# Third Eye: An Eye for the Blind to Identify Objects Using Human-powered Technology

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***Abstract*— The visually impaired face a number of challenges when performing their daily tasks. These tasks may be differentiating objects that have similar shapes or knowing the content of a restaurant menu. In fact, there is an increasing interest in developing effective solutions that can help the visually impaired to recognize objects. However, automatic techniques cannot answer most of the questions asked by the visually impaired. In addition, it can be seen that there is an obvious deficiency in the number of applications that target Arabic blind users. Therefore, to address all of these issues, there is a need to design an effective solution that can help Arabic blind people to identify any objects at any place without any restrictions. The proposed solution is developing a mobile application that uses human-powered technology to help the visually impaired cope with the many challenges they face. This application is developed using an Arabic language interface to enhance the content of Arabic mobile applications and targets Arabic blind users. As a result of evaluating the proposed application, it is shown that it is easy to use and useful and can be employed for many important purposes in daily life.**

***Keywords— human computation ; blind; identification; visally impaired; human powered technology***

## I. INTRODUCTION

Clearly, there is a growing interest in the number of users who use popular social networking sites (SNSs), such as Facebook, Twitter and Instagram. SNSs are described as online communities for internet users where they can meet each other. The benefits of associating with social networking are not restricted to making friends and interacting with them, but also include searching and gathering information and sharing experiences in order to obtain accurate, personalized and high-quality replies from trusted friends [1]. According to the Arab Social Media Report (ASMR), there are 3.7 million Arab Twitter users while Facebook states that over 55 million users are Arabs [2]. This significant interest in social networking can draw attention to the idea of designing an application with an Arabic language interface using human-powered technology in order to help blind people identify objects.

Object identification is an essential and important task in daily lives; in addition, it plays an initial role in the completion of any sophisticated tasks. Even though blind people are able to identify objects by their tactual features there are some differences between objects in terms of their optical appearance; for example, two objects with the same size and tactual features may have different labels. Although visually impaired people can ask for help from sighted persons to differentiate between objects, this can affect blind people's independency [3]. Therefore, there is a need to put more effort into developing effective solutions that can help them to identify objects.

In this paper, the proposed solution is to develop an application using accessibility features in smart phones and a built-in camera, in addition to human sources, in order to provide descriptions of all the pictures or videos captured by visually impaired people. Actually, a great deal of effort is made to select the best technology that can be used for developing the proposed application. Therefore, a comprehensive survey is prepared [4] for the assistive technologies that can be used to help blind people identify objects. This survey gives a summary of the advantages and disadvantages of the technologies. Moreover, it provides an evaluation of them according to different criteria, such as cost, accuracy, response time, performance, scope and ease of use in order to find the best assistive technology that can be used for designing an efficient identification application. According to the results of this evaluation, human-powered services technology would be the winner due to its convenience, effectiveness and high performance. For this reason, a comparison between the mobile applications that use this technology is also provided to reveal what the limitations and issues are that requires more research and improvement. The previous paper that was prepared [4] can be considered a starting point for research that investigates the development of an efficient assistive application that can help visually impaired people identify surrounding objects.

This paper will be organized as follows. Section II presents the related works and a comparison between mobile applications that use human-powered technology for object identification. Section III provides the details about the proposed solution, while section IV contains the details about the evaluation of the proposed application. Finally, section V presents the conclusion and future work suggested as a result of this paper.

## II. RELATED WORKS

There are many assistive technologies that can be used to help blind people identify objects. These technologies can be classified into two classes (as shown in Fig.1): the first class is automatic services while the second class is based on human-powered services [4].

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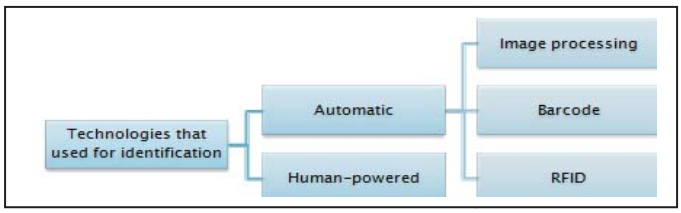


Figure 1 : Classification of technologies that used for object idenitification

There are various examples of automatic technologies: image processing, which includes optical character recognition (OCR), colour identifiers, brightness identifiers and object recognition algorithms. Furthermore, barcodes, radio-frequency identification devices (RFIDs), tactile signs and Braille have also been used for a wide range of applications. However, there are still some limitations to these techniques, which gives rise to the need to design a solution that attempts to address these issues [1, 5, 6]. For example, image recognition algorithms can fail to recognize an object's image if it does not exist in the database or if there is any difference in the orientation. Moreover, the limitation with using barcode and RFID readers is that objects have to be attached to special tags; otherwise the objects cannot be identified [6]. This shows that automated software is not accurate when used by visually impaired people to identify objects and usually involves various restrictions [7].

