THE USE OF RFID TECHNOLOGY AT PEDESTRIAN CROSSINGS TO ASSIST DISABLED USERS: ON-STREET TRIAL RESULTS

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1. INTRODUCTION

At signalised pedestrian crossings, people with disabilities can experience difficulty in locating the push button unit and then subsequently crossing the road within the duration of the crossing period. Furthermore, some pedestrians with disabilities may experience difficulty reaching the push button and/or pressing it. There is a potential benefit from equipping signalised crossings with technology to detect vulnerable pedestrians and call the green man without requiring that they press the button.

This paper presents the results of an on-street trial at a Puffin crossing in Edinburgh to test the use of Radio Frequency Identification (RFID) technology that provided the user with a location message and a facility to input a remote demand for the green man. The trial was commissioned by Transport Scotland and supported by the City of Edinburgh Council (CEC).

Thirty people participated in the trial, twenty six were blind or partially sighted and four were mobility impaired. The participants undertook questionnaires before and after using the trial site to gauge their attitudes towards the trial equipment and to crossings in general.

The trial produced a proof of concept for the use of RFID equipment at signalised pedestrian crossings. In general, the trial equipment proved to operate successfully and was popular with the users. The trial concludes that whilst the system requires further technical development, it has the potential to add benefit to disabled pedestrian's experience of using signalised road crossings.

This paper follows up on a paper presented at last year's STAR conference (*The Use Of RFID Technology At Pedestrian Crossings To Assist Disabled Users*) which discussed the background to the trial, its objectives and the methodology employed. A brief overview of last year's paper is set out before the results of the trial are summarised. The results are derived from the analysis of questionnaires undertaken by trial participants and by observations made during the trial. The paper concludes with a summary of potential future uses and ongoing equipment development.

2. THE NEED FOR RFID TECHNOLOGY

For many disabled people fear of crossing the road is a major factor that deters them from using the pedestrian environment. This fear also prevents disabled people from accessing other forms of transport such as the bus or train.

Signalised crossings can be equipped with features to assist disabled users to cross the road, such as rotating tactile cones and audible signals. There is a potential to further benefit disabled users by equipping the crossing with the technology to detect vulnerable pedestrians and call the green man without requiring that they press the button. There are many other useful features that could be added onto such a system (e.g. a spoken wayfinding location message given to the user as they approach the crossing and the extension of the crossing time to suit the users' needs) which are discussed later in this paper.

Radio Frequency Identification Devices (RFID) can be used to allow communication between pedestrians with disabilities and the crossing equipment to automatically activate a location message and input a demand for the green man.

RFID is the use of an object (typically referred to as an RFID tag) for the purpose of identification and tracking using radio waves. RFID can most simply be thought of as an electronic radio wave barcode.

RFID tags can be used for wayfinding, and/or the provision of travel information. RFID technology is promoted by the Royal National Institute of Blind People (RNIB) with its 'React' talking sign system and at Real Time Passenger Information (RTPI) signs at bus stops. These systems are activated by a RNIB React trigger fob.

With RNIB React, the user carries a trigger fob, which is programmed with a unique ID protocol that triggers the system and activates pre-programmed audio announcements. The operational range of each RNIB React unit can be individually set.

The system developed for the trial was based on a modified version of RNIB React. The operation of the system used in the trial is detailed in section 5.

3. BACKGROUND TO THE TRIAL STUDY

As a trunk road authority, Transport Scotland published the trunk road Disability Equality Scheme and Action Plan document *Roads for All* in December 2006. One of its objectives was to investigate the potential for technology to assist disabled people in the travelling environment.

The report recommended that RFID technology be considered for the input of contactless demands and feedback features at signalised pedestrian crossings. The report recommended that on-street trials be performed to test this technology.

Subsequently, Transport Scotland funded an on-street trial to test the use of RFID technology through the Major Transport Infrastructure Projects (MTRIPS) Roads Research Programme. The trial was supported by the City of Edinburgh Council (CEC) who provided the trial site and technical support.

A Steering Group was established to oversee the project that included Transport Scotland, the City of Edinburgh Council, the police, SCOTS, disability groups, TRL, Halcrow and RNIB. The DfT were fully consulted on the findings of the Steering Group.

