

# A Qualitative Study to Support a Blind Photography Mobile Application

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## ABSTRACT

Both sighted and visually impaired people value having a photographic memento of a place or an event. However, due to the visually oriented nature of photography and the lack of non-visual cues to indicate the content of the photo, the common belief is that it is difficult for people with limited vision to take, organize and share pictures. However, we did not find a structured study on the photographic practice of those with limited vision. We ran a survey among 54 totally blind, light perception, and legally blind participants to investigate their photo taking, browsing, and online sharing. Based on this survey, we developed a mobile app to help blind persons take and recognize picture content using non-visual cues. The application was tested with five legally and totally blind persons with mostly positive results.

## Categories and Subject Descriptors

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

## General Terms

Human Factors; Design; Measurement.

## Keywords

Low-vision, blind, visual impairment, photography, iPhone, application.

## 1. INTRODUCTION

Photography is a visual way to capture a moment in time. Photos can be used for artistic expression and to remember significant events. Both sighted and visually impaired people value having a photographic memento of a moment, a place, or an event. Due to the visually oriented nature of photography and the lack of non-visual cues to indicate the content of the photo, photographs taken by visually impaired people often are lacking, sometimes missing the photo subject entirely [1]. Furthermore, it is difficult for visually impaired people to independently organize and identify photos after they have been taken. Due to the proliferation of online photo sharing services and digital cameras, online photo sharing is becoming increasingly popular. Previous work has investigated some photography trends such as whether or not a visually impaired person have used a camera, why they have taken photographs, and what they have photographed [1]. This work has also investigated how visually impaired people might foresee using a camera phone in their day-to-day life. There is

also work on making photo capturing without sight easier, however, there is little work that tries to understand the photo browsing and sharing behavior of visually impaired persons.

Visually impaired people should be able to capture, browse, organize and share photos just like their sighted counterparts. The advent and ubiquity of smartphones provide a customizable framework that can help visually impaired people capture, organize, browse, and share photos. There are currently different methods for associating some sort of photo description with its corresponding photos (e.g. associating text or audio with the photo); however, many of these methods are not designed with the visually impaired user in mind, and thus are often times difficult or impossible to use by visually impaired users.

By understanding the current photo browsing, organizing, and sharing practices of visually impaired people, as well as the shortcomings of the current photography tools they use, tools can be designed to cater to their photography needs. We conducted an online survey in the summer of 2012 to investigate various photography trends by visually impaired people, including photo capturing, organizing/browsing, and sharing. By analyzing the results of this survey, several striking points were revealed that motivated the design and implementation of an iPhone application to facilitate photography for visually impaired people. We learned most visually impaired people would like to be able to capture, organize, or share their photos independently, however, as we predicted, there are currently limited visually-impaired accessible services to assist in the photography needs of visually impaired people. The organization of the paper is described as follows:

- Section II: Related works and the current state of photo capturing, browsing, and sharing by visually impaired people are discussed.
- Section III: Details of the survey we conducted among visually impaired people, and the motivation behind the questions.
- Section IV: An analysis of both the quantitative and the qualitative results of the survey is given, which segues into the motivation behind the design choices of an iPhone application to assist visually impaired people in capturing, organizing, and sharing photos independently (described in the next section).
- Section V: We discuss the details of the application and how it is used by visually impaired people.
- Section VII: We discuss how the features of the application we designed were motivated by the analysis of the results of the survey.
- Section VIII: We conclude our study and discuss future work.

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## 2. RELATED WORK

### 2.1 Blind Photography

A number of published manuscripts suggest that those with no or limited vision perform photography-related activities [8, 9, 10, 11, 12]. These people take photographs for pleasure and artistic expression, [1, 2, 3, 5] as well as for more functional reasons, such as to assist in identifying grocery labels while shopping [16]. There are currently several photography aids that help out with different aspects of photography, such as aiming, verifying resolution and brightness, and recognizing a photo within a photo album, which are discussed more in detail below.

Because of accessibility features such as VoiceOver for iOS [6], and TalkBack for Android, adoption of smart phones is becoming wider among those with limited vision [5]. Smart phone apps to help with photography-related tasks without vision are starting to become widely available. Examples include using a camera to assist users to “view” the environment around them. VizWiz::LocatIt is a smartphone application that locates objects within a user’s environment using the smartphone’s camera, and with feedback provided by the application, visually impaired users are much more likely to locate a specific object than without it [2]. VizWiz, which utilizes VizWiz::LocatIt’s object location techniques, allows users to snap a photo of their environment, and returns a textual description of that photo in almost real-time [7]. This allows users to assess their environment without having to see it. oMoby [14] is an application similar to VizWiz; computer vision techniques first try to identify the contents of the photo, and if unsuccessful, the photo is crowdsourced to identify the contents.