On the other hand, human-powered technology, which is also called human computation, can be defined as "a new research area that studies the process of channeling the vast internet population to perform tasks or provide data towards solving difficult problems that no known efficient computer algorithms can yet solve" [Chandrasekar et al. as cited in 8]. This technology has been used to solve different problems that need human skills, such as language understanding and visual recognition. Therefore, there has been recent interest in using human-powered technology to provide assistance for people with different disabilities to solve many real accessibility problems. This is actually called human-powered access technology [9].

After reviewing the research conducted in this field, a comprehensive comparison and evaluation of the above technologies are performed. They are presented and discussed in detail in the previously prepared research [4]. In addition, an investigation into the applications that use human-powered services in identification tasks is given below with brief descriptions. These applications are MySmartEye, LendAnEye and Vizwiz.

The MySmartEye application is available for iOS and Android platforms. It is designed to show visually impaired people the answers to their needs using a human-source mechanism. It will help both blind users and volunteers, as the volunteer can conveniently help anytime and anywhere, and the visually handicapped will receive the volunteer's contributions in just seconds. By using the accessibility features in smartphones, it will make capturing photos for the visually impaired easy. This picture will then be shared between micro-volunteers waiting for their answers. Once a volunteer replies, the answer will then be converted into speech for the visually impaired individual [10].

LendAnEye is a mobile application that works as a guide to help visually impaired people in their daily lives. This software is actually two separate Android application versions: one is intended for the volunteers, LendAnEye (Volunteer), and the other one is LendAnEye (Visually Impaired), which is for the blind users. The blind user has to double tap the phone to contact a volunteer to guide them via a live video call [11].

VizWiz is a smart phone application designed for both iOS and Android visually impaired users. This application allows a blind user to a capture picture of any surrounding object and send it tagged with an audio question about what they want to know about the photo taken. The answer is received quickly and then read using the smartphone screen-reading software. VizWiz offers the blind user different options to receive the answer. These options are collecting the answers from workers on the Amazon Mechanical Turk, using IQ Engines and using friend-sourcing, including Twitter, Facebook and Email. However, based on the users' comments, the workers option is not currently available [12, 13].

In order to find the best features to consider in designing an efficient application, a comparison between the above mobile applications and the proposed solution is presented (see Table I in APPENDIX). According to this comparison, the goal is developing an iOS mobile application, "ThirdEye", that has different features that assist visually impaired people. This mobile application will be different from all the other applications and will be dedicated to Arabic users. Moreover, it is unlike the applications LendAnEye and MySmartEye in that it allows the visually impaired to ask for help from not only any random volunteer in the crowd source but also their family and friends. This will enhance privacy and confidentiality. Moreover, MySmartEye and Vizwiz allow the user to add just a picture, while the proposed application allows video capturing. In addition, many additional features are developed in this application. These features will be presented in detail in the proposed solution and they are shown in Table I.

## III. PROPOSED SOLUTION

The main aim of this solution is to develop a mobile application that can help blind people to identify objects using human-powered technology. As shown in Fig.2, the scenario of this solution can be described as follows: the visually impaired can take pictures or videos of any objects and send them through the application server. Meanwhile, the volunteers can view the posts and describe the objects and anything around them. Once the volunteers send their description messages through the application, the visually impaired can listen to these messages one by one.

