
BEYES : A Shopping Solution for Independent Clothing Experiences of the Visually Impaired

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The visually impaired; clothing; shopping; color; independency; smartphone; mobile application;

ABSTRACT

While clothing is one of the requisites of human life, the visually impaired have limitations in their shopping and need to rely on acquaintances or shop assistants to choose and purchase clothes. Given that fashion is a means of self-expression, their independency of expressing themselves has been limited. In this work, we sought to provide technological solutions for visually impaired people, to help them distinguish the color of clothes while shopping. After conducting exploratory user studies, we derived design requirements and developed a voice service mobile application which guides them through recognizing and choosing colors of clothing.

1 INTRODUCTION

Statistically, the approximate number of people who have some form of visually impairment on the globe is 1.3 billion [6]. At this point, the definition of the visually impaired follows the International Classification of Diseases 11 and those who are blind or have bad eyesight are included in the number. Given that world population is around 7.6 billion [4], nearly one sixth of them are seen as those who need some kind of assistance when seeing. Furthermore, the number is estimated to be greater in the future according to the research conducted by Bourne & Flaxman [1]. Bourne mentioned that even a small handicap on vision affects human lives and becomes an obstacle to their independency. Also, he added that the number of the visually impaired is expected to skyrocket since the average expected lifespan has increased dramatically and the population is aging. As a result, it is necessary to be proactive towards the growing demand for solutions to alleviate the hardship of the visually impaired. This project focuses on the clothing condition of them and suggests a solution for the problem found. Since information gets digitized and smartphones are widely pervasive, the solution finds a chance to utilize smart devices as its means.

2 LITERATURE REVIEW

Regarding a life pertaining to clothing of the visually impaired, Kim [2] conducted interviews and asked her interviewees their habits of purchasing and managing clothes. Her research shows that the visually impaired feel the most difficulty in two cases when purchasing clothes: recognizing design and moving to go shopping. Thus, they accompany someone to get assistance. In most cases, companions are their friends or families as they believe that they would provide better recommendation which fits them more than what shop assistants do. Therefore, they have the most effect on the visually impaired for making a purchase decision. Her research also caught that visually impaired people tend to want simple, trustworthy, practical and stable information more than the non-impaired do. Shopping online was not their first option to choose in that web interface is designed uncomfortable for them.

For their better clothing purchase, some attempts were made. Mobile application design for better clothing habits of the visually impaired has been brought out by Yang [7]. Yang saw that enabling them to choose what to purchase without assistance is very important to the quality of their experience of buying clothes.

**Table 1: Quotations from the Responses
: Color Recognition**

Interviewee Code	Comments
A	“Recognizing colors is very important for us not only to classify them but also to get more clear and precise understanding about objects. You know there are a lot of implications in colors used around us.”
B	“It would be really good if I can get full information about colors. However, I don’t want to be confused by too much details. That will be the worse, definitely.” (Interviewee B)

**Table 2: Quotations from the Responses
: Clothing Purchase**

Interviewee Code	Comments
C	“In case of department store, there is no braille block on the floor and the aisle is too narrow. That is the reason why I do not go there.”
D	“If I get help from my mom or call Bokji-call (Special vehicle supported by Korean government which helps the visually impaired), I think I can go shopping. But Bokji-call is not always for me and sometimes I feel sorry to my mom.”

3 FORMATIVE USER STUDY

3.1 Interview

To explore factors the visually impaired people consider the most important as clear as possible, interviews were conducted. The Interview group consisted of 31 male and female participants of varying ages. All interviewees were visually impaired and affiliated with or got service from rehabilitation centers nearby Seoul and Incheon, and were given thorough explanation about its usage from the interviewers. The profile of the interviewees was encoded as hidden. Most of the interviewees (93%) responded that they got their impairment after being born. This ratio resembles the proportion (90%) of those who have congenital impairment in the overall visually impaired population [3]. The questionnaire contained five categories; color recognition, clothing purchase, correlation between clothing and color, other factors of clothing habit, and smartphone usage. Answers were open responses. Quotations of the answers for each category are available in Table 1 to Table 5.

In color recognition category, the interviewers intended to explore how the visually impaired recognize and describe color. Even though they do not see color with their retina, they think matches and differences between colors are very important. Brightness and chroma were less meaningful than hue, but the interviewees wanted to gain more information such as how bright or vivid the color is in a simple way. Most of them perceived that simple, objective description about color is better than subjective and sentimental one since they think it distracts making their own choice due to bias.