Jayant et al. developed a system that helps visually impaired people aim a camera. They showed that certain cues provided by the smart phone can increase the quality and accuracy of the photo taken [1]. This system provides non-visual identification cues for the photo for future retrieval in an accessible photo album. Vázquez and Steinfeld’s work assists in aiming a camera by suggesting a region of interest (ROI) - the suggested center - in the camera frame through a choice of three feedback modes: speech, tone, or silent feedback. Once the new ROI is suggested, the user is directed to the new ROI via the feedback modes previously mentioned. Developers of this system also provide a blur detection mechanism to improve overall quality of the photo [2].

EasySnap is an iPhone application that provides a framework for users to receive real-time aural feedback about blur and darkness, camera tilt, and location and size of peoples’ faces within the camera frame [1]. EasySnap has three modes, “Freestyle,” which functions like a normal camera, providing no feedback, “People,” which tells the user whether there is a face in the camera, its location, and size, and “Object,” which allows the user to take a photo of the object up close, then instructs the user to whether the object is still in the frame as the user moves the camera back. Even though these technologies have been shown to improve framing, lighting, and focus of photographs, many visually impaired people who wish to take picture still do not do so because of accessibility problems of mainstream cameras [1].

PortraitFramer is an Android application that assists people with visual impairment capture a “well-framed” photograph [1]. While EasySnap is designed for one person, PortraitFramer is specifically designed for groups of people. The user begins by taking a preliminary photo of the group of people, and after receiving aural and tactile feedback about the frame, the user is able to readjust and take a more “well-framed” photograph.

### 2.2 Visual Impairment and Social Networking

Hewett and Douglas from the Royal Institute for the Blind in the United Kingdom ran a survey investigating social networking habits and mobile phone usage among teenagers with visual impairment aged 14-17 years old [4]. These researches have evidence showing the level of visual impairment among participants in the study does not impact their opportunities to spend time with their peers outside of school. Sixty nine out of 70 participants claim to own or have access to a mobile phone. Seventy five percent use smartphones. Interestingly, one common activity with the mobile phone was taking photos (65%). Most participants (54%) have used accessibility features on their phone, such as changing font size/style and using zoom functions. The most significant findings proposed here is that a higher proportion of visually impaired people have set up their own social networking profile (91%) than the general population of young people.

## 3. PHOTOGRAPHY SURVEY

Based on our literature survey, we argue that if we are to develop a blind-friendly application that can facilitate photography (taking pictures, recognizing them and sharing them through mainstream social networking tools) for those without or with limited sight, we need to first understand the photography habits, needs and preferences of blind persons. To do this, we ran an online survey among those who are totally blind, with light perception, and legally blind on Survey Monkey for a month in September 2012. Before we launched the survey, we tested our survey with two of the most common screen readers, JAWS and Window Eyes, to make sure the survey is accessible when read through a screen reader. We received 54 valid responses. Two \$20 Amazon gift certificates were offered as incentives through a random draw.

### 3.1 Design

The first set of questions of the survey were informed by Jayant et al.’s survey that investigated how visually impaired people aim a camera [1]. We then added questions to include photo sharing and browsing rather than just photo capturing.

#### 3.1.1 Demographics

The survey starts with demographics questions: age, gender, visual impairment level (legally blind, light perception, totally blind), and how long they had the visual impairment. If the respondent is legally blind, the survey asks for his/her visual acuity (they can answer they do not know or leave the answer blank). It then moved to a question about problems in general with photography-related activities.

#### 3.1.2 Photography Behavior

The next set of questions asked about their photo taking behavior, followed by photo sharing behavior. The list of questions include whether they had ever taken (or are interested in taking) pictures independently, whether they had ever had (or are interested in having) someone else take a photo for them, and whether they had ever shared (or are interested in sharing) photos online. They were also asked about the devices and services that they used for these activities if they had done so. For those who had not done so or are not interested in these activities, we asked why in open-ended format.

#### 3.1.3 Photography Satisfaction

A series of Likert-scale questions were used to assess, for those who had done photo taking, recognizing and sharing, how satisfied they were with their current photo taking, recognizing

and sharing methods and tools. These then led to open-ended questions to suggest design improvements or a wish list. For those who had not done these activities, we still asked them for their wish list.

