mu = 24$ ($\sigma = 4.22$)	$\mu=76.1$ ($\sigma = 14.12$)

Table 3. Number of touches

	MAG Ring	Touch Gesture
Text	$\mu = 7.2$ ($\sigma = 1.99$)	$\mu = 6.7$ ($\sigma = 1.64$)
Picture	$\mu = 8.9$ ($\sigma = 2.81$)	$\mu = 9.2$ ($\sigma = 2.49$)

Table 4. Number of correct answers

The result of the number of correct answers is as shown in Table 4. Here, the average and the standard deviation of the correct answers did not show big difference between using MAC Ring and using touch gesture zoom. The result of conducting the independent t-test also shows that p-value with significance level of $\alpha = 0.05$ was 0.547 in the text environment and 0.803 in the picture environment, showing no statistically significant differences. In other words, there is no big difference in the comprehension ability of contents when using MAC Ring and using touch gesture zoom.

2) Questionnaire

The result of the three questions that were answered through 5-point Likert scale shows $\mu = 3.42$ ($\sigma = 1.00$) for "It was convenient to use MAG Ring," $\mu = 3.92$ ($\sigma = 1.08$) for "It was fun to use MAG Ring," and $\mu = 3.50$ ($\sigma = 1.09$) for "I would like to use MAG Ring.", indicating that the subjects were favorable to MAC Ring in general. Especially for the second question, it received

higher score than the other two questions, which can be interpreted that the interaction of applying a certain object, a magnifier to the smart phone as a metaphor had relative advantages in attracting interest and fun. Also, considering that the performance of the prototype was not excellent, the scores of the other two questions can be improved to some extent if the performance is improved with optimization.

3) Interview

The most frequently mentioned in the interview was the size of the MAC Ring. Even though all the experiments were conducted using one prototype, some people said it was big, some said small and some said adequate, which gave us the insight that the needs of people vary depending on individual person. Also, the experiment was carried out with one smartphone, and since there are a variety of products from 4-inch screen to 6 in the real market, this response is expected to be deepened considering those environmental factors.

Other than this, there were responses related to portability such as "It would be good if it is easy to carry around," "It can be made as an accessory," "I would like it to be convenient to carry around and simple to use."

Also, there were some positive opinions such as "It is fun to see that the size changes according to the movement" and "It is novel and fun." while there were negative opinions such as "It is complicated to use." and "It is inconvenient due to the slow reaction."

V. Conclusion

This research suggested a new way of smartphone screen zoom in/out through MAC Ring and the magnifier-shaped appcessory, which can use the smartphone display with limited size more widely. In the existing methods, the users could not magnify only the part that they wanted since those methods required several times of touches and drags, being applied to the whole area.

On the other hand, the method of magnifying only with the appcessory being touched on the screen bears its significance in that it can provide convenience of magnifying only the part the users want as well as it is economical. This is expected to improve the visual perception in the smartphone for the elderly people and people with low vision who have trouble using the smartphone, which will enhance their level of information.

Actually, the experiment conducted for this research verified that the subjects felt convenient when using MAC Ring and also the number of touches of the users dropped when using MAG Ring than using the touch gesture zoom. This phenomenon was more obvious in the picture environment than in the text environment. Also, another strength of MAC Ring would be that it gives fun to the users as it provides the new way of interaction.

However, there is also room for improvement. The subjects suggested various opinions on the design and the size and these opinions did not have consistency, which brings the necessity of further researches on the method that can satisfy all the users. Also, since it is provided in the form of the

appessory, there are new issues related to portability, which did not have to be considered when it was operated only in the form of a software. The portability of MAC Ring needs to be strengthened and also the benefits that can offset this issue need to be found.

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ge=kor&obj_var_id=&itm_id=&conn_path=E1](http://kosis.kr/statHtml/statHtml.do?orgId=113&tblId=DT_113_STBL_1015552&vw_cd=MT_ZTITLE&list_id=113_11314_02&seqNo=&lang_mode=ko&language=kor&obj_var_id=&itm_id=&conn_path=E1).