Clothing purchase category asked their preference when buying clothes. Regardless of the answer, almost all of the respondents pointed that accessibility is the biggest obstacle. To select an item at an offline shop, the interviewees need to ask clerks or their companions. In that situation, respondents answered that they sometimes feel uncomfortable if they get recognized as the handicapped while shopping. Furthermore, some answered that they have never gone shopping to buy clothes as they do not want to be in trouble. Online shopping is not different in that online malls have very complicated designs and they upload information in an image.

Questions regarding the correlation between clothing and color asked the importance of color in their experience of clothing. When asking for the most important factor in shopping for apparel, we found that color is one of the two most frequently recorded answers with texture. Features such as washing method and design followed them. Since they get more information from tactile impression, the interviewees tend to consider texture more than the non-visually impaired do. Preferred color also varied but what is notable was that there were answers such as ‘elegant colors’. This implies that the visually impaired also connect colors with sentiment and self-representation.

When asking other factors which affect clothing purchase, clothes with a timeless design were more popular than trendy ones. Most of the interviewees replied that they think they are less sensitive to fashion trend. Also, those who answered that they do not go shopping tended to respond that they are not interested in trend.

Table 3: Quotations from the Responses : Correlation between Clothing and Color

Interviewee Code	Comments
E	"I see color as the top priority because I do not want to be a weird guy wearing ridiculous. I do care colors for the others who see me. I want to give them good impression."
F	"For me, texture is the most important thing because of several reasons. First, texture is very intuitive for me to feel the difference. Second, I am a businessman so I wear suit every day. But if I wear coat on it, I know there are always some fluffs left on the dress shirt. I could have removed them if I could see but I should leave it as it is because I do not know it. So I deliberately check fabric."

Table 4: Quotations from the Responses : Other Factors Affecting Clothing Purchase

Interviewee Code	Comments
G	"My daughter and I are both visually impaired. I do not know what is trendy nowadays but my 28-years-old daughter knows. Maybe that's because she works with young students."

Though, the visually impaired wanted to express themselves rather than simply following social trends. In addition, they perceived that patterns such as dots or stripes are also significant when choosing clothes.

Lastly, the interviewers asked about their smartphone usage habit. A large share of the visually impaired population, especially young generations use smartphone with the help of a special feature in smartphone supported for them. For example, 'Voice-over' feature in iPhone reads all the information or action on the screen so that users can recognize what is happening without seeing it. Thus, it was revealed that their frequently used applications were messenger, podcast and music streaming application, and book-reader for the visually impaired as they all provide such voice support.

3.2. Insights and Design Requirements from User Study

Total of five meaningful insights were discovered from the user study. First, recognizing color is important as it is closely related to self-expression of the visually impaired. Second, the visually impaired need assistance to reach a shopping place or select items and there is almost no way to purchase clothes alone. Third, there is demand for color recognition when the visually impaired shop clothes since they want to recognize color without someone's help. Fourth, there are many visually impaired people who use smartphone and make their common usage pattern. Lastly, smartphone offers proper feature for the visually impaired by reading information on screen.

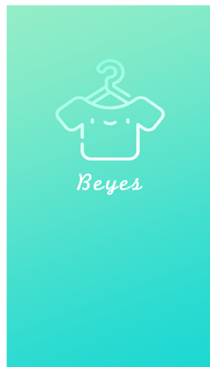
4. DESIGN AND PROTOTYPE OF "BEYES": A MOBILE APPLICATION FOR CLOTHING SHOPPING FOR THE VISUALLY IMPAIRED

4.1. Design Goals and Structure

Based on the insights, we developed a smartphone application named 'Beyes' which is specialized to clothing shopping of the visually impaired. The name contains multiple meanings which are 'Be eyes' and 'Be yes'. When user takes a picture by opening Beyes application, it analyzes information and informs users of color and pattern of clothes in an audio format. To keep consistency with the way how visually impaired people are using smartphone applications, Beyes offers voice guideline instead of visual buttons and texts and the voice script is also intended to be very simple, clear and obvious. Furthermore, rather than touching a specific button, users can simply touch anywhere on the screen to make it work. Likewise, it is designed to have as brief and clear process as possible not to confuse the users. Since it is a prototype, it only supports color recognition at this present but is going to apply pattern recognition as well for the next model. And along with that, the following version is going to collect and analyze users' usage pattern in order to provide a customized recommendation service for each user. Fig. 1 is the application icon and Fig. 2 is the application's splash screen.