4. TRIAL OBJECTIVES

The study objective was to explore the proof of concept and usefulness of RNIB React technology at Puffin crossings for assisting pedestrians with disabilities.

Specific objectives included the development of a suitable design solution which would form the basis of further development, if the trial were successful.

This design solution should be:

a. Affordable (for local highway authorities to install and for pedestrians to use);
b. Easy to install;
c. Effective;
d. Easy to use; and
e. Capable of being retro-fitted to existing Puffin crossings.

5. DESCRIPTION OF SYSTEM OPERATION

The trial equipment provides pedestrians with disabilities a location message and a remotely activated pedestrian phase demand, which does not require the user to physically press the push button at the crossing. The system is primarily aimed at blind and partially sighted users, pedestrians with mobility impairment, and pedestrians who find it difficult to physically press the pushbutton. Of these three user types, the location message is considered to be of most benefit to blind pedestrians. The remote demand of the pedestrian phase will assist all users.

Other features such as the insertion of a user-specific crossing time are not possible with the technology used in the trial and are aspirational.

The system operation, as used in the trial, is described below.

Disabled users carried a small RNIB React trigger fob. The trigger fob has two buttons; for this trial, the left hand button was utilised. The trigger fob range is configurable from approximately 1-10m. The range was set in the region of approximately 5m.

The RFID receiver equipment and speaker were housed in an AGD 925 unit (of the type used for small high level pedestrian signal repeater at Puffins). This was placed above the Pedestrian Display Unit (PDU) at a height of approximately 1.7m. This height complies with the recommended distance for high level repeater units as described in the *Puffin Good Practice Guide* and is approximately at ear level for people of average height.

The front of the repeater unit was faced off with an RNIB logo to avoid false reporting of faults with the unit that may have been generated if the unit had a standard green and red man facing that was not illuminated.

Once switched on, the trigger fob emitted information pulses approximately every second. Once in range of the crossing, a voice message was activated from the receiver equipment. The message was '*You are at the pedestrian crossing on Craigmillar Park at Suffolk Road. Press the left button on your fob to request the green man and wait for the signal to cross*'. This message was kept as short as possible to avoid confusion. Once the left button of the trigger fob was pressed, a demand was inserted at the crossing for the pedestrian crossing phase. The user would then proceed to use the crossing in the same manner as in normal use. At the crossing used in the trials, the invitation to cross was presented to the user by means of the green man signal, an audible signal and a rotating tactile cone.

The use of a confirmation message to confirm that a demand for the pedestrian stage had been placed was considered. This would have inform the user that the demand has been inserted once the left trigger fob button is pressed. However, the trial equipment was unable to accommodate this message.

The RNIB React units used in the trial operated independently from one another. This meant that once on the crossing, the user activated the location message on the opposite side of the road when the trigger fob came into range. It was hoped that this additional location message would be useful in providing additional wayfinding information for users on the crossing, especially for blind pedestrians.

It had been suggested that the message be modified to include an additional location description that specifies a particular unit (e.g. "*You are at the pedestrian crossing on the west side of Craigmillar Park at Suffolk Road*" etc.). However, it was decided to keep the message simple and this additional location message was not used. The usefulness of the location messages under these conditions was tested as part of the trial.

Once the location message was activated, the same trigger fob would not activate the message again for a set period of time. This delay was set at one minute but monitored on site. The arrival of a new trigger fob activated the message without a delay. The unit was capable of remembering up to 20 trigger fobs at one time.

The RNIB React technology units operated independently of the signal controller and consequently the activation of the message was independent of the traffic signal cycle. This meant that it was possible that the location message was activated concurrently with the audible signal.

6. TRIAL METHODOLOGY

The trial site was the Puffin crossing on Craigmillar Park at Suffolk Road, Edinburgh.

Volunteers for the trial were sourced from a number of sources: members of the Steering Group, RNIB staff, the Scottish Braille Press and pupils of the Royal Blind School. The last two groups were located close to the trial site.

Thirty people participated in the trials, twenty six were blind or partially sighted and four were mobility impaired. Ten were pupils from the Royal Blind School. Royal Blind School mobility officers oversaw the trialling of the equipment when used by these pupils.

The trial participants completed a pre-trial questionnaire before using the crossing to ascertain experience of existing signalised pedestrian crossings and gauge attitudes towards the existing technology used at signalised pedestrian crossings.