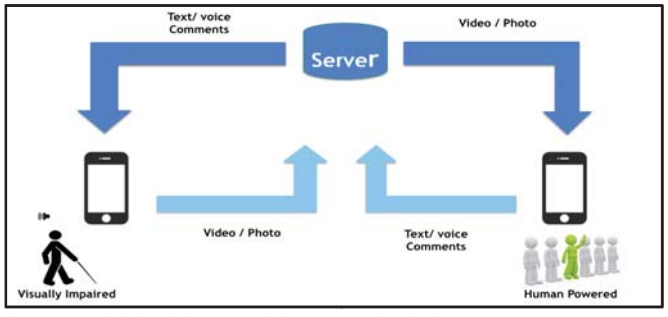


Figure 2 : Initial architecture of the proposed solution

To describe the main features of the proposed application, it should be mentioned that there are two main home pages: one for the volunteers and the other for blind people. Regarding the main page for the blind users, there are three choices: capturing a photo, capturing a video or checking the history. To increase the accessibility, these choices can be selected using a finger tap. In addition, the user also has the ability to record a question tagged with the captured photo. Then, they can share their posts with all the volunteers already registered for the application or only with their followers, which can enhance privacy. Furthermore, the application stores all of the blind person's posts in their history; so they can listen to the volunteers' comments. Different screenshots from the application are presented in Fig.3.

On the other hand, the main page for the volunteers contains five choices. First, the volunteer can access the home page that contains the photo and video sent by the blind user following them. Therefore, they can make helping them a priority and add text or voice comments to describe their posts. Second, they can also explore the posts that blind users share. In addition, they can view the list of blind users already registered with the application and choose whether to follow or not follow any of them. Moreover, the application gives the volunteers points and levels to measures their participation and increase their motivation. In addition, it accordingly presents a list for the most active volunteers. Furthermore, the application sends a notification to the volunteer when any blind user from the following list adds a post. Therefore, the volunteer can always be there whenever a visually impaired friend is in need. Different screenshots for the volunteer page are shown in Fig.4

The proposed application also provides basic functions, such as login, log-out, register and recover password for the blind users and volunteers. For a further explanation of the application's features, check Fig.7 in APPENDIX.

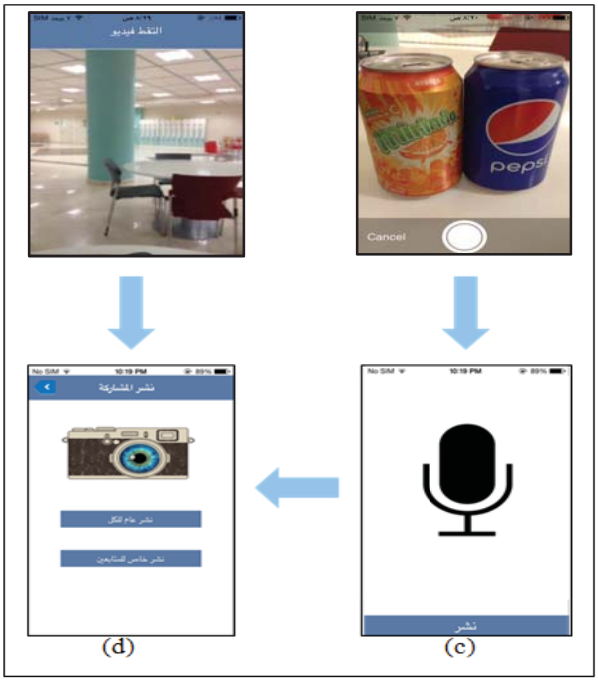


Figure 3 : (a) captruting a video, (b) capturing a photo, (c) tagging a question, (d) share the post

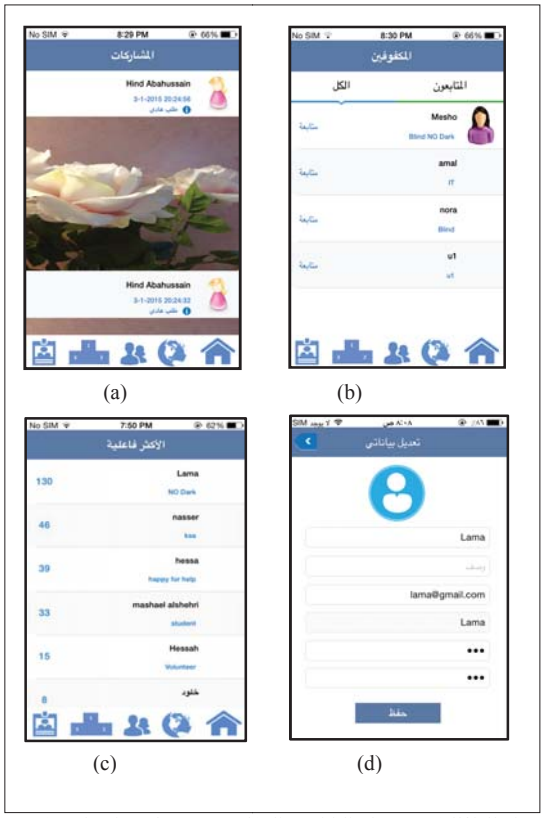


Figure 4 : (a) viewing the posts, (b) list of blind users (all/follwing list), (c) most active volunteers, (d) update the profile

