GoingEasy® with Crowdsourcing in the Web 2.0 World for Visually Impaired Users: Design and User Study

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ABSTRACT
Sharing "blind-specific" information among people who are visually impaired, especially those in the same local community or of similar background, can be very valuable in promoting active and independent life styles. Unfortunately, while having gained tremendous popularity in recent years, existing Web 2.0 technologies/systems do not provide adequate support for effective information sharing among people with visual impairment. In this paper, we present the development of GoingEasy®, a social networking site built for crowdsourcing information that caters to the special needs of computer users with visual impairment. We describe our design and implementation of the site for achieving the desired crowdsourcing capability, and present user studies including those intended for establishing the design principles and those for evaluating the first version of the site. The evaluation experiments based on participants who are blind suggest that the proposed approaches for building GoingEasy® are effective and promising, and thus continued development may lead to a full-scale solution for providing a new and much-needed capability in the Web 2.0 world.

Categories and Subject Descriptors
H.3.4 [**Web2.0**]: Custom webpage, visual impaired, social networking, crowdsourcing. H.5.2 **[Information Interfaces and Presentations**] User-centered design. K.4.2 [**Social issues**]: Assistive technologies for persons with disabilities.

General Terms
Design, Experimentation, Human Factors

Keywords
Social networking site, Web2.0, accessibility, crowdsourcing, Navigation.

1. INTRODUCTION
In the past few decades, assistive technologies for the visually-impaired have seen tremendous developments, producing innovative devices (e.g., various haptic-enabled gadgets) and software products (e.g., widely-used screen-reading software). Nevertheless, there are still many practical barriers for a blind individual who strives to lead an independent and active life. Some of the challenges he/she faces may even become worse comparatively speaking in the digital age, resulting in the so-called "digital divide". Many efforts have been dedicated to closing this digital divide, ranging from technology development by the research communities (e.g. [1-3]) to enactment of new policies by the government (e.g. [4-6]). The increasing popularity of social media and participatory Web presents new opportunities that make it possible to engage people with visual impairment and their families and friends to directly contribute to a joint endeavor of enhancing information flow, increasing awareness, and improving efficiency of assistive practices. This can provide unique capabilities and information that are missing in most existing on-line information sources, such as the website of the American Foundation for the Blind (AFB), which, while being comprehensive, conveys mostly general and static knowledge (such as legal documents pertaining to blindness) rather than specific and dynamic information that a blind individual may need in order to accomplish essential daily tasks.

The objective of the current study is to develop a *social-media based crowdsourcing* capability that enables visually-impaired people to form loosely-connected groups, actively contribute their information and knowledge, and ask/answer unique questions that address special needs. The key approach is to develop GoingEasy®, a blind-friendly social networking site for supporting the above capability for a community of individuals with visual disability, their families and friends, and volunteers and support groups. The current version of the system is intended for people in the same local area and thus it provides a platform for the users to contribute and share information that are directly relevant to their daily lives. For example, a user on EasyGoing® can ask for detailed walking direction for getting to a location, and he/she may get responses from other users. Such responses, when posted by a user with visual impairment and with experiences of going to that location, may be especially valuable since it can be very "blind-specific" and "blind-friendly".

While people are increasingly relying on collective knowledge from other users in making important decisions in their daily life in the age of Web 2.0, existing Web interfaces and designs are primarily developed with the sighted users as the target audience, making it challenging to actively contribute to and fully utilize the underlying services by users who are blind. This remains more or less the case even for Websites that are made accessible, since the underlying design principles are still the same with only emphasis on proper HTML tags being included and the extent of information on a page being diluted to make it easy to navigate. In this paper, we present our solutions for addressing the practical challenges associated with participatory Web for users with visual impairment. We describe our design and implementation of the GoingEasy® site for achieving the desired crowdsourcing capability. We also present user studies, including those that were performed for establishing the design principles and those that were carried out for evaluating the first version of the site.

The remaining of the paper is organized as follows. In Section 2, we briefly review relevant work. Then, in Section 3, field studies that were intended to understand essential design requirements are reported. Section 4 describes the details of the proposed design and implementation. Section 5 presents the evaluation experiments, including the protocols, the outcomes, and discussion of the results. We conclude in Section 6 with a brief discussion of our plan for future work.

