Evaluation of Crowdsourced Accessibility Information Sharing

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Abstract

Because of limited local disclosure of accessibility information for people with disabilities, it may be difficult to determine the accessibility of public facilities. To increase the availability of this information, information from paper-based assessments written by disability services experts must be extracted and shared. In this paper, we evaluate a schema that facilitates the sharing of accessibility information for people with disabilities. The schema allows crowd workers to upload handwritten accessibility information, which can then be presented in an easily readable format; the schema also provides an information sharing interface. The evaluation results indicate that crowd workers accurately enter the data using our interface. However, they cannot enter data for more detailed scenarios because of information shortages on written accessibility assessments. To improve this situation, the system should provide crowd workers with supplemental media content such as pictures and diagrams.

Keywords

Accessibility map, crowdsourcing, people with disabilities, volunteers, disability services experts

Introduction

Although public facilities and routes have become more accessible in recent years, visually and physically impaired people may have difficulty acquiring accessibility information for these places. This is mainly the result of limited local disclosure of this information. To address this situation, an increasing number of online resources now share accessibility information. The Eco-mo Foundation provides information related to public transportation, including the interiors of train stations, through the *Station & Terminal Information Search* website (Eco-Mo Foundation, n.d.). Public administration offices also provide a collection of links to accessibility maps for prefectural capitals (Cabinet Office, n.d.).

However, these online resources only include downtown areas. In addition, it is occasionally impossible for mobile phone users to read accessibility maps because of unreadable formats. Volunteers and non-profit organization (NPO) members have performed accessibility data collection and sharing for some uptown areas, as well as downtown areas. Maps of multipurpose restrooms can be mentioned as a successful case (Maps of multipurpose toilets, n.d.). However, this accessibility information is still insufficient, because most of it is only provided on paper media. This paper-based information is commonly added to assessments written by disability service experts and volunteers. Experts can excerpt basic information from the assessments and add it to accessibility maps. This process can provide easily understandable accessibility information to people with disabilities; however, it can also result in limited information disclosure.

In contrast, the prevalence of mobile and cloud computing technologies provides an environment in which people can accumulate, share, and browse various accessibility data for many places. In response, various research efforts have aimed to facilitate the effective and easy sharing of accessibility information. Holone et al. proposed a system that can superimpose accessibility annotations utilizing OpenStreetMap. However, for continuous use of such a system, security issues must be addressed (Holone and Misund, 2008). Hara et al. and Tarkiainen et al. reported on systems in which volunteers check accessibility conditions using Google Street View (Hara et al., 2013), and a system in which volunteers can verify brief information about accessibility conditions in Finland (Tarkiainen et al., 2011). Although these systems can reduce barriers and difficulties related to accessibility information sharing, some frontline experts from disability service offices have been reluctant to adopt them, despite their recognition of the importance of accessibility information sharing. Thus, it is important to propose a scheme that does not place an unnecessary burden on the experts and can support the sharing of detailed information written in natural language. We assume that this scheme can be achieved through crowdsourcing (Howe, 2006. Kittur et al., 2013). However, key issues must be addressed:

- Q1. Can the reliability of accessibility information entered by crowd workers be guaranteed?
- Q2. What are the characteristics of input data entered by crowd workers, compared with data generated by field assessment volunteers?
- Q3. What element types can be used to improve the quality of crowd worker data entry?

In this study, we evaluate a schema that facilitates the sharing of accessibility information for people with disabilities. The schema allows crowd workers to upload handwritten information, which can then be presented in a readable format; the schema also provides an information sharing interface.