## IV. Evaluation and Results

The aim is to evaluate the extent to which the proposed application is easy to use and useful. Therefore, 16 participants, eight of them blind users and the rest volunteers, are asked to complete a questionnaire about their opinions on using the application. In addition, to determine the application's robustness in terms of extreme loads, stress testing is used.

### *A. Questionnaire*

Different aspects are considered in the questions in the survey. For the blind users the questions are as follows.

- Is the application easy to use?
- Do you think that you will use the application on a daily basis?
- What do you think is more useful: capturing a video or photo?
- Give some examples of the uses of the proposed application?

For the volunteers, the questions are as follows.

- Is the application easy to use?
- Do you think that you will use the application frequently to help blind users?
- Do you think that the application will be useful for blind users?

### B. Responses

Regarding the results of the survey (as shown in Fig.8 in APPENDIX), five blind users report that they "strongly agree" that the application is easy to use, while three of them "agree" with this. Therefore, around 90% find that that ThirdEye is easy to use. Moreover, all of them agree that this application will assist them in their daily lives. In addition, five of the eight respondents report that both capturing a video and capturing a photo are useful, while three of them think that capturing a photo is more useful than capturing a video. In addition, the blind users give different examples of the uses of the proposed application. These examples are as follows (see Fig.5):

- Recognizing products in a supermarket.
- Differentiating between boxes that have similar shapes and sizes, like soft drink cans and juice boxes.
- Differentiating between medicine containers and eye drops.
- Checking the expiration dates of different products.
- Differentiating between colours and paper money.
- Reading text and book titles.

For the volunteer group (as shown in Fig.9 in APPENDIX), it is obvious that most of them report that they "strongly agree" with the fact the application is easy to use and they would frequently use it to help the visually impaired. Furthermore, all of the volunteers believe that this application will be very helpful and useful for the visually impaired.

It should also be mentioned that the blind participants who answer the questionnaire are really impressed and happy with this application. Moreover, one of them says that "This project will be an innovation in the history of the visually impaired applications". Moreover, the visually users are highly motivated to support and help the blind people. Therefore, it is obvious that this project will have a significant impact on the lives of the visually impaired.

### C. Stress testing

Stress testing in normally used to assess the upper limits of the capacity within a system and to help administers to determine if the system will perform sufficiently if the current load goes above the estimated maximum. A cloud-based load testing tool called "Loader.io" is used to perform this testing. The test is performed with 250 clients over one minute. The results (as shown in Fig.6) show that the average response time for the requests is 107 ms and the error rate is 0.0%.

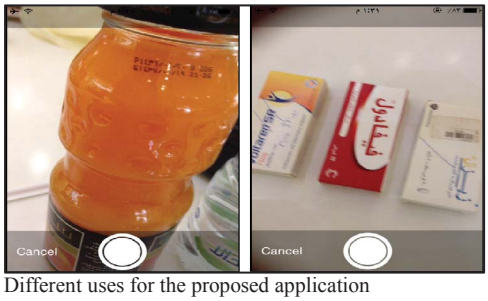

Figure 5: Different uses for the proposed application

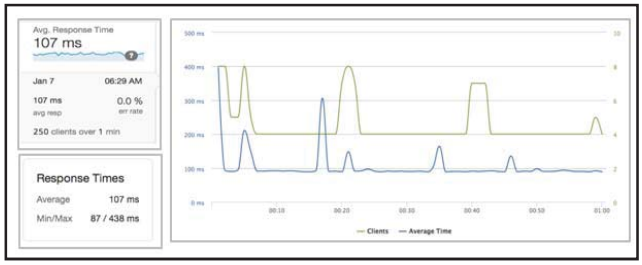

Figure 6: : The results of stress testing.