2. RELAVENT WORK

In 1998, the United States Congress amended the Rehabilitation Act to require federal agencies to make their electronic and information technology accessible to people with disabilities [7]. Similar legislation exists in Europe and a small number of countries. Accessibility issues with respect to websites came into limelight when the legislation introduced the Disability Discrimination Act (DDA), which ensures that websites are accessible to blind and disabled users. Independent sources like W3C [8] have been widely accepted as standard usable guidelines in USA. American Foundation for the Blind [9] has set down their own set of guidelines to make information technology more usable to the blind population.

Accessibility is a subjective term [10] and hence the guidelines are very hard to define and follow completely. Work has been done on different methods for finding accessibility problems affecting users who are blind [11]. There are a lot of websites that offer to test a webpage and evaluate the accessibility. In addition to testing these guidelines, studies have been done to establish relationship between accessibility and visual design, browsing behavior, usability [12][13][14].

Companies like Google, Amazon, Facebook, etc have special accessible pages to reach out to a larger audience. But most of the accessible pages are concerned with proper HTML tags associated with the pages or scaling down of functionalities in a page to make the page less cluttered. There are advances from the browser side to support accessibility. Serotek [15] and Visum [16] are browser provided services available that aid accessibility. HearSay [17] is a voice browser developed and released by Stony Brook University. Work has been done on developing transcoding systems by IBM [18][19], SADIE [20], and aiBrowser [21] for characterizing active HTML, flash and AJAX content. The issues like making optimal layout, organization and architecture of the site are those we propose to address in this work.

Social networking sites have become popular in recent years and a lot of research has been done to observe the behavior and modeling of on-line communities. Sites like Amazon's Mechanical Turk [22], Innocentive [23], 99designs [24], etc., which provide monetary incentive for tasks performed, are an indication of success of the on-line platforms of information sharing. On the other hand, websites like Wikipedia [25], Yelp [26], Facebook user groups [www.facebook.com], etc., where people contribute altruistically, have managed to become trusted sources of information. Social captioning for the deaf and blind are also becoming popular. Bookshare [www.bookshare.org], AFB's Helen [27], Youtube Subtitler [28], e-learning content captioning by Welcome [29], Nico-Nico Douga [30] have used social crowdsourcing effectively to address accessibility. Research on issues concerning accessibility on Web 2.0 technologies and their solutions are still in a nascent stage [31-35]. We have also seen the success of collaborative effort in solving accessibility issues [36]. We have seen some work on developing networks specially for blind computer users as a solution to accessibility issues faced in mainstream networks [37][38]. A closer look at these social networks for the blind is an exact replication of a mainstream social network, but a very simplified accessible version. This field has a lot of room for improvement and innovation.

Work has also been done on studying the need/usage pattern of the Internet by the visually impaired users in comparison to sighted users. Statistics [39] indicate that only 29.2 percent of blind/visually impaired people use the internet in comparison to sighted users who stand at 59.7 percent. Studies also show that the disabled people are more likely to use the Internet for services pertaining to information retrieval when compared to sighted users. We intend to build a community that enhances the information content available and hence would have a broader impact on reducing the existing digital divide. None of the existing online communities have totally succeeded in providing all the required information. This is partly because no single source can possibly provide all the information needed. Especially when it comes to local resources in everyday life, information can be gathered only from the experiences and wisdom of the people in the community. We argue that crowdsourcing based on a social networking site is the best approach to provide and obtain such information.

3. UNDERSTANDING THE CHALLENGES THROUGH USER STUDIES

We conducted two phases of field studies when we started exploring the problem in hand. The first phase was intended to understand the need for a new, blind-friendly social networking site with crowdsourcing capabilities. We also gathered information on areas where information deficit is felt the most. The second phase of the study tested the accessibility issues faced by the existing social networking sites and drawbacks of the most popular existing Web 2.0 applications. The details of the studies are given below. Most of the users continued to give us feedback periodically after they started using the system when it was first launched.