## 4. SURVEY RESULTS

### 4.1 Demographics Data

Our respondents ranged from 18 to 78 years old of age (mean = 47.6, S.D. = 18.79 years). There were 37 females and 17 males. Thirty three were legally blind, nine with light perception, and ten were totally blind. For those who were legally blind, their acuity ranges from 20/200 (the starting point of being considered legally blind) to 20/2400 although there were some special cases such as some respondents who were blind in one eye and legally blind in the good eye or those who had a varying condition from legally blind to light perception on good/bad days. Thirty seven respondents had their visual impairments all their lives (as indicated in answers that include “since/from birth”, “all my life”, “congenital” or “lifelong”). The rest varies but the shortest (time from the moment they started having their visual impairment) was 3 years.

### 4.2 Independent Photography-Related Activities

The next set of questions aimed to understand whether blind persons perform photography-related activities independently, for if we are to find that a very small percentage of blind persons perform these activities independently, we will have to re-think our idea of designing a tool to help photography without sight (and instead either design an educational tool to train blind persons to become independent photographers or a tool for sighted persons to help blind persons perform photography-related activities, independently). These questions investigate current photography behavior. Twelve (22%) respondents had not taken a picture independently. Ten (19%) had never asked somebody else to take a picture for them. Twenty (37%) had never shared their pictures online.

Only two respondents (both are males, one legally blind and one totally blind) had never done any of these three activities. To make sure that these two respondents did not randomly answer the survey, we analyzed the reasons why they did not perform these activities (especially as for those who answered “no” to all these three activities, the only data left to analyze was the reason for not doing these activities). The legally blind participant stated, “*While I'd like a good photo of myself that I could post on Linked-in and perhaps other social network sites, I don't have much interest in photography because I can't see the pictures.*” We found this comment interesting as this person participated in social networking, and is interested in making use of a “good” photo. The totally blind participant stated that the reason he was not interested in taking picture on his own was because he “[was] *not able to see at all and don't really know what I'm doing at all or really how to point and shoot with the vision required camera.*” We also found this comment interesting as it indicates that if we could help blind persons understand how to point and shoot a camera, we could perhaps persuade more blind persons to try to take pictures independently.

We asked respondents whether they wished they could take photos on their own. Ten out of the twelve respondents who had not taken photos on their own (without help) provided an answer. Figure 1 shows the distribution of the answers. As Figure 1 shows, only five out of 37 answered negatively. Likewise, 25 out of the 34 respondents that answered that they had taken photos by

themselves (without help) and that they have had someone take photos for them provided an answer. Figure 2 shows the distribution of the answers. As Figure 2 shows, only two out of 25 answered negatively. Both of these indicate that there is a need to help those with no or limited vision to take their own photos as there is a significant interest in being able to take their own pictures in blind and visually impaired community.

### 4.3 Technology of Choice

The next set of questions asked about the devices and services that the respondents used or had somebody else used to help them take pictures. These questions investigate current photography behavior. For the device used to take pictures, we provided a pre-defined set of devices, which are digital camera, non-smartphone, smartphone and other device (they can choose more than one). Please note that respondents were allowed to choose more than one device or service. We also invited them to list the name of the particular device if they knew it. Thirty two respondents used a digital camera. For those who knew the brand of the device, they listed mainstream brands such as Nikon, Canon, Fuji and Sony. None listed a specialized brand. Only nine used non-smartphones to take pictures. Thirty one respondents used a smartphone to take pictures, mostly iPhones of various generations. Finally, 16 used other devices to take pictures, mostly iPod Touch or iPad.

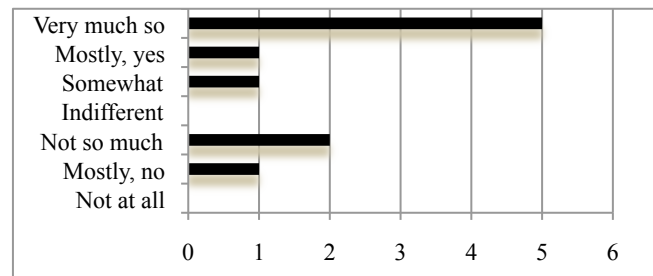


Figure 1. The distribution of desire to take photos on their own (without help) for those who had not done so.