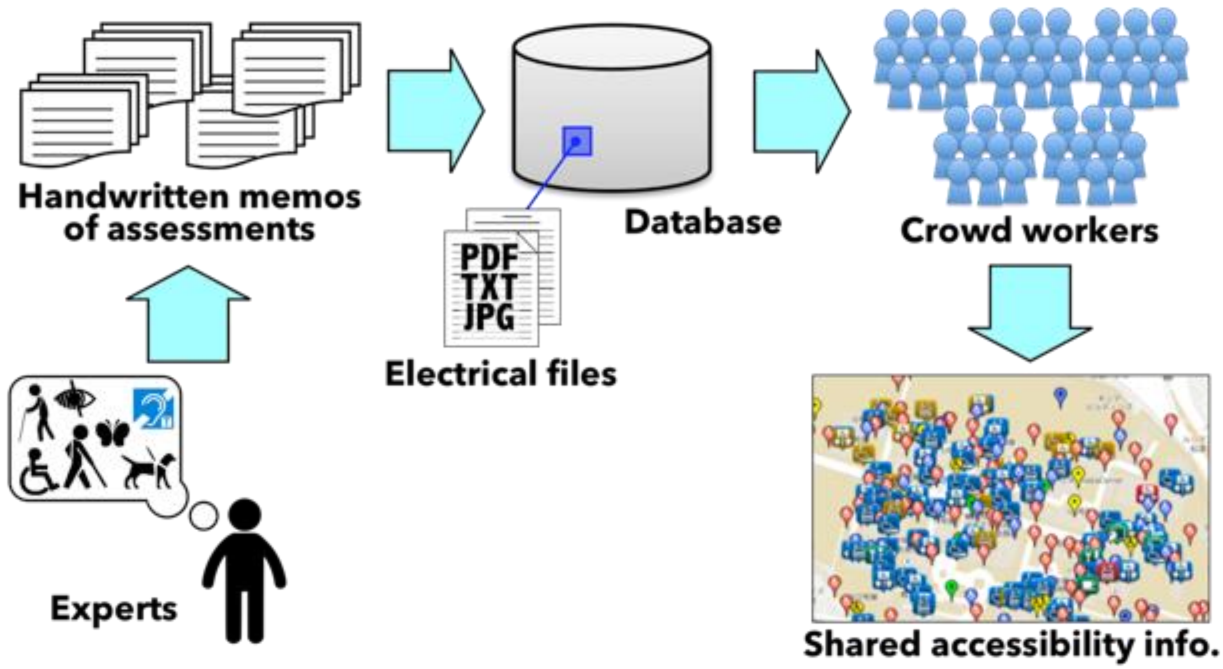


Fig.1. Concept to share electronic accessibility information by crowd workers.

Discussion

Schematic concept to share accessibility information

Figure 1 shows the schematic concept for sharing handwritten accessibility information with internet users. First, assessment results written by experts engaged in disability services are scanned and uploaded, then stored in document formats such as pdf, txt, and jpg files. Subsequently, crowd workers check these files, extract the relevant accessibility information, and enter the information using an interface specifically designed for accessibility information sharing. In this paper, we decided to use the interface described below.

Fig. 2. Examples of user interfaces displayed on Webkit-based browsers such as Google Chrome (Left), and magnified map UI with marker definitions (Right).

Interface for inputting brief and specific accessibility conditions

The user interface (UI) for sharing accessibility information is shown on the left side of Fig. 2. The system was implemented using Google App Engine, and can be accessed via web browsers on most devices. The left side of Fig. 2 shows examples of the UIs, which are displayed using Google Chrome on a Windows PC. This view of the system includes a map UI and a post UI.

The map UI manages information presentation. This UI includes a search area, a button for obtaining the user's current location, a map view containing a map and markers, and a view of comments on selected markers. After a location name is entered in text form, the search area provides relevant maps and barrier conditions at the indicated location. When the current location button is selected, the user's current position can be acquired through the specific and coarse locations identified via GPS and Wi-Fi. The map view displays a map of the current position; hovering markers represent accessibility information.

A magnified image of the map UI is illustrated on the right side of Fig. 2; a legend that defines the markers is included on the map. These markers summarize barrier information using three colors: red (dangerous/impassable), yellow (caution needed), and blue (safe/passable). The information is classified into two categories — subjective and objective — to facilitate easy information sharing for both sighted and visually impaired people. It is relatively easy for sighted people to determine what types of assistive systems are installed; conversely, people with visual impairments may only have a vague impression of their surroundings. Furthermore, some volunteers may wish to post accessibility information about a particular place for specific groups of people; for example, some slopes are installed not for wheelchair users, but for the conveyance of equipment.