3.1 Phase 1

We performed the first phase of the study before the start of the initial design of GoingEasy®, in order to understand the challenges the users face and the desired features they would want to have if they have the choice. We now present the key results from such studies. We had 5 users in our focus group studies: 3 totally blind and 2 very low-vision users. Five of them took all the surveys and one of them ended up giving up feedback without taking the surveys. All of them use screen readers or screen magnifiers to access the Internet on a daily basis. These participants are of different academic background, age, number of hours of Internet use per week, proficiency with the screen readers, and types of blindness. They participants were asked questionnaire that was intended to identify the importance of the problem and potential solutions.

The three areas where the information deficit was felt the most were identified to be in the areas of navigation, daily living information (grocery deals, entertainment), and applicable information retrieval. All the participants confessed to having trouble in at least 2 of the 3 mentioned areas and they would resort to Internet search as a means to finding ways around it. They also brought up the concept of "blind-specific" daily living information, which is illustrated by the following example. The users were asked to name some local places that were not blind friendly. One user immediately named a very popular shopping mall frequented by ASU students. She mentioned that it is extremely disorienting to blind costumers since the mall has multiple speakers playing music *in the parking lot*, causing the blind user to mistaken the parking lot for the stores in the mall. This is an excellent example illustrating that information given by users with visual impairment can have special value. And this is behind our motivations to build a social networking site with crowdsourcing capability.

Most of the participants were avid Facebook users and used it in spite of the accessibility issues to connect with friends and family. They complained about the time taken to learn the Facebook layout, the clutter in the page, the Captchas in use, excess graphical content, inability to use the entertainment features, and the reduced feature set of the accessible version of Facebook and Amazon. We also observed that participants from different age groups used social networking sites to a different extent.

Table 1. Statistics collected from Amazon usage

Participant	Level of familiarity of the user	Time taken to find an item on Amazon	# of times assistance was asked
1	Used once or twice	3'10''	2
2	Never used	6'10'' (fail)	1
3	Familiar	2'50''	1
4	Never used	4'20''	0
5	Every day user	2'11''	0

3.2 Phase 2

The second phase of the study furthered our understanding of accessibility, usage patterns, and common problems. In this phase, the users were asked to perform 7 tasks and their performance was noted down. Their usage pattern was recorded which helped us during the designing stage. They were also asked 35 questions. Some of the questions were chosen from the set recommended in [40]. We also composed additional questions to collect the user ratings, timings on completing different basic functionalities on some popular websites – Amazon, Amazon Access, Facebook, Craigslist, YouTube and our site GoingEasy®. We collected statistics on usage of the sites the participants, common problems faced, opinions on what they thought would be better. We also tested different layouts, observed usage of functionalities of the sites, and analyzed the collected information. The studies also cleared many issues that are important to our research design. We summarize a couple of such results here.

Table 2. Statistics collected from Facebook usage

Participant	Level of familiarity of the user	Time taken to join a group on Facebook	Number of times assistance was asked
1	Familiar	2'00''	0
2	Familiar	1'55''	0
3	Very Familiar	2'56''	1
4	Never used	6'33''	2
5	Used once or twice	2'42''	0

As an example, in Table 1 and 2, we summarize some of the important data we collected from the Phase 2 study, for the tasks involving the Amazon site and the tasks involving the Facebook site. It can be seen from the table that navigating the main-stream websites is still very challenging for the visually impaired. For example, the median time needed for finding an item on Amazon for our users is 3'10'' (compared to less then 30'' by an average sighted user), and the median time needed for the users for joining a group on Facebook is 2'42'' (compared to merely about 10" by an average sighted user).

The reason for the large amount of time taken to perform these tasks is the linearity associated with the screen reader, accessibility violations in the page design, visually pleasing design details of the pages that are hard to navigate, etc. Also, when a page is divided into panels with links grouped on each panel, it is hard to predict the order in which the screen reader accesses the content. The users who learnt some advanced shortcut keys in the screen reader software could get around faster. And this number was very small when compared to number of users we surveyed.

The field studies provided a lot of important observations that were later reflected in our design of the GoingEasy® site. At high level, two critical design considerations are to make the layout blind-friendly (supporting easy and efficient navigation) and to include functionalities/information sources that keep people motivated to use and contribute to the network. These will be elaborated in the next section.