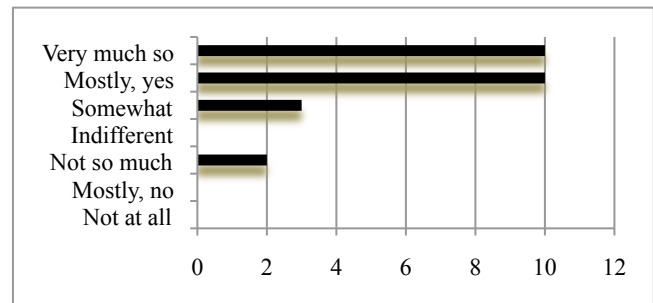


Figure 2. The distribution of desire to take photos on their own (without help) for those who had done so but have also had someone else do it for them.

The respondents were asked in an open-ended fashion how they shared their pictures (they can list as many ways of sharing as they wish). Thirty two respondents provided answers. Twelve attached the pictures on their email, 22 posted them on Facebook. Four mentioned Twitter and some used photo-sharing services such as Photobucket and Flickr.

### 4.4 Problems with General Photography-Related Activities

To inform the design of the functionalities of the application, we need to understand, in general, problems that blind and visually impaired persons have with photography-related activities, and

therefore this question just asked in general about obstacles that they face in doing these activities. We asked this question to both those who have taken photos on their own (without help) and have shared photos, and those who have only taken photos on their own (without help). This is an optional question, and we received 38 responses. Three coders coded the open-ended answers into themes, and the following are the themes that emerged, organized by photo taking, sharing, and organizing and editing categories, and within each category, listed by frequency. Please note that some respondents listed multiple problems that fell into more than one category.

#### 4.4.1 Photo Taking

1. Aiming, focusing and positioning, framing<sup>1</sup> (12 counts). Example sentence: *"Since I have no vision, I don't know if I am focused correctly when taking the picture. I often take pictures and they do not come out because I am not focused properly."*
2. Need sighted help (6 counts). Example sentence: *"If I am in a group, I usually have someone advise me on the camera placement even if I take the picture myself."*
3. Device (4 counts). Example sentence: *"Unable to distinguish what buttons on camera are for unless I pull out my hand magnifier."*
4. Photo quality (3 counts). Example sentence: *"Things like detecting whether a whole person is in the picture or whether sunlight is obstructing the view would be good information."*
5. Lighting and pose (1 counts). Example sentence: *"Through experience, I have gotten better at properly placing cameras, but every situation is so different due to lighting, the way people are posing, etc...."*

#### 4.4.2 Photo Organizing and Editing

1. Identifying photo (16 counts). Example sentence: *"My phone will not let me rename photos so I can't remember which ones are which."*
2. Label (12 counts). Example sentence: *"...need a way to give longer description than title to photo for later 'viewing'."*
3. Device (8 counts). Example sentence: *"Since most photos are organized by numbers on phones/cameras, it's hard to know which photo is which..."*
4. Photo quality (6 counts). Example sentence: *"Identifying which photo is which; which takes are the best shots; which photos are doubles/blurry, etc."*
5. Accessibility issues (5 counts). Example sentence: *"photo editing programs don't talk with JAWS; same for organizing."*
6. Need sighted help (4 counts). Example sentence: *"I have to have friends/fam, mainly my BF, go through photos with me so I know what they are, which takes are good, and label them before up[loa]ding."*
7. Manipulation (3 counts). Example sentence: *"I have had some trouble seeing to edit and crop."*

#### 4.4.3 Photo Sharing

1. Need sighted help (3 counts). Example sentence: *"i can never post a picture on my own, i have to ask for help because i can post the wrong picture on facebook or internet, , etc. i have done it in the past."*
2. Accessibility issue (3 counts). Example sentence: *"I can successfully upload photos from my iPhone to Facebook, but if I want to create an album, I have to go through the website*

*on a computer, and I have to use the "classic" way of uploading 5 pictures at a time rather than the newer version which consists of flash content so I cannot access any of the browse or upload features with my screen reader JAWS."*

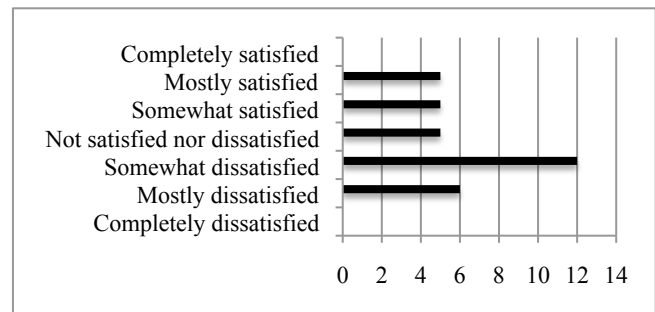
3. Photo quality (2 counts). Example sentence: *"I don't know which ones are good enough to share."*
4. Don't know how (2 counts). Example sentence: *"eyesight getting worse and not really having the hang yet of filing photos and then dropping into docs or emails."*

In general, it appears that most of the problems are to do with making sure that the pictures taken are of good quality (i.e. by providing help in aiming, focusing, ensuring good lighting, etc.) and that the process for organizing and sharing is easy for interaction without sight (e.g., by allowing easy renaming of pictures). We took these findings into consideration when it was time for us to start designing the mobile application to help with blind photography.

