Research Report Summary

Eleni Christofa, PhD *6/30/17*

Visually Impaired Pedestrian Safety at Roundabout Crossings

Continuously flowing roundabouts are a very elegant solution to traffic flow operations, but can come at the cost of pedestrian access. This is particularly true for pedestrians with visual impairments who may rely on auditory cues from traffic and signals for safe crossings. These cues become difficult or impossible to detect with continuously flowing traffic, a problem further exacerbated by hybrid and electric vehicles. From the driver's perspective, it can be difficult to detect pedestrians at crosswalks while handling the cognitive load of navigating a roundabout with traffic.

To date, there has been a substantial amount of work done to evaluate and develop various roadway treatments at roundabouts for visually impaired pedestrian safety *(1–4)*. Adding traffic signals to a roundabout essentially undermines the very benefits of the passive control design, but studies have found that novel design approaches, such as combining zig-zag or offset crosswalks with signals, can minimize operational impacts *(5)*. However, the assumption that push-button-activated signals are the most effective treatment for visually impaired pedestrians may be overstated. A study by Liao et al. *(6)* showed that in many situations visually impaired pedestrians fail to even find the push-button or, worse, attempt a crossing not during a walk signal. A dynamic signal not linked to signal phasing is an ideal situation for the use of automatic pedestrian detection, through traditional detection (e.g., video, pressure, infrared, etc.) or emerging technologies such as mobile devices.

Overall, the majority of the studies that have been aimed at improving safety are from the pedestrians' perspective, putting the burden of responsibility on the pedestrian. To date, very little research has been done to

Dynamic Sign

Figure 1: Unlit sign

Figure 2: Lit sign

Figures 1 and 2 depict an example lit and unlit sequence for the sign used in the driving simulator. In the lit phase, the sign is flashing rapidly. The flashing crosswalk on the sign corresponds to the active crosswalk.

investigate this issue from the drivers' perspective. The goal of improving safety by informing drivers of potential pedestrian hazards in a roundabout is aligned with NCHRP report 674 *(7)*, which recommends focusing future research on treatments geared towards reducing speeds and increasing yielding behavior.

"The sign is intended to improve situational awareness and reduce cognitive load by providing drivers with advance warnings."

To help mitigate this issue, a novel new dynamic warning sign, which warns drivers before entering the roundabout if and where pedestrians are attempting to cross, is tested. The sign is a yellow diamond warning sign with a symbolic traffic circle and symbolic crosswalks for each approach of the roundabout. If a pedestrian is about to cross a roundabout approach, the associated crosswalk symbol on the sign will flash to warn drivers which crosswalk is active (i.e., has pedestrians present).

The sign is intended to improve situational awareness and reduce cognitive load by providing drivers with warnings of expected hazards before entering the roundabout. This may not only improve universal access and safety for pedestrians at roundabouts, but is also expected to allow drivers to adjust their planned trajectory in anticipation of an event. This will promote smoother traffic flow operation and potentially reduce emissions.

The apparatus in this experiment is a full-scale stationary driving simulator with nearly 360 degrees of screens. The experimental design consists of a driving participant driving through four scenarios: a control roundabout with no pedestrian or sign; a roundabout with a pedestrian and no sign; a roundabout with a static non-flashing sign and a pedestrian; and a roundabout with a dynamic sign and a pedestrian. Data will be recorded from the driving data of the vehicle and from an eye-tracking device worn by the participants. It is the intent of the experiment to test whether a dynamic warning sign has the potential to improve pedestrian safety.

References

1. Guth, D. a., R. G. Long, R. S. Wall Emerson, P. E. Ponchillia, and D. H. Ashmead. Blind and Sighted Pedestrians' Road-Crossing Judgments at a Single-Lane Roundabout. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, Vol. 55, No. 3, 2012, pp. 632–642.
2. Vaughan, W. I., G. W. Davis, and D. Sauerburger. *Pedestrian access to roundabouts: Assessment of motorists' yielding to visually impaired pedestrians and potential treatments to improve access.* Federal Highway Administration, 2006.
3. Ashmead, D. H., D. Guth, R. S. Wall, R. G. Long, and P. E. Ponchillia. Street Crossing by Sighted and Blind Pedestrians at a Modern Roundabout. *Journal of Transportation Engineering*, Vol. 131, No. 11, 2005, pp. 812–821.
4. Schroeder, B. J., N. M. Rouphail, and R. G. Hughes. Toward Roundabout Accessibility—Exploring the Operational Impact of Pedestrian Signalization Options at Modern Roundabouts. *Journal of Transportation Engineering*, Vol. 134, No. June, 2008, pp. 262–271.
5. Lu, G., F. Guan, and D. Noyce. Simulation Study of Access Management at Modern Roundabouts. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2265, No. 1, 2011, pp. 209–225.
6. Liao, C.-F. Using a smartphone application to support visually impaired pedestrians at signalized intersection crossings. *Transportation Research Record: Journal of the Transportation Research Board*, No. 2393, 2013, pp. 12–20.
7. Schroeder, B., L. Rodegerdts, P. Jenior, E. Myers, C. Cunningham, K. Salamati, S. Searcy, S. O'Brien, J. Barlow, and B. L. (Beezy) Bentzen. *Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities: A Guidebook*. Transportation Research Board, Washington, D.C., 2017.