4. GOINGEASY: PROPOSED DESIGN

We reached our initial design based on the field studies described above and updated the solution through multiple iterations. The first version of the proposed site, GoingEasy.org, is a social networking website that was built with visually-impaired and blind users as the targeted audience. A major force driving social networking websites is having something unique to offer that is necessary and unique. This will be discussed in Section 4.1. Then, in Section 4.2, we present the details in designing the site interface for supporting efficient and easy access by the target user. It is worth noting that GoingEasy is designed with blind users in mind (WAI compliant), not built to be visually pleasing alone. Also, this paper presents the current version of the system, which undergoes constant updates.

As an introduction, we show the homepage of the GoingEasy® site in Figure 1. A registered user can log into the system, while a new user can register an account to begin with.

Figure 1. The Login page of GoingEasy.org.

4.1 Services/Information to Provide

Conventional wisdom is that crowdsourcing networks are hard to sustain without monitory incentives involved [41]. We approached this problem with coming up with services that are deemed essential and were requested from us by the end users in our field studies. As have been discussed in Section 3, we observed that navigation, daily living information (groceries, entertainment) and specific information retrieval are the major problems faced by the visually impaired users in their everyday life. This, in conjunction with the requirement of being simple to navigate, helped us in defining the key functionalities (and interactive buttons) to provide in the first page of our site after a user logs into the system. Our current design of this page is given in Figure 2. We would like to note that, while the page illustrates the key functionalities or information sources the site intends to provide, in the current version, some of the functionalities have not be fully loaded yet. However, keeping all the buttons enabled us to evaluate the fully-loaded functionalities with an intended interface. We elaborate below what the functionality buttons are intended to provide.

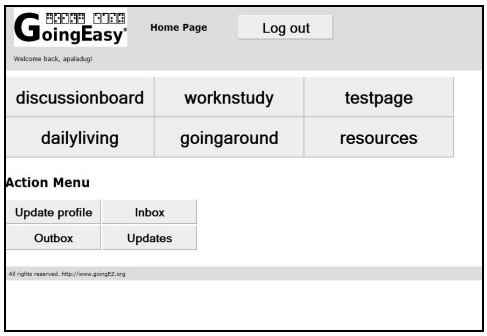

Figure 2. Functionalities provided on GoingEasy.org.

4.1.1 Work and Study

This page caters to information needs of the blind students and working professionals. We found that even in a very disability friendly campus, students and/or their guardians may still need to come to the campus' disability recourse center for information that is not available online. This is an example illustrated what the WorknStudy page may contain. We emphasize that this is different from a generic site such as the American Foundation for the Blind site (afb.org) because our site caters to a local community, and it is the local people who contribute to the information. Other topics to be included in this page include local jobs, conferences, places that convert books to alternate formats, blind activity clubs, etc.

4.1.2 Daily Living

We identified an area where the accessibility issues come in the way of making an informed decision. Most of the entertainment and coupon websites are rich in graphical content and not accessible. A sighted user has access to printed coupons, discount flyers, mail in coupons, emails rich with graphical description and prices of items, etc. Thus we have a dedicated Daily Living page that caters to providing information such as ads from local grocery stores and places of entertainment.

4.1.3 Navigation

This is an area where we identified the blind people to have most difficulty. Our navigation page is customized to the user depending on whether the user is sighted, low-vision, or blind. We offer customized settings for Google Maps and a provision to request for customized tactile maps for any destination in a reasonable radius. We customized Google API to read out text information and set the mode of transportation to walking under the assumption that the users are covering short distances on foot.

4.1.4 Resources

During our field study, participants confessed that their family did not know about the rights their blind kids had, the facilities that should be demanded from educational institutions by law, and some local resources that would have made a difference in their lives. We have a dedicated Resources page that collects and provides such information for the guardians and friends of visually impaired people. We also provide local and global news related to Visual Impairment/blind individuals to increase the awareness levels among the users. Figure 3 illustrates what a user may see from the current Resources page.

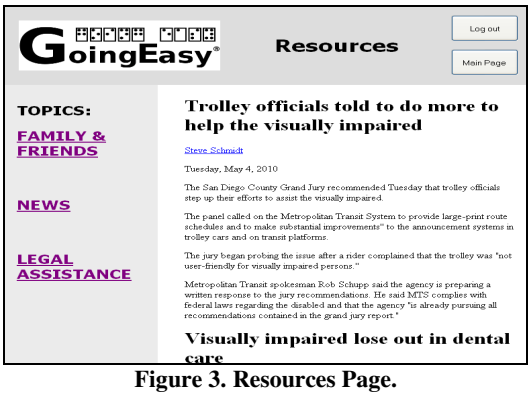

Figure 3. Resources Page.