### 4.5 Photo Sharing Behavior

Through our literature survey, we found that photo sharing behavior of those with limited or no vision is not as extensively studied as photo-taking behavior is. Hence, the next set of questions in our survey aims to get a better understanding at photo sharing behavior. These questions aim to identify requirements for a future (improved) application.

The first question that we asked for those who shared their photos online was "How satisfied are you with your current method of sharing photos online?" Thirty three respondents answered this question (please note that there are only 34 respondents that had shared their pictures online). Figure 3 shows the distribution of the answers.

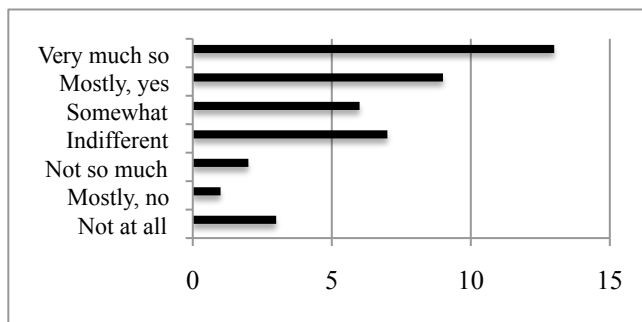


**Figure 3. The distribution of respondent satisfaction with their current method of sharing photos online.**

As Figure 3 shows, nobody answered that they were completely satisfied or completely dissatisfied with their current method. However, only 10 out of 33 respondents were either somewhat satisfied or mostly satisfied with their current method.

We also asked them the question of "Do you wish you could share photos online?" regardless of whether the respondents had shared their photos online or not. Forty one respondents answered this question. Figure 4 shows the distribution of the answers. As Figure 4 shows, only six out of 41 respondents answered negatively about sharing photos online, providing us with a confirmation that there is a desire among blind photographers to share their photos online.

<sup>1</sup> By framing, we mean determining what is in the frame.



**Figure 4. The distribution of desire to share photos online.**

To understand better these opinions, we looked at the qualitative data, i.e., the answers to the open-ended questions about the problems they faced with sharing photos online (for those who share) or why they have not shared their photos online (for those who have not shared). This is an optional question, and 28 respondents provided an explanation (mostly those who had not shared their photos online). To categorize the answers, three coders coded the data into themes. Below are the themes that emerged, in the order of frequency. Please note that some respondents have more than one theme in their answers (e.g., “Don’t know which are good; process getting difficult for me”).

1. Don’t know/forget how (8 counts). Example sentence: “[I] was 5 years ago; didn’t know how to send.”
2. Unsure about the quality of the photo (7 counts). Example sentence: “mostly because my photos have not come out good. If they do come out good, I do share them.”
3. Current sharing process (3 counts). Example sentence: “process to post to FB changes too often.”
4. Privacy (3 counts). Example sentence: “I photograph for individual people, events, schools. These are private customers.”
5. Lack of time (2 counts). Example sentence: “lack of time to learn more ways to do so.”
6. Need sighted help (2 counts). Example sentence: “I do not have enough confidence in my judgment to do it without someone sighted reviewing them first, and I am ok with that. However, even with the best technology, I will probably always seek sighted assistance, because I feel that a person who I know will have a better idea of what I consider to be an acceptable picture than any computer program.”
7. Not interested in sharing (2 counts). Example sentence: “Not interested in sharing, just taking practice photos.”
8. Not an option with the current camera (1 count). The sentence was exactly that.

From these answers, it was apparent that the two major issues here were that the respondents did not know how to share and they were unsure about the quality of the pictures that they took. If we were to design an application to help them, these would be two major requirements that we need to consider, especially as these two issues appeared in respondents’ comments related to various photography-related activities.