## V. Conclusion and Future Works

This paper provides details about developing an IOS mobile application that helps blind people in the identification task with any surrounding objects using human-powered technology. Moreover, it presents related works in this field and provides a comparison of the mobile applications used for this purpose. As a result of this comparison, the best features that should be considered in designing such an application are shown. Furthermore, it pays attention to the limitations that can be improved upon.

After developing the proposed application, the usability is tested and the results show that ThirdEye is an application that is easy to use. Furthermore, it is very useful and has important uses in daily life. Hopefully this application will help the blind as well as give people a chance to be volunteers and provide a service for blind users.

For future work, there are many features that can be developed. The visually impaired can identify the extent to which the post is important, so that the volunteers can provide help quickly. In addition, blind users will be able to upload any pictures so that they can learn about their content. In addition, to test the credibility for the user, a small test involving the tagging of three images can be added at the time of registration. Moreover, the application can be developed to work with the Android platform and provide an English language interface. Finally, to add more interactivity, the application can support live video calls.

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## APPENDIX

TABLE I. COMPARISON BETWEEN HUMAN-POWERED TECHNOLOGY MOBILE APPLICATION

| | **Mobile Applications** | | | |
|---|---|---|---|---|
| **Features** | **MySmartEye** | **LendAnEye** | **VizWiz** | **ThirdEye** |
| Platform | **Android +iOS** | **Android** | **iOS + Android** | **IOS** |
| Arabic Language | X | X | X | ✓ |
| **Features for visually imparied** | | | | |
| add a picture | ✓ | X | ✓ | ✓ |
| add a video | X | X | X | ✓ |
| record a voice question for the picture | X | X | ✓ | ✓ |
| Share the picture/video with all volunteers or only my followers | X | X | ✓ | ✓ |
| Checking the history | X | X | ✓ | ✓ |
| Making Live-call | X | ✓ | X | X |
| Text comments | ✓ | X | ✓ | ✓ |
| Voice comments | X | X | X | ✓ |
| Having list of followers | X | X | X | ✓ |
| **Features for Voulnteers** | | | | |
| View the blind posts | ✓ | X | ✓ | ✓ |
| View the most active volunteers | X | X | X | ✓ |
| Follow/unfollow a blind user | X | X | X | ✓ |
| Text/voice comment | ✓ | ✓ | ✓ | ✓ |

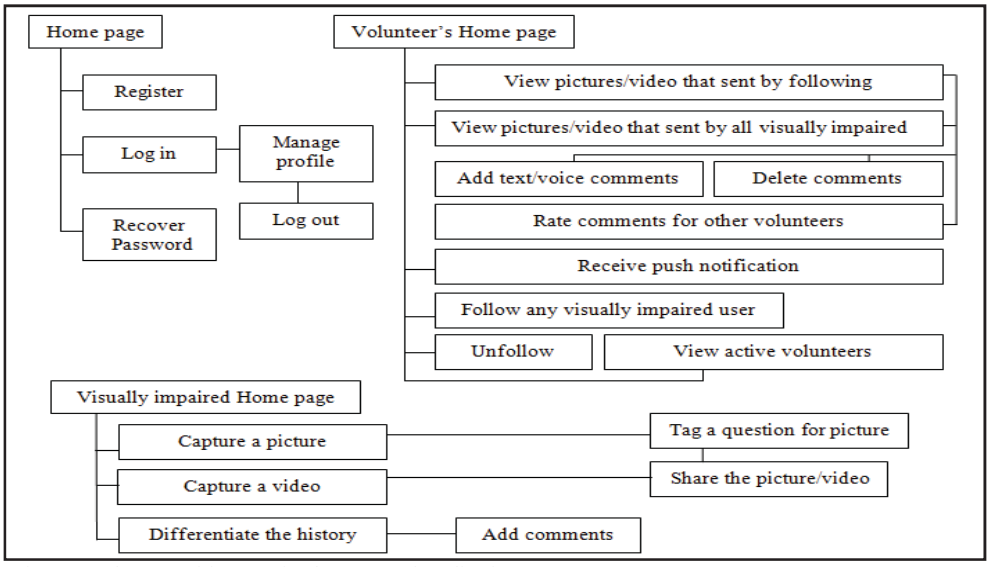


Figure 7 : The map of features for the proposed application.