4.1.5 Forum

A forum was deemed essential for exchange of information, record experiences and as a medium for people to help each other out. It also provides a platform for crowdsourcing and active interaction. We have created a very basic clutter free forum with every confusing add-ons stripped off. A sighted person can look at a forum and at a glance, infer the latest thread, most active

thread and most posted thread. A visually impaired person would have to go through the thread topics sequentially to determine these parameters. We have provided options like sort by popularity, activity and default by timeline.

4.2 Details of the Design of the Site

The language used for our current development is HTML, PHP and JavaScript. The database was implemented using MySql. After the initial rounds of field studies, the salient design features that have been included in the solution are presented below.

4.2.1 Dynamic Homepage

We explore ways in which the dynamism associated with the Web 2.0 technologies can actually be used to the advantage of the blind users. A sighted user glances at a page and can search for the link he/she is looking for in no time. But for a screen-reader user, she/he would have to go through *all the links* sequentially to get to the link she/he needs which is time consuming. (They could use the shortcut keys once they are familiar with the page and know what exactly they are looking for. But not many users in our surveys knew all the useful shortcut keys.) We propose to reduce this time by making customized dynamic pages that learn and adapt to the user behavior. Every time a user clicks on a link, uses a page or functionality, the user statistics are recorded. For example, if the user uses the forum a lot, and hardly uses the other functionalities in the homepage, that should be the first thing he should hear on the screen reader in his homepage. We currently sort out functionalities in descending order of usage. Figure 4 gives a sample illustrating this feature.

In our field study, we explicitly asked the following question: can a dynamic webpage help? All the younger users (college students) acclaimed the idea while their counterpart had reservation (and asked for an option to keep everything static). This has been reflected in our design, and is behind our emphasis on keeping a proper balance between dynamic layout for saving navigation time and static layout for supporting a sense of familiarity.

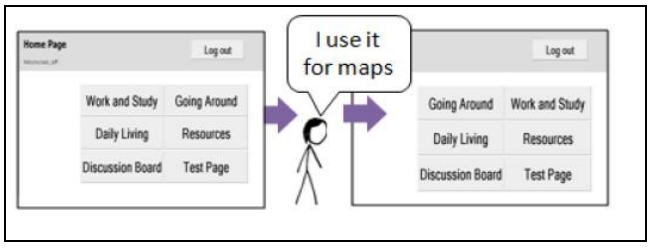

Figure 4. Illustration of customization of homepage

4.2.2 Customization of Map API

A salient feature we provide in the Navigation page is an interface customized to each user's needs. When a user creates his or her profile, if he chooses to indicate his visual disability type, the navigation page tailors itself to provide navigation instructions as her/his needs. For example, a blind user's page contains only text information about the directions. A low-vision user will see an enlarged version of the map and directions. A sighted use will see a map and instructions as would normally be returned by Google Maps. These are illustrated in Figures 5 to 7.

