SMARTPHONE BASED SOLUTIONS TO MEASURE THE BUILT ENVIRONMENT & ENABLE PARTICIPATION

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ABSTRACT

Persons with disabilities are often unable to fully participate in the community due to limited accessibility of public buildings. Unfortunately, there are no systems in place to acquire accessibility information in advance of an outing. To eliminate this problem, researchers developed the Access Ratings for Buildings (AR-B) software system for smartphone devices. This application allows a trained evaluator to take detailed measurements of the built environment in order to provide individuals with disabilities highly detailed impairment specific accessibility information. To provide individuals with such detailed information, researchers have included three innovations in the system, a electronic data entry and storage system, a series of application based environmental measurement tools, and a branching question structure. In conjunction, these innovations provide solutions to long standing issues in measurement of the built environment and now allow for an efficient and highly detailed assessment. This proceeding will describe each innovation and the implication for practice.

INTRODUCTION

Over 54 million Americans have a disability, which may impair their ability to walk, climb stairs, think, hear, or see for example (U.S. Census Bureau, 2007). Because of these limitations, persons with disabilities frequently experience difficulties using public buildings. To facilitate full participation of persons with disabilities in society, policy-makers have mandated that community buildings meet basic accessibility guidelines with legislation such as the Americans with Disabilities Act Accessibility Guidelines (Access Board, 2002, 2005).

Unfortunately, many buildings are exempt from the required standards and others simply do not meet code. Therefore, the only way a person with a disability is able to ensure that they will be able access a building is to visit the community site in advance. For example, a wheelchair user is often limited by the size of doorways, and he will need to propel through both the front entrance and the bathroom doorways when using a building. There is no way for a wheelchair user to find out the width of a doorway in advance of going to a building. This level of uncertainty of accessibility and high level of architectural barriers present in the community thereby decreases the participation of persons with disabilities.

Another issue in the measurement of accessibility is that persons with disabilities represent a heterogeneous group (e.g. persons who are blind, deaf, or use wheelchairs). Therefore, a building feature that is accessible for one group may be inaccessible for another. Not only is accessibility information needed for users to access public buildings, but the information must be tailored to the person.

We acknowledge the need for an information solution; however, there is no system presently available to meet the needs of consumers. Therefore, to help this population better access public building and enhance their participation, researchers developed a system to determine building accessibility.

The initial prototype was called the Restaurant Accessibility and Task Evaluation Information Tool (RATE-IT), a tool to inform patrons about the accessibility of restaurants prior to their experience. Through the RATE-IT process, researchers developed many skills and knowledge around built environment measurement, and then applied information to a more generalized system (Park, Smith, Ligel, 2011; Erfurth & Smith, 2012)

The Access Ratings for Buildings (AR-B) software system for smartphone devices. This application package allows a trained building rater to take detailed measurements of the built environment in order to provide individuals with disabilities with highly detailed impairment specific accessibility information. While this may seem like a lofty task requiring the rater to take hundreds of thousands of measurements, researchers have developed three innovations to facilitate the measurement of the built environment. The purpose of this proceeding is to describe the process and product of the innovations and their impact on the field of accessibility evaluation.

METHODS

The AR-B system was developed in five steps, content development, prototype development, creation of the application, and iterations to incorporate feedback and fix bugs in the system. First, experts in the field of accessibility developed items using the standards present in the Americans with Disabilities Act Accessibility Guidelines and a literature reviews of accessible features. Items were developed around specific building element commonly found in small public buildings. The initial set of building elements have been designed around a small restaurant experience. Building elements present in the AR-B system are found in Table 1. After the items were developed, researchers determined any tools needed to answer the question and placed the items in a branching structure.

Table 1: Building Elements in AR-B System

Parking	Stairs
Paths	Elevators
Signage	Restaurants
Restrooms	Handrails
Doors	Seating
Ramps	Floor/Ground Surface
Railings	Floor Foot/Knee Clearance

Once the content was decided, researchers then created a series of prototypes to communicate how items needed to be presented to the user. The engineering team was then was able create a functioning application based on the above documentation.

Branching questions, stored on a server, are pulled by an iPhone in XML format. These questions, combined with their corresponding tool (e.g., distance measurement tool, slope tool) are displayed to the user. After all questions have been answered, the responses are sent back to the server.

Once a usable application was developed, user testing was conducted within the team to ensure clarity of content and interface, accessibility to users of a variety of abilities. The engineering team then updated the application based on feedback from the team.

INNOVATION

Through the above process, the team developed three major innovations to improve the speed and accuracy of measurement of the built environment. First, researchers transitioned from paper and pencil evaluations to electronic collection and data storage. Second, application based measurement tools for were developed to increase speed of assessment. Finally, items were transitioned to a branching question structure to eliminate unnecessary questions. This section will describe each of these innovations.