#### 4.6 Features of the Application

We also collected the open-ended answers that referred to the features of a blind-friendly tool that can help take, recognize/organize or share picture. The following are the features suggested, with the original sentences from the respondents:

1. “Having a way to name and place a pic after shooting”
2. “It would be great to confidently access time/date and description of photo or circumstance”

3. “If I could attach a verbal description to the shot, that would at least give me the feedback I need when sharing in person or online” or “being able to record a small sound byte for some pics”
4. Information about “how much distance to put between the lens and the object”
5. “a way to quantify ways to detect whether a picture is good, it would be cool if I could be advised whether a picture is good or whether it should be retaken”
6. “detecting whether a whole person is in the picture or whether sunlight is obstructing the view”
7. “making labels appear universally, no matter how you access your photos”
8. “vocal assistance with anything having to do with pictures”
9. “more accessible ways to take, store, and upload photos”
10. “need to be able to know whether the lighting is right for our photos”
11. “need to know how to get the photos from our camera or phone onto our computers and onto eBay or social networking sites or to send them as at[t]achments in emails.”
12. “a ‘low vision tool’ to ‘see’ things (enlarged) that I otherwise can’t clearly see” or “The ability to magnify the view screen on digital camera”
13. “getting the ones I don’t want deleted and out of my way” or “programs could at least weed out the really bad pictures to save time.”

In general, in line with the open-ended answers from other questions, the features for this application seem to relate to helping ensure a good quality picture (i.e., vocal assistance to ensure good lighting, pose and focus; and weeding out bad pictures) in an easy/accessible way, followed by an easy way to add verbal information about the picture (which can be date/time, place or other information) for easier identification, and an easy, accessible way to share the pictures.

#### 4.7 Significant Differences for Those Who Are Legally and Totally Blind

In the area of assistive technology for people with visual impairment, there is a significant difference between applications built for those who are legally blind (but can still see with some degree of magnification and image enhancement) and for those who are totally blind (including those who only have light perception). Therefore, we took a second look at our data to see if there are significant differences between any aspects of our survey between those who are legally blind and totally blind.

We ran One-way ANOVA analysis between the visual impairment level of the participant and the Likert-scale questions regarding attitudes toward photography and online photo sharing. People who are legally blind are more likely to have taken photos themselves (with no help) than people who are totally blind ( $n=55$ ;  $p=.004$ ). Analyzing the qualitative answers of these two groups, it was apparent that those who were totally blind made more comments that relate to lack of confidence about the quality of their photos or not knowing how to take their own pictures, something that we also had to address in the design of our photography helper.

### 5. PHOTOGRAPHY APPLICATION

Based on the analyses results from the aforementioned survey, an iPhone application was created to assist users with limited or no vision in capturing a photo and browsing their photos through an accessible photo album. iPhone already has a face detection feature that can help center a face, so we took advantage of this

feature and embed it into our application. Several applications that we reviewed in the Related Work section are also available to help aim and focus. Therefore, we decided that while our application also helps in aiming the camera as the user requirements indicated as an area of importance, it adds some features on helping those without or with limited sight browse the pictures after the photos are taken. A full description of the technical details and functionality of the application can be found in [5].

As the survey indicated, the most common obstacles in photography without sight after the photos are taken are remembering the content of the photo at a later date and lack of capability to assign verbal information to the photo for future reference. For this reason, the tool is equipped with the ability to include machine-mined information with each photograph to assist the user to remember the content of the photo, namely the date and time as well as the location of the picture based on GPS information (translated into the name of the city or a much more detailed information (e.g., the name of a district or neighborhood) if available). While the photo is being taken, the application also records ambient audio, and right after the picture is taken, the users are provided with an option to add a voice memo. In addition, to make finding what is in the picture easier, the information tagged to the photo (audio sound byte, time, date, and location) is easily accessible while browsing photos. Figures 5-7 show the screenshots of the application.

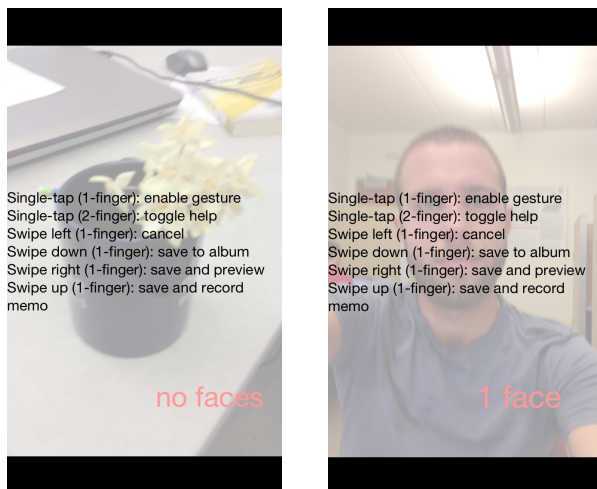


Figure 5a: no faces were detected

Figure 5b: One face was detected.