The subjective information includes users' impressions of locations, which identify accessibility situations using icons representing people with visual, auditory, and physical impairments. The objective information includes the existence of slopes, elevators, multipurpose toilets, and flat entrances to interior and exterior places. When users select markers, detailed information about those markers is displayed in the comment window at the bottom of the map UI. These markers represent not only the information stored in the system, but also the accessibility information openly available on the web. For example, a green marker with a train icon contains a link to information about the barrier-free conditions at all Japanese train stations, provided by the *Station & Terminal Information Search* website (Eco-Mo Foundation, n.d.).

The post UI allows users to submit accessibility information. This UI contains a box indicating marker locations, a pull-down menu containing information targets, a pull-down menu containing brief information on accessibility, and a text box for entering specific information. When a user enters or posts any barrier information from a location, the corresponding coordinate on the map is indicated on the marker location indicator box. The target information pull-down menu lists the targets for the information provided, with tags for people with no impairments and for people with vision, auditory, or physical impairments. Brief information on accessibility — including subjective information such as whether an area is passable and whether it is dangerous or safe, as well as objective information — can be selected from the appropriate pull-down menu. The text box used for entry of specific information accepts information about particular situations.

Evaluation of the system for data entry by crowdsourcing

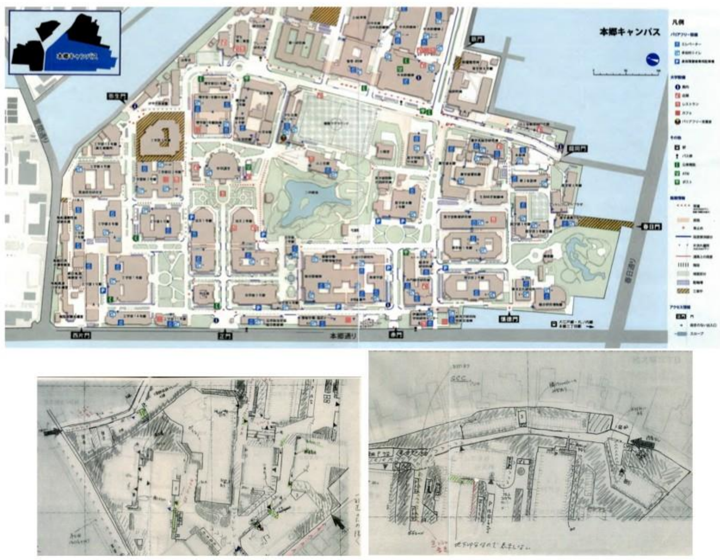
In order to evaluate the system for crowdsourcing data entry, we cooperated with the Disability Service Office (DSO) of the University of Tokyo to gather information related to accessibility for people with disabilities. They assessed the accessibility conditions on campus irregularly in 2012 and 2013, with the objective of renewing an outdated accessibility map. Approval for the evaluation was obtained from the university's Office for Life Science Research Ethics and Safety.

Participants

Six females were recruited to participate as crowd workers. They were informed that they would be compensated according to the number of entries they created. All participants had experience in volunteer activities that assisted people with disabilities. They used their own personal computers to enter accessibility conditions.

Materials and methods

We asked the participants to enter data from accessibility assessments and campus accessibility maps, as shown in Fig. 3. These data were created by four experts, including two wheelchair users, and two volunteers with physical disabilities. The experts included DSO officers and employees of an accessibility consulting firm. The data from these accessibility-related materials were generated after scanning the paper originals of the released prints (2 pages) and the draft prints (16 pages) of a campus. The draft prints were handwritten by officers of the aforementioned DSO after assessing the campus.



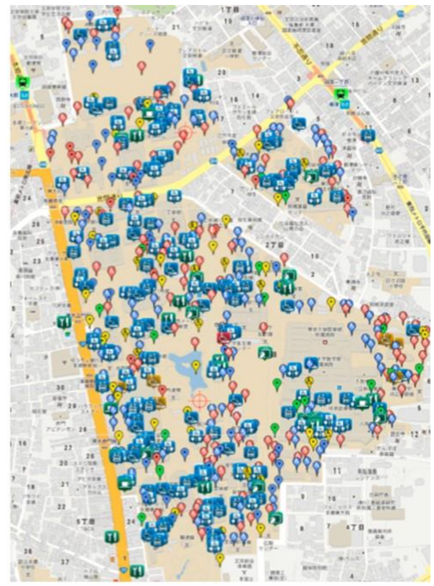


Fig. 3. Crowdsourcing evaluation materials: a portion of a campus accessibility map provided by the DSO (Upper) and handwritten drafts of the map (Lower).