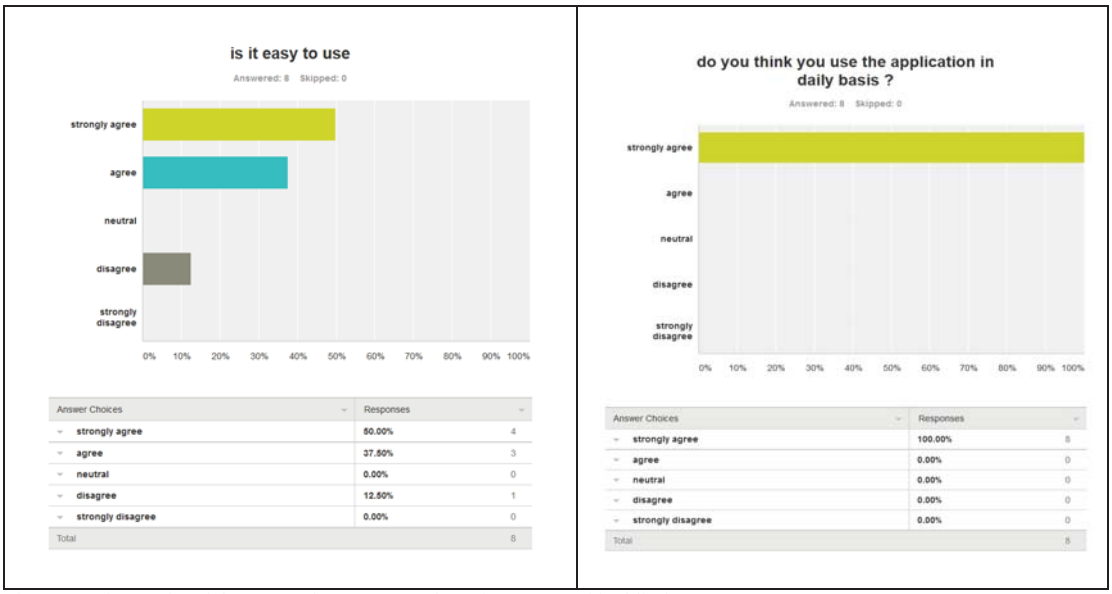


Figure 8 : The results of the survey for some questions that answered by blind users.

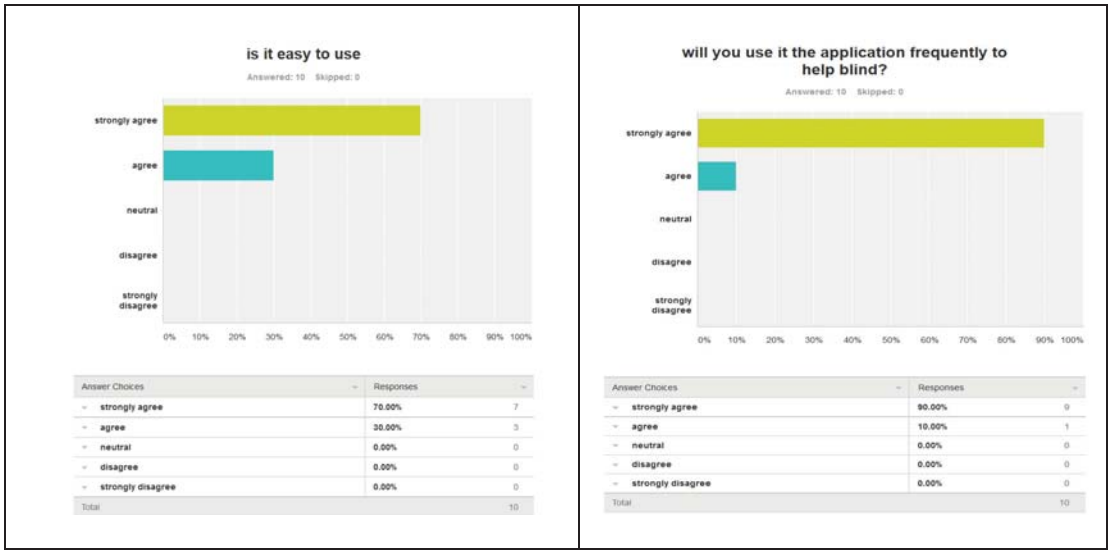


Figure 9 : The results of the survey for some questions that answered by voulnteers