Figure 5. The camera mode.

## 5.1 Application Details – Camera Mode

When the application opens, the user is presented with a camera view, shown in Figure 5, which is the Camera Mode. The camera view has six functions: Enable gesture, Toggle help (displays and hides help menu), Save to album, Save and preview, and Save and record memo.

Figure 5a shows the case when there is no face detected, while Figure 5b shows that the camera detects one face. This textual message is spoken out loud by VoiceOver allowing blind users to know how many faces were detected.

As soon as Camera Mode is opened or after a photo has just been taken, the device begins recording ambient audio up to a maximum of 30s – which can be restarted at any time by double tapping the screen – which is associated with the photo once

saved. By using a single swipe up gesture, the user snaps a photo. Once the photo is captured, the user has the option of recording a voice memo, by tapping and holding, waiting for one second (after which a confirmation sound indicates voice memo recording has begun). Upon releasing hold, voice memo recording stops and the voice memo is automatically replayed. At this point, the user may re-record the voice memo, or if they are happy with the memo, single-finger swipe down to save the photo, ambient audio, and voice memo into the photo album.

## 5.2 Application Details – Album Mode

The album mode is depicted in Figure 6. In this particular screenshot, the album is organized by the date the pictures were taken, but the users can organize the photos by location. At the bottom of the screen in Figure 6 is an easy way to go back and forth between various functions, which are: Camera view, View all [pictures], By Date and Settings.

The user may access the photo album by using left-swipe gesture in Camera Mode (please refer back to Figure 5). When the photo album is grouped and sorted by days, the user swipes left or right to access an earlier or later date, respectively. Once the user arrives at a desired date, they can access a time-wise sorted list of all photos taken on that date by double tapping. While accessing the list of photos, the user may swipe left or right to access each individual photo, giving it focus<sup>2</sup>.

When the user highlights a photo, the memo audio is played, followed by the reading of the time, date, and location the photo was taken via iOS VoiceOver. Double tapping the photo changes the screen to the detailed view screen, shown in Figure 7.

In this screen, the photo is shown in full screen, partially covered by a textual overlay with the information about the photo, which includes the duration of the voice memo, the dates and local times and the location of the photo. Upon loading this screen, the voice memo followed by ambient audio (which was recorded while the user was aiming the camera) is played. Once ambient audio stops, the orientation of the photo is announced, i.e. “Landscape” or “Clockwise,” to indicate how to properly show the photo to a sighted person. The user may three-finger swipe left or right to navigate to other photos from this screen. The top of the screen indicates how many photos were in that album (in the case of Figure 7, there were 3 photos, and this was the second photo).

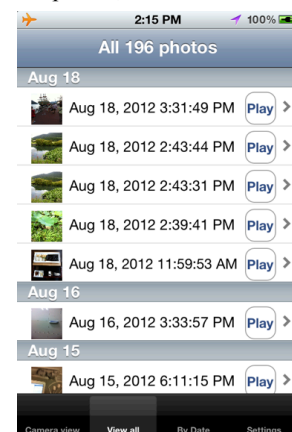


Figure 6. The album mode.

<sup>2</sup> Focus is given each item in an application in iOS when VoiceOver is turned on, giving a vocal description of the focused item.



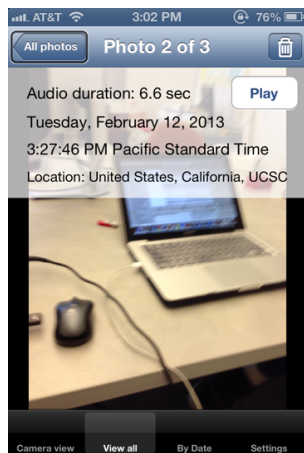


Figure 7. The detailed view mode.

## 6. DISCUSSION

This paper reports a largely qualitative analysis of a survey that aims at understanding the requirements among blind and visually impaired persons regarding independent photo taking and sharing activities. The results of the survey informed the features of the mobile application that we developed, that we then tested with five persons, also in a largely qualitative user evaluation method; the results of this user study can be found in [5].

