The 20th International ACM SIGACCESS Conference on Computers and Accessibility

ASSETS 2018

Author Response

Title: Leveraging Augmented Reality to Create Orientation and Mobility Apps for People with Visual Disabilities

Authors: Chris Yoon, Jeremy Ryan, William Derksen, Ryan Louie, Simran Malhi and Paul Ruvolo

Instructions

The ASSETS 2018 author response ("rebuttal") period has begun. The reviews for your submission are displayed on this page. If you want to respond to the points raised in the reviews, you may do so in the box provided below. There is a limit of 600 words TOTAL for the response, and responses are due by 17:00 PDT on Tuesday, May 29. The response allows you to address any clarifications or questions in the reviewers comments.

Please note: *you are not obligated to respond to the reviews*.

For reference, you may see the review form that reviewers used to evaluate your submission. If you do not see some of the filled-in fields in the reviews below, it means that they were intended to be seen only by the committee. See the review form HERE.

Review #1

Appropriateness (1-5): 5
Clarity (1-5): 5
Originality / Significance (1-5): 4
Soundness / Correctness (1-5): 4
Recommendation (1-5): 4
Reviewer's Confidence (1-5): 5
Submit as Poster/Demo?: Yes

Detailed Comments

This paper describes two new iPhone apps for visually impaired users, one which helps a traveler retrace their steps when backtracking along a route, and the other which helps a user find a desired object of interest in the scene. Both apps harness the augmented reality functions included on modern conventional Apple and Android smartphones, such as visual-inertial odometry (VIO) and the 3D estimation of horizontal and vertical planes in the environment.

The first app, named Clew, provides turn-by-turn directions to a traveler who wishes to follow a route that has been previously recorded -- either by the traveler him/herself (in which case the app provides a method of backtracking from a new destination to an earlier starting point), or from other travelers who have previously recorded the route. Clew harnesses the dead reckoning capability afforded by VIO to track the user's movements relative to a starting point. Directions can be given using audio (speech or audio tones) and/or haptic feedback.

The second app, named Viewshare, allows the user to specify which item s/he wishes to locate in the nearby environment. A crowdsourcing procedure enlists the aid of one or more remote sighted volunteers, who locate the item from images taken roughly every 2 sec. on the user's iPhone. The item is located in 3D and appropriate audio/haptic guidance (including direction and range information) is issued to help the user approach and locate it.

Both apps were conceived and developed in conjunction with multiple people with visual impairments (including two members of the research team) using a participatory design approach. While preliminary tests were conducted only with college students with normal vision (which limits the significance of the results), informal testing of prototype versions has also been performed with visually impaired users.

I appreciate the attention to important technical details in this paper, including a discussion of how blind users might hold the smartphone camera while walking (and a proposed pause feature for those times when they can't hold the camera), and a clarification of how ViewShare items are localized in 3D by triangulation if they are not sited on a plane that is estimated by ARKit.

The writing was mostly very clear, with just a few points that confused me: (1) Please describe the college students in the Clew usability testing section. I assume they had normal vision, but how exactly was their vision "occluded" (a few lines above "Future Work for Clew" heading). (2) In this passage: "For successful trials (the user navigated to all waypoints), we recorded the distance from the user's final position to the ground truth position. A summary of each of the routes and the results are shown in Table 1.", it was unclear how many trials were unsuccessful, and if they were included (I assume not) in Table 1. This is key information that needs to be supplied.

The contributions of this paper are novel, but not quite as novel as claimed. Past and ongoing work using iPhone IMU-based step and turn detection tackles the same problem as Clew, namely path retracing for blind travelers:

G. Flores, Manduchi, R., and Zenteno, E., "Ariadne's Thread: Robust Turn Detection for Path Back-Tracing Using the iPhone", in International Conference on Ubiquitous Positioning, Indoor Navigation and Location-Based Services (UPINLBS 2014), 2014.

Flores, G., & Manduchi, R. (2018). Easy Return: An App for Indoor Backtracking Assistance. CHI 2018.

And an upcoming paper (in press, which the authors would have been unaware of when submitting their manuscript) uses VIO for indoor localization for visually impaired travelers:

Fusco, G., & Coughlan, J. (2018). Indoor Localization using Computer Vision and Visual-Inertial Odometry. In International Conference on Computers Helping People with Special Needs (ICCHP '18). Date Published 07/2018, Linz, Austria.

Overall, however, I feel this paper is well worth publishing to highlight the promise of augmented reality for orientation and mobility type applications.

Review #2

Appropriateness (1-5): 5
Clarity (1-5): 4
Originality / Significance (1-5): 5
Soundness / Correctness (1-5): 4

Recommendation (1-5): 5
Reviewer's Confidence (1-5): 4
Submit as Poster/Demo?: Yes

Detailed Comments

This paper describes innovative apps that combine the power of augmented reality (AR) and the iOS platform to help with common O&M tasks. One app assists with guidance on route reversal/retracing and the other uses crowd sourcing data to assist with guidance to known landmarks or finding desired objects. A preliminary usability study is described, with results discussed in terms of improving future devices and implementation.

This paper deals with two of the hottest sources of tech in the AT domain, and addresses a longstanding and ongoing challenge of successful navigation and spatial abilities. The O&M field has a long tradition but, in this reviewer's opinion, is well served with the addition of modern tech to aid the endeavor. As such, the topic is timely and relevant and likely of interest to the ASSETS audience. The paper is clear and is logically coherent and there is good motivation of background and coverage of related literature (although a few more studies could be cited). The methods could be detailed a bit more but I understand that this is mostly a proof of concept study. I think this is a strong paper and I believe it would be an excellent contribution as a talk at ASSETS.
I have a few comments below that would hopefully be addressed / clarified before final acceptance and publication.