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Appendix



발명의 명칭 Title of the Invention

터치 디스플레이용 입력 장치, 이를 포함하는 터치 디스플레이 장치 및 터치 디스플레이 화면 제어 방법

특허권자 Patentee

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발명자 Inventor

등록사항란에 기재

위의 발명은 「특허법」에 따라 특허등록원부에 등록되었음을 증명합니다.

This is to certify that, in accordance with the Patent Act, a patent for the invention has been registered at the Korean Intellectual Property Office.



2015년 07월 29일

특허청장
COMMISSIONER,
KOREAN INTELLECTUAL PROPERTY OFFICE

최 동 규

Certificate of Patent

Patent Number : Item 10-1542020

Application Number : Item 10-2014-0166870

Filing Date : November 26, 2014

Registration Date: July 9, 2015

Title of the Invention

: Input device for touch display, the touch display device that includes this, and the screen control method for touch display

Patentee

: Sungkyungwan University Research & Business Foundation

Sungkyungwan University (Cheoncheon-dong), Seoubu-ro 2066, Jangahn-gu, Suwon City, Gyeonggi-do, South Korea

Inventor : As written in the registration

This is to certify that, in accordance with the Patent Act, a patent of the invention has been registered at the Korean Intellectual Property Office.

July 29, 2015

Dongkyu Choi,

Commissioner

Korean Intellectual Property Office

국문초록

MAG Ring: 중·노년층을 위한 돋보기 형태의 화면 부분 확대 도구

유 지 환
휴먼ICT융합학과
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스마트폰은 시장에 등장한 이래 피쳐폰과는 비교할 수 없는 뛰어난 자유도를 원동력으로 하여 꾸준한 성장곡선을 그려왔다. 그 자유도 덕분에 스마트폰에서는 방대한 양의 콘텐츠를 소비할 수 있게 되었지만 제한된 화면 크기 때문에 다소의 불편함이 수반되게 되었다.

이것은 특히 중·노년층들에게 큰 문제였는데 이들은 젊은 세대에 비해 새로운 기술에 대한 적응력이 떨어질 뿐만 아니라 눈의 노화에 따른 노안으로 인해 스마트폰의 작은 화면으로는 자유로운 콘텐츠 소비에 어려움이 있기 때문이다. 그 때문에 화면 확대 방법에 대한 연구가 지속적으로 이루어져 왔지만 중·노년층들을 타겟으로 한 연구는 찾아보기가 힘들었다.

그 점에 착안하여 그동안 스마트 환경에서 소외되어온 중·노년층들도 기술 발전의 수혜자로 만들기 위해 그들에게 맞는 스마트 기기 사용 환경 조성이 필요하다고 보았다. 그리고 그것을 위해 스마트폰 화면 확대 방식에 대한 연구를 진행하였으며, 돋보기를 모티브로 하여 처음 보는 사람도 직관적으로 사용방법을 알 수 있도록 하

는 MAG Ring을 개발, 제안한다.

MAG Ring은 돋보기와 유사한 형태의 인터페이스를 가지고 있으며 원형의 링 안쪽 부분의 콘텐츠만 확대하여 보여준다. MAG Ring을 스마트폰 화면에 접촉시키면 동작하며 시계방향으로 rotate시키면 확대 배율이 증가, 반시계방향으로 rotate시키면 배율이 감소한다. MAG Ring을 화면에서 제거하면 다시 원래의 상태로 돌아온다.

본고에서는 MAG Ring의 프로토타입을 제작하여 20명의 중년층 피험자를 상대로 실험을 진행하였으며, 특히 터치 횟수 면에서 경제적이고 편리한 도구라는 점과 사용자들이 사용하면서 재미를 느낄 수 있는 도구라는 결론을 도출하였다.

주제어: MAG Ring, 부분확대, 노년층, 노안, 앱세서리