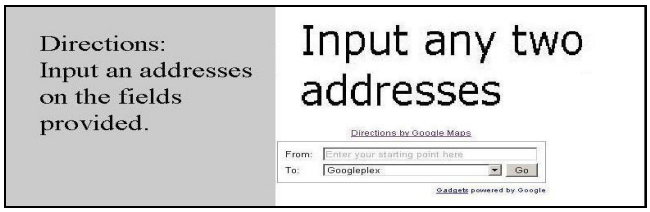

Figure 5. Navigation page for Low Vision user

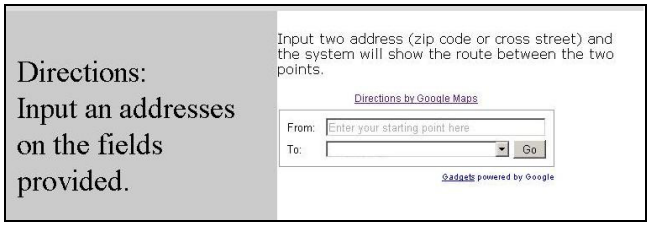

Figure 6. Navigation page for the blind users

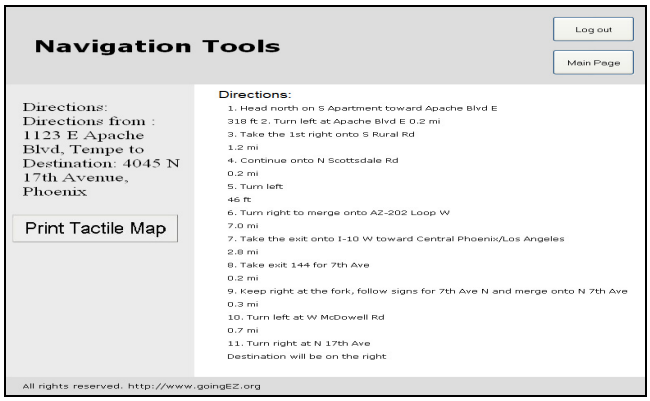

Figure 7. Navigation results presented to a blind user. If a user clicks on the "Print Tactile Map" button, a request will be sent to the system administrator, who will create a tactile map and mail it to the user (this supported on a limited availability basis)

4.2.3 Architecture of the site

Traditional social networking sites that we see have a homepage that contains a link to every functionality that the website offers. We observed that this kind of architecture is what takes up a lot of time when trying to find something on a page by a screen-reading software. When the architecture of the site is changed to a more distributed tree like structure where the functionalities are hierarchically grouped, the user may be able to navigate to the desired button/function quicker. We tested two kinds of architectures for GoingEasy®. The first architecture contained all the functionalities in the site listed on the homepage like most existing sites like Amazon, Facebook, Orkut, MySpace, etc. The second one had a layered structure where similar functionalities are grouped and presented in each layer (with much few buttons) while the buttons can be expanded in the next layer. Every user preferred the layered structure better and disliked websites that were not tiered because the screen readers read out a lot more information every time they visited the page. This has been reflected in our design of the homepage and the pages for the functionalities (Figure 2).

4.2.4 *Forum Design*

The forum is a critical part of the design that aids in collecting information from the users. A screen reader scanning the forum sequentially becomes a disadvantage and time consuming as the size of the forum increases. A blind friendly forum should include a way to sort the forum as per user preference. GoingEasy® has a default view of the forum as well as options to sort the forum based on activity, popularity and time. And the forum is very clutter-free and easy to use, requiring minimal learning. The users disliked the idea categorizing topics in the forum and hence this detail was removed. Figure 8 illustrates a view of the current forum design.

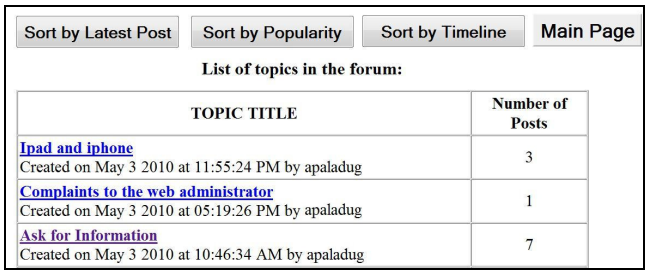

Figure 8. A user friendly Forum

5. EVALUATING GOINGEASY®

The main features to put forth in this paper are a crowdsourcing community as a solution to meet information deficit, add-ons to motivate people to use and contribute to this network, usage of dynamic pages to eliminate the linearity of a screen reader, and user input based customized maps. The current version of the system has implemented all these features and in this section we report the evaluation of the system based on three users, two of which are blind and the third is low-vision.

5.1 Qualitative User Feedback

The users were asked to take a survey about their experiences with using GoingEasy®. This survey was based on [42] which addresses measuring the effectiveness of social networks. All the users mentioned the effortlessness in signing up to use the website. They praised the effort for enabling them to connect to other visually impaired people on common grounds and not having to worry about accessibility issues. All of them indicated that they faced no webpage accessibility issues in accessing the pages of GoingEasy®. The forum served as a platform to discuss a wide variety of topics like useful websites, information on a shopping malls, entertainment related information about movie theaters, support and encouragement for a new user, appreciation of the local heroes, discussion of technical products, recession in the US, etc.