Specific comments:

1) I think the abstract could be streamlined: first giving a problem statement and also giving more on what results/findings were actually found.

2) The ms reads: "Due to the importance of O&M, there is a long history of assistive technology designed to bolster these skills [3, 7]" This is too vague. Can more be said on what skills have been addressed and how? Citing some refs doesn't tell us anything about what tech has been used, if it worked, where the problems lie, etc. This should be explained.

3) The two apps help with route retracement and finding objects. However, it is not clear from the discussion that these are actually problems faced by BVI people or that these activities are taught or shown is problematic from the O&M literature. While both tasks would likely benefit from apps of this nature, more background and justification for why these two tasks were chosen should be described. You do give justification based on your pilot participants later but motivating this earlier and tying to the literature would be best, especially as there are so many other spatial tasks that are also problematic for BVI travel, e.g. Spatial updating, cognitive map development, spatial inference, etc. For good reviews of these topics, see: Long, R. G., & Giudice, N. A. (2010). Establishing and Maintaining Orientation for Mobility. In B. B. Blasch, W. R. Wiener, & R. W. Welch (Eds.), Foundations of Orientation and Mobility (3rd ed., Vol. 1: History and Theory, pp. 45-62). New York: American Foundation for the Blind. Schinazi, V. R., thrash, T., & Chebat, D. R. (2016). Spatial navigation by congenitally blind individuals. Wiley Interdisciplinary Reviews: Cognitive Science, 7(1), 37-58. Thinus-Blanc, C., & Gaunet, F. (1997). Representation of space in blind persons: Vision as a spatial sense? Psychological Bulletin, 121(1), 20-42. doi:10.1037/0033-2909.121.1.20

4) I realize that this is not a review of accessible navigation systems but many are not discussed that are relevant here. I'd suggest adding a broader range of groups and technologies over multiple papers by the same authors. Some others to consider include: Legge, G. E., Beckmann, P. J., Tjan, B. S., Havey, G., & Kramer, K. (2013). Indoor Navigation by People with Visual Impairment Using a Digital Sign System. PLoS ONE, 8(10), e76783. Riehle, T. H., Anderson, S. M., Lichter, P. A., Whalen, W. E., & Giudice, N. A. (2013). Indoor Inertial Waypoint Navigation for the Blind. Paper presented at the Proceedings of the 35th annual IEEE Engineering in Medicine and Biology Conference (EMBC'13).

5) The use of human-centered design throughout the app development process with BVI people is important and laudable, especially as this is often missing in AT development.

6) "uses cases" should be "use cases"

7) Can you put text description of the route complexity, e.g. its length, number of turns/choicepoints, portal transitions, etc.

8) The object finding app is not clear to me. I admit that this technical aspect is not my area but I don't understand how the system knows what object it is 'seeing'. How does the user tell the system what object to find. Are these trained through some pattern classification? I doubt my confusion will be singular, so I suggest trying to elaborate/clarify a bit more in the description here.

9) More info is needed about the four pilot participants.

Review #3

Appropriateness (1-5): 5
Clarity (1-5): 4
Originality / Significance (1-5): 4
Soundness / Correctness (1-5): 2
Recommendation (1-5): 2
Reviewer's Confidence (1-5): 4
Submit as Poster/Demo?: Yes

Detailed Comments

This short paper presents two applications designed for people who are B/VI. Both use camera and sensors in smart phones to assist with O&M tasks—the first is designed to help people retrace their steps to get back to a given place (e.g., a seat in a classroom after going to the lavatory). The second uses volunteer crowdsourced assistance to help users find objects.

This work is very promising and is an exciting area of research using the powerful commodity sensing and AR APIs in modern phones to create AT applications. Both applications are interesting in their own right and could be excellent research contributions to the literature. My main frustration with this work is that is just too early for an archival scholarly paper. The authors built some apps and then provide some very early proof-of-concept evidence that they could be effective. At this stage, each of these apps would be great posters, but I do not feel the paper (note) is ready for ASSETS archival publication.

For both Clew and Viewshare, there is not sufficient evaluation of the work with target users for me to understand how well they work or what the issues are. While I'm very pleased to see the diversity of the design team (including a student with RP), having a single blind member of the team is not sufficient to see how these systems would work for B/VI folks. There is no evaluation of Viewshare, and the evaluation presented for Clew is based on four sighted students who used the app while blindfolded for 4 routes (and 2 w/o blindfold). The details presented in Table 1 are not particularly useful for readers, though they might be helpful in development. While there can be role for using simulated blindness in debugging and developing an app, it is not appropriate for doing any kind of evaluation of the system (and even design). There are numerous examples for how this is problematic (see Nario-Redmond, M. R., Gospodinov, D., & Cobb, A. (2017, March 13). Crip for a Day: The Unintended Negative Consequences of Disability Simulations. Rehabilitation Psychology. Advance online publication. http://dx.doi.org/10.1037/rep0000127). The authors note potential problems with holding the phone among their sighted users, and I've seen even more issues along these lines for B/VI users in my own work. For applications like these, we really need to see how they're used by the people they're supposed to be built for!

Bottom line, this is exciting work, but it needs to be further developed for archival publication. I want to see how the apps are used by real people even in controlled settings, and *especially* in the wild. Either of both of these applications presented along with a careful and nuanced

user study would make a fantastic contribution to ASSETS. As it stands now, they may make for a good poster, but I would not advocate for publication in the archive (either as note or full paper).

Submit Response to Reviewers

Use the following boxes to enter your response to the reviews. Please limit the total amount of words in your comments to 600 words (longer responses will not be accepted by the system).

Response to Review #1:

Response to Review #2:

Response to Review #3:

General Response to Reviewers:

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