Several features of the application that were motivated by the results of our survey were:

- Provides both magnification and voice outputs: The application must be accessible by visually impaired and blind users, which means that not only must the interface be magnified for those with low vision, but also interact aurally for those with light perception or no vision.
- Gesture Modes: As some of the respondents in the survey complained about the complexity of the operations to take and share pictures of the existing applications, we developed a series of Gesture Modes that allows for very minimal steps to do these activities. More specifically, these gestures allow users to toggle a help menu, save a photo with audio to the album, save and preview the photo with audio, and save photo and video and record voice memo – all with just various swiping motions without necessitating them to listen to menus.
- Time, date, and location metadata: As the survey indicated that identifying the contexts of the pictures is problematic, the application must assist users in locating the photo at a later time, such as by saving metadata automatically.
- Ambient audio: In the same light as above, to assist users in identifying the photo at a later time, and to enhance the non-visual experience of the photo, our application also allows recording of ambient audio of where and when the photo was taken.
- Voice memo: Finally, again to help users identify the photo at a later time, our application also allows users to record voice memo.
- Various grouping options: When a large number of pictures are taken, there is a need to have folders that either are automatically assigned by the system or defined by the users. Our application allows both options.
- Face detection: As the survey indicated, many users are concerned about focusing and aiming the camera. By taking advantage of the face detection feature that the iPhone has,

our application helps in focusing and aiming the camera in relation to faces.

There are some other features that the survey indicated that we have yet to implement to our application, which we will discuss in some level of detail in the Conclusion section.

## 7. CONCLUSION AND LIMITATIONS

Through the analysis of a survey conducted among 54 totally blind, with light perception, and legally blind participants investigating photography trends, we have shown the need of a mobile application to assist those with limited or no sight with capturing, organizing, and sharing photos. As noted, the application was tested on five low-vision (including totally blind) participants with mostly positive results, detailed in [5].

It should be noted that the medium through which the survey was conducted, the Internet, suggests the sample of participants in this survey is more tech savvy than the general population of people with low vision. It will be necessary in the future to complement this survey through telephone surveys and visits to centers for orientation and mobility for blind persons.

While the survey revealed many important aspects of low-vision photography, as is the nature of the survey, we cannot really observe the actual practices of these people when they take and share pictures beyond the five people we interacted closely when they tested our application. In addition, the survey did not include a way to get a glimpse into the pictures that blind persons took and shared. We plan to follow up the survey with a series of interviews and focus groups to gather this information. This will allow us to verify the respondents' perceptions about the quality of their pictures, given that this theme appeared many times.

From the application development side, our future work will build on work done by Jayant et al. [1], Vazquez and Steinfeld [2], and our own work [5]. We plan to investigate the different photo capturing methods low-vision people are currently using and whether we can create a way to customize our application to match their preferred method. We also plan to follow in the footsteps of Swanson et al., who developed a game, Panorama, which investigates visual composition preferences using photography composition rules (such as balance, thirds alignment, symmetry, and spacing) [17]. The game automatically scores screen shots' composition quality. Swanson et al. obtained pairwise ranking scores of the images through crowdsourcing, and compared the scores given by Panorama and those given by the crowd, and showed that the game is mostly accurate in personal preference and general composition preferences. The algorithms used in this game will be distilled and tested in our future study of how to assist visually impaired people to capture a "good" photograph.

Even though we already started inquiring about how low-vision people organize their photos or maintain a photo album, there is a lot to be done to really look into their organization method for a variety of media files. We plan to develop a customizable organizational method within the next generation of our application to account for individual differences in organizational preferences. We anticipate utilizing principles to sonify images proposed by [18] to design such an organization scheme, such that users are able to interpret the content of a photo by interacting with the photo through a touch-screen interface.

We also wish to investigate how visually impaired people are sharing their photos online and offline and the types of photos they shared. We plan to investigate the extra information they provided about these photos to those who are blind and sighted.

Finally, we had only touched upon the differences between those with some residual vision and those with no vision. We plan to investigate more deeply their preferences, to see both the commonalities and differences between these two user groups.

Having listed the limitations of the study, we believe that our study is unique in its contributions, in that it presents an extensive survey about photo taking and sharing issues among those with limited and no vision. Although some research groups have developed a variety of photographic aid for this user group, our application is unique in having its features informed by the needs and concerns of our user group as stated in the survey, and in having the features that make photo taking and sharing easier for this user group. There are a lot of pending questions and ideas that we need to implement in the next generation of our application, but we believe that this study is a first step in the right direction to helping those with limited or no vision to be able to take and share their pictures independently.

The technological value of the future of this work lies in the novel methods for i) computer vision algorithm to improve photo taking without sight; ii) audio life-logging to retrieve from large amounts of audio data. This work will also provide a deep understanding of how visually impaired people take, organize and share pictures. This research will produce a technological artifact that turns a smartphone into a photo-taking aid without sight.

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