Fig. 4. Campus accessibility information accumulated via crowdsourcing.

The participants were asked to enter accessibility information using the aforementioned interface, after checking the files shown in Fig. 3 and visually confirming accessibility conditions. When entering character input, they were asked to enter as much detail as possible about the accessibility conditions. They were also instructed to add tags indicating whether information was subjective or objective. These tags specify whether handwritten information mainly conveys the impressions of the assessors, or provides objective perspectives and quantitatively measured data. A subjective example might describe an area that is “difficult to go through by wheelchair users” while an objective example might identify a “steep slope with rough road conditions." Subsequently, the experts were asked to briefly check the entries, and to provide their impressions regarding the accuracy of the entries. Based on those answers, we analyzed the reliability of the accessibility information, as mentioned in Q1. Afterward, the participants were asked to describe any difficult points in the experiment, which was conducted over a one-month period.

The characteristics of the entries, as mentioned in Q2, were analyzed by comparing them against entries obtained during our previous field assessment study (Yabu et al., 2014). The comparison studied the content and length of the entries. In the field assessment, volunteers and DSO experts checked the conditions of a different campus, and entered the information into the web-based application shown in Fig. 2 via their smartphones and personal computers.

The answer to Q3 was determined using the results of these analyses.

Results and discussion

Overview of entries and evaluation by the experts

Fig. 4 shows information collected by the crowd workers. There were 538 entries in all, including 212 subjective and 362 objective entries, and 29 entries for other types. The remaining entries contained information about facility locations that were not directly related to accessibility, such as ATMs, parking areas, and construction sites that could not be entered. This information also included the opening times of some gates, public phone locations, smoking areas, and busy streets.

According to the evaluation comments by the experts, most of the shared entries were useful, while some of them were merely acceptable; these comments were based on a reassessment of the campus' accessibility. However, we note that these entries were created during an experimental procedure, and contain information gathered by conscientious volunteers who are committed to assisting others. In large-scale information gathering, it is necessary to implement methodologies that ensure data quality, such as a mechanism to screen crowd workers effectively.

Characteristics of entries: subjective information

The subjective information included 11 and 201 entries for visually impaired people and wheelchair users, respectively. There were 148 and 94 entries for "impassable" or "caution needed" situations and safe situations, respectively. The subjective information for the visually impaired included locations with textured paving blocks, audio assist systems, and roads that were difficult to walk on. Differences between the passable and impassable information that was entered were observed through their complementary information: the number of characters in the passable information (mean: 28.7 letters, S.D: 27.4 letters) was lower than that of the impassable information (mean: 32.1 letters, S.D: 28.9 letters); however, there were no significant differences (Tukey-Kramer's test: $p > .10$). These results were different than those in our field-assessment test (Yabu et al., 2014): the number of characters in the impassable information was significantly higher than that of the passable information. This difference in significance might have been caused by condition differences: the crowd workers could not access supplemental information about the assessment places and could only enter described content. In the assessment test, the information about passable places tended to include the names of corresponding buildings and places, while the information about impassable places included not only the names, but also what types of barriers existed and how difficult these barriers were to pass. However, in this crowdsourced test, we can observe the same tendencies in the information related to passable and impassable places. These results and the comments by the participants suggested that crowd workers accurately entered the data, but could not enter information about more detailed situations because of information shortages. To address this problem, the schema should present crowd workers with supplemental media content, including pictures and diagrams.

Characteristics of entries: objective information

The objective information included 251 assistive instruments installed at an outside location and 46 facilities with barrier-free conditions. Similar to the text length tendencies of the subjective information, the number of characters in the convenient instrument information (mean: 13.5 letters, S.D: 19.2 letters) was lower than that of the with-caution instruments (mean: 38.7 letters, S.D.: 66.6 letters); however, there were no significant differences (Tukey-Kramer's test: $p > .10$). The reasons for this may be similar to the subjective information case.