Electronic Data Collection and Storage

An essential component of the AR-B system, is sharing accessibility information with consumers. A common issue in accessibility measurement is that most measurement tools are paper and pencil based, which increases the time for gathering data and then requires the rater to enter their results in the computer afterwards. The AR-B system allows raters to document measurements as they go, improving the speed of the assessment process. Data is then uploaded and stored on the cloud, where it is available to consumers through a different application system. Not only does the electronic data collection and storage facilitate building evaluators and persons with disabilities but researchers as well as the database can be used for research purposes to investigate the accessibility of communities. An image of the application interface can be seen in Figure 1.

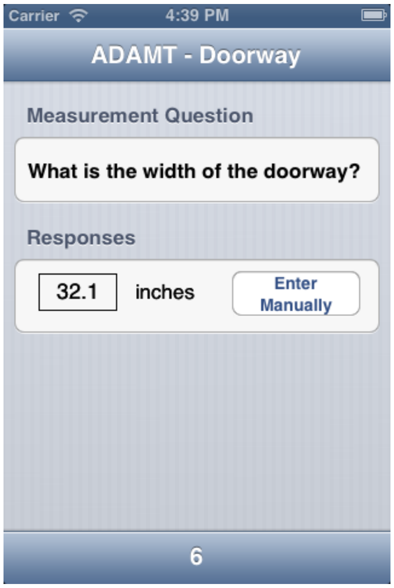

Figure 1. User Interface Screen Shot

Measurement tools

The second innovation was the development of application based measurement tools. Traditionally, during a building accessibility evaluation, an evaluator would have to use several tools such as a light meter or tape measure. Researchers have developed either 1) new hardware that plugs into a smartphone or 2) different ways of using current hardware in the smart phone to allow evaluators to more efficiently and accurately take accessibility measurements.

For example instead of using a level to measure the slope of the ramp, a rater may use the accelerometers within the phone to create a measure of slope. To measure distance, instead of a tape measure, a rater may use an ultrasound device that attaches to a smartphone to measure distance. A full list of currently active measurement tools may be found in Table 2. Not only do the measurement tools facilitate the rater by limiting the number of tools needed to be carried, but each of the tools interface with AR-B system improve the rating process. For example, if the system prompts the user to measure the width of a doorway, the distance measurement tool will automatically be loaded and enter results directly into the assessment, limiting the burden on the evaluator.

Table 2: Measurement Tools

Slope	Light
Distance	Sound
Time	Font/ Signage

Branching Question Structure

The final innovation of the AR-B system is the branching question structure. Because traditional built environment assessments are in paper and pencil format, evaluators must be presented will all assessment items. The burden falls to the evaluator to decide if the item is appropriate or not. In a system designed to gather masses of information, having a evaluator presented with every possible question was not feasible, so questions were designed in a branching structure so that the evaluator is presented with only the most appropriate items. For example a power door and a manual swinging door have different accessibility needs. Therefore, if the user designates the door as a manual swinging door, then items specialized for power doors and sliding doors are not appropriate and will not be presented to the user. This innovation uses the smartphone to limit the number of items presented easing evaluator burden. An example of the branching question structure can be seen in Figure 2.

DISCUSSION

Implications

By creating a electronic system for data collection and storage, developing a series of built environment tools, and developing a branching question structure, researchers have created several solutions to the problems previously found in the measurement of the built environment. With these innovations, accessibility assessment can be quick and efficient allowing researchers and accessibility advocates will be able to gather massive amounts of information related to the accessibility of public spaces. This information can be shared with consumers with disabilities in order to improve ability to fully participate in the community.

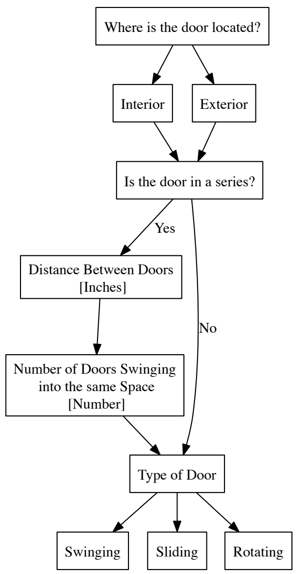

Figure 2. Example of Branching Question Structure for Doorways

Future Directions

Currently, the AR-B system is limited to small stand alone buildings, specifically focused on restaurants. To truly meet the societies needs, the scope of the system must be expanded to include a variety of public buildings including large multipurpose buildings such as shopping malls and concert venues.

Secondly, while the use of an application based measurement system improves the process of building evaluation, the system is a new measurement tool and therefore requires psychometric testing similar to paper and pencil evaluations. Inter-rater reliability, concurrently validity, and consequential validity testing are planned for the future.

Finally, while several tools (e.g. light meter, sound meter, etc.) have been developed to facilitate the building measurement process, more tools are needed to further improve the speed and convenience at which buildings are able to be assessed.

Conclusion

The AR-B system with the electronic data collection and storage system, application based tool set, and branching question structure have solved several long standing issues in the measurement of the built environment. This system have the potential to revolutionize accessibility assessment. Future research is needed to further develop system capabilities, complete psychometric testing, and to implement the system into current practices so that benefits can be realized by consumers.

ACKNOWLEDGEMENTS

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