Table 5: Quotations from the Responses : Smartphone Usage

Interviewee Code	Comments
H	“Since we cannot enjoy media using vision, there are not many things the visually impaired people have as hobbies. So we use book reader applications a lot. I listen to audiobooks but I think there are not many books as printed books.”
I	“Using smartphone is hard for me because I do not feel the location of keyboard. But young generation is very open to use smart devices as technology has been advanced so fast. More and more people are using it.”

**Figure 1: The application icon of Beyes****Figure 2: Splash screen of Beyes**

The video is available at <https://www.youtube.com/watch?v=953URkmFSD8>. The user walkthrough of using Beyes prototype is as follows.

1. Tap 'Beyes' mobile application to enter into it.
2. Listen to the voice instruction “Beyes application has been initialized. For your convenience, please connect internet network before using it. Set the phone in front of the clothes you want and touch the screen.”
3. Tap anywhere on the screen in front of the clothes. Wait until the instruction “Saving completed! Now processing” comes.
4. Get color information by the instruction “The color of the clothes is _____. If you want another one, please touch the screen.” If there are more apparels to check, touch the screen.
5. The user can show others the clothes he or she checked via pictures in a folder.

4.2. Development Environment

The prototype application of Beyes was launched in Android OS for ease of testing. React was used to build the user interface and Google Cloud to detect color. A simple sequence of works the application serves is as follows. (1) Open camera application. (2) When user takes a picture, save it in a folder. (3) Analyze a dominant color throughout the picture, and take RGB value from it. (4) Based on a list of RGB values of colors, find the closest color. (5) Speak the name of it as an output, go back to step 1. Since it is a prototype, only 20 colors were registered in the app, and pattern recognition is not yet implemented. The application is now available on Android app store.

5. USER FEEDBACK

User tests were conducted to prove validity of the prototype and improve it. 6 reviewers, mainly composed of experts and potential users, participated in the tests and were asked to recognize testing examples with specific colors by the prototype. Two of them distinguished lightness or very limited number of color but the rest of them were reviewers with complete vision loss. After few trials, they answered their first impression about the application. The sample colors were red, blue and yellow. Consequently, three positive, one neutral and two negative feedbacks were reported. Table 6 shows some responses from the reviewers that are representative.

6. DISCUSSION

There are multiple suggestions which were developed for more satisfying experience of the visually impaired in recognizing color information. However, the services are not focused on the clothing activities of the visually impaired. Sullivan is the most well-known mobile application for the visually impaired in Korea. Sullivan provides various functions and it is similar to Beyes in that they recognize objects and read the colors of them. However, it does not collect and analyze user data for clothing recommendation as Beyes does.

Also, it does not offer pattern recognition which Beyes is planning to apply in the next model.

**Table 6: Quotations from the Responses
: Prototype Review**

<i>Reviewer Code</i>	<i>Comments</i>
A	“I see its vision as a fashion application for the visually impaired. They are neglected in fashion market but more active approach should be made for better quality of life.”
B	“I think the interface not relying on visual information is very simple and easy to use. The application is easier to get used to.”
C	“But, I hope the prototype supports more features such as pattern recognition and recommendation.”

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In a similar vein, as aforementioned, Yang [7] brought up a mobile application for better experience of shopping for the visually impaired but it neither mentions sustainable model nor collects user data for smart recommendation. In this respect, this project considered that Beyes attains its unique position.

However, there are limitations it should overcome for the foreseeable future. First, due to the interview date and location, there were more elderly interviewees than young people. Thus, more research and interviews on younger generation should follow for detailed observation on smartphone usage. Second, the prototype does not contain pattern recognition and recommendation yet as it only tested color recognition and the overall interface. For the next step, the prototype with pattern and texture recognition is going to be developed reflecting the user feedback. Lastly, the prototype does not cover the mechanical flaws of color recognition such as the effects of camera filters as it was only for brief testing purposes. Such weaknesses are to be considered in the follow-up study.

7. CONCLUSION

This project was conducted to aim three important implications for the society. First, the project demonstrates the experiences regarding clothing purchase of the visually impaired which were relatively less highlighted than other experiences. Second, the project seeks a solution which improves autonomy and independence of the visually impaired population. It encourages the visually impaired not to feel difficulty when trying to enjoy the same activity as the non-visually impaired people do. Considering that the number of single-person household has increased and this tendency is predicted to be stronger in the future [5], this project achieves more necessity. Lastly, the work suggests a new attempt of mobile interface design which is easy to use for the visually impaired.

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