We observed that GoingEasy® promoted a sense of community among the users. The users indicated a strong comfort zone when interacting with the fellow people in the network because they have the same issues, either knew or heard about some of the people they were interacting with and were talking about issues in the same locality as each other. Users also expressed using the forum for altruistic reasons and felt good about helping each other.

The users expressed a liking for the platform and wanted us to scale it up to make it better. We quote a participant's comments below from the user evaluation:

> *"I would like to see this broadened to include blind people both in the city of Phoenix and the state of Arizona. I think the more people that sign up for the service, the livelier the discussions could become. Most discussion for the blind are email messages sent back and forth between individuals or through listservs. Having a website where messages could be sent and answered almost would, I think, be a godsend."*

According to [42], the quality of a network can be characterized by its ability to connect with people in new ways: The effortless to sign up, its ability to shift power from institutions to the people, generation of enough content in the community to sustain itself and having an open platform that invites partnership. Based on our current study, we believe that the current version of GoingEasy®, while with only limited functionalities in every aspects, indeed promotes the first four of the five mentioned criteria to make a successful social network.

5.2 User Activities

The forum and the statistics from the backend database are the indicator of usage of website. The statistics indicate that the registered users visited the site on an average of 5.5 times per day. The users reported spending anywhere around 10 to 30 minutes per day browsing the content or the forums on the website. Table 3 summarizes such data. The topics discussed covered a wide range of aspects and instigated very helpful posts. When we told them this was a testing prototype, all the participants requested us to continue with this service and asked us to advertise this service on major disability conferences.

Table 3. Statistics collected from GoingEasy usage

Participant	Level of familiarity of the user	Time taken to find a certain article	Number of times assistance was asked
1	1	<30 sec	0
2	1	<30 sec	0
3	1	<30 sec	0

5.3 Add-ons

The Navigation (GoingAround), Resources, Daily living, and Work and study pages were introduced on request of the users. And the users helped decide the content to put in these pages, and worked to make them useful. This did promote a sense of ownership on the content and had a higher scale of responsibility and awareness to contribute. Some of the content on the forums made it into the static pages with the users being the contributors. While currently such inputs from the users were directly collected from the users in person since we had only a small number of participants, the site has the potential of gathering such inputs automatically through the forum from a larger user group in the future. Thus we expect that the above benefits will still be felt by future users.

5.4 Customized Directions

Every user in our experiments got to see a navigation page that was relevant to him/her. The users gave us feedback saying they were happy to hear textual directions that were walking directions from a source to a destination. And the users could obtain tactile maps of places which they said was indeed novel and very convenient. Most of the users requested maps of where they lived to learn about their surroundings better.

5.5 Dynamic Pages

We introduced an adaptive homepage tailored to user statistics. In the phase one field study, participants replied affirmatively when we explained the idea. But some of the users had apprehensions because every time a page changes, it would involve some getting-used-to period. From the feedback we got from the users after they started using GoingEasy®, most of the users did not even sense the changes in the homepage. When they were later told about this feature, they were surprised that they did not notice the changes. But they did mention how "easy" it was to find what they wanted. They did not have a problem with the website maintaining statistics on their usage histories on the site. It helped our understanding of the navigation paths on the site and user behavior.

6. CONCLUSIONS AND FUTURE WORK

We presented a novel social networking site, GoingEasy®, which aims at providing crowdsourcing capabilities to help a local community of computer users with visual impairment for improved information sharing. We presented our design principles and implementation details. We also reported the findings from various phases of field studies in the process of developing the system. The evaluation results suggest that the proposed approach is very promising in providing a unique solution for meeting the information needs faced by the users with visual impairment. In particular, we found that the dynamic internet interfaces supported in our system was able to make information access easier without creating a burden of learning.

The current version of EasyGoing® is the first functioning version of what we planned to make. There are some limitations in the current study, one of being limited user evaluation. Evaluation with increased number of users will be among our next-step efforts. We are continuing on improving the system in other technical fronts as well. In addition to fully expand the functionalities discussed in Section 4, we are experimenting with adding artificial intelligence algorithms to scan the content and find the appropriate keywords to tag the content. The users would have helped make the tags in a traditional forum, but our users indicated a strong dislike for them making the tags or categorizing the articles by themselves. Hence automatic algorithms will be preferred.

7. ACKNOWLEDGMENTS

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