Other remarkable results and participants' comments

In this evaluation, we observed effective cooperation between crowd workers. In one case, a crowd worker entered information about an inconvenient library entrance condition for wheelchair users and commented that he did not know their substitutional routes; subsequently, another worker added the correct substitutional route for them. This scenario indicates that our system is useful for people with disabilities, because it can improve accessibility information by making use of collective knowledge. To improve information quality, the system should contain functions that facilitate this type of cooperative work.

Categorizing information as either subjective or objective proved useful for entering and browsing information, when the differences in this information were described in detail. After comparing the comments by the experts and the crowd workers, however, when a large amount of information was entered, it was difficult to browse the desired information. To address this problem, this system should provide the ability to display particular markers.

According to a comment from one of the participants, a marker for mixed information should be provided, because some places have multiple accessibility drawbacks. For example, construction sites are inconvenient for wheelchair users and totally visually impaired people, but they have different inaccessibility issues: the former mainly suffers from uneven roads while the latter suffers from sound localization difficulties caused by a noisy environment. A simple input form and a user-friendly display method should be implemented for managing specific complex accessibility conditions.

Conclusion

In this study, we evaluated the idea that crowd workers could facilitate the sharing of handwritten accessibility information created by disability services experts. The conceptual system provides functions that can accumulate and present electronic versions of handwritten accessibility assessments, and can facilitate the sharing of accessibility conditions corresponding to focal points on a map. The evaluation results indicated that crowd workers could accurately enter data using our interface, but could not enter data for more detailed situations because of information shortages on accessibility documents. To improve this situation, the system should provide crowd workers with supplemental media content, including pictures and diagrams.

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Works Cited

A. Kittur, J. V. Nickerson, M. Bernstein, E. Gerber, A. Shaw, J. Zimmerman, M. Lease, and J. Horton. “The future of crowd work.” In: Proceedings of the 2013 conference on Computer supported cooperative work. CSCW ’13. San Antonio, Texas, USA: ACM, 2013, pp: 1301–1318.

Cabinet Office. “List of barrier-free maps of major cities in each prefecture.” n.d. http: //www8.cao.go.jp/souki/barrier-free/link/bfmapken.html (Last checked: 2015/04/09) (in Japanese)

Eco-Mo Foundation, “Station and Terminal Information Search: rakuraku odekake-net.” n.d. http://www.ecomo-rakuraku.jp/rakuraku/index?nextpage=TerminalSelectE.html (Last checked: 2015/04/09) (in Japanese)

H. Holone and G. Misund. “People helping computers helping people: Navigation for people with mobility problems by sharing accessibility annotations.” In: Computers Helping People with Special Needs, Lecture Note in Computer Science, Volume 5105, Springer, 2008, pp. 1093–1100.

J. Howe. “The rise of crowdsourcing.” In: Wired magazine 14.6 (2006), pp. 1–4.

K. Hara, S. Azenkot, M. Campbell, C. L. Bennett, V. Le, S. Pannella, R. Moore, K. Minckler, R. H. Ng, and J. E. Froehlich. “Improving Public Transit Accessibility for Blind Riders by Crowdsourcing Bus Stop Landmark Locations with Google Street View.” In: Proceedings of the 15th International ACM SIGACCESS Conference on Computers and Accessibility. ASSETS ’13. Bellevue, Washington, USA: ACM, 2013, pp: 16:1–16:8.

K. Yabu, T. Miura, M. Sakajiri, M. Ueda, A. Hiyama, M. Hirose, and T. Ifukube. “Accessibility information gathered by a field assessment using a social platform to share accessibility information among people with disabilities.” In: NTUT Education of Disabilities, Vol.12, 2014, pp: 1–5.

M. Tarkiainen, A. Bäck, J. Hulkkonen, and K. Könkkölä. “Crowdsourcing accessibility related information from POI-destinations in Finland.” In: Proceeding of the 18th World Congress on Intelligent Transport Systems (ITS). Orland, Florida, USA: ITS America, 2011, pp: 1–10.

Maps of multipurpose toilets (this translated title was prepared by the authors), n.d. http://wc.m47.jp/ (Last checked: 2015/04/09) (in Japanese)