The experiences of the participants in the trial were captured by a post-trial questionnaire. The questionnaire asked the trial participants their experience of using signalised crossings with the assistance of the RNIB React system and their attitude towards it.

The trial ran from May to August 2011.

7. TRIAL QUESTIONNAIRE RESULTS

An analysis of the trial questionnaires found the following results:

1. The majority of the trial participants (25 of 30) found it useful or very useful to activate the crossing using the remote trigger fob. Four preferred the push-button box and two had no preference;

2. The main reasons for preferring to use a trigger fob were associated with the removal of the need to find the pole. However, using the push-button allowed the user to align themselves with the road before crossing;

3. The majority of problems reported on the ease of use of the crossing were associated with the audible message, either it did not activate at times or it activated at different distances from the crossing. Two trial participants reported problems with the trigger fob's battery power;

4. Two thirds of participants rated the message as quite useful or very useful. Similarly, two-thirds considered that the volume and the amount of information were just right;

5. The comparison showed that there was a significant difference between ratings given for the crossing in an unfamiliar area and the modified crossing. On average, the respondents found it significantly

more difficult to locate the crossing on an unfamiliar road than they did to locate the modified crossing;

6. The majority of trial participants would prefer the message to come from the crossing itself rather than the remote trigger fob or an earpiece;

7. The majority of people were confident they had activated the crossing with the remote trigger fob;

8. Half the participants would like to see a confirmation message;

9. The usefulness of the repetition of the location message as a wayfinder while crossing the road was unproven due to the unreliability of the activation distance;

10. The majority of the trial participants think that the trigger fob should be provided free of charge if the system becomes widespread; and

11. The presence of an audible signal was the primary factor in the ease of use and confidence when using signalised crossings.

8. TRIAL OBSERVATIONS

The survey results largely confirm the observations made by Halcrow staff during the trial. The insertion of the pedestrian demand by the trigger fob was very reliable and users appeared to have no problems using the trigger fob, crossing the road in a calm unhurried manner. Most users appeared to find this function useful.

The distance at which the location message was activated was observed to vary. In setting up the trial site, the equipment was tested under controlled conditions and adjusted until a reasonable accuracy and reliability of activation was achieved. In practice the operation of the location message did not comply with these controlled conditions.

The activation of the message is dependant on the strength of the signal from the trigger fob. It is suspected that the strength of the signal is dependant on a number of variables such as where the user holds or stores the trigger fob, the strength of the batteries and interference.

Users were requested to use the trigger fob suspended on a lanyard placed around their neck when approaching the crossing, to try and create as consistent conditions as possible. Trial participants were happy to do this for the trial but some expressed reservations about carrying the trigger fob in this manner in practice. Some users stated that the most convenient place to carry the trigger fob was in the pocket, possibly on a key ring. One trialist suggested that displaying a trigger fob would increase their feeling of vulnerability.

The trigger fob batteries themselves were observed to be unreliable.

The volume of the system appeared to be set at a reasonable level.

Observations from the Royal Blind School mobility officers agree largely with those of Halcrow staff. The equipment was generally well received and the confirmation message was considered useful. Again, the main problem was with the trigger fob detection, which was unreliable.

9. TRIAL CONCLUSIONS

The trial produced a proof of concept for the use of RFID equipment at signalised pedestrian crossings. In general, the trial equipment proved to operate successfully and was popular with the users. The trial can conclude that the system has the potential to add benefit to disabled pedestrian's experience of using signalised road crossings.

The trial proved the following specific objectives:

a. It is easy to install (although the final system specification is not complete);
b. It is effective and easy to use; and
c. It can be retro fitted into existing Puffin crossings.

The final system specification is not complete and, therefore, the cost of the system cannot be estimated at this stage.

10. FUTURE DEVELOPMENT

A number of developments could be introduced to the system to provide potential additional benefits. Some of the enhancements that may be considered useful are listed below although this is not necessarily an exhaustive list. These benefits would require appraisal to gauge their usefulness.

1. Provision of demand confirmation message. The provision of this function was part of the trial questionnaire. The results suggest that approximately half of the trial participants would like to receive a confirmation message. The equipment used in the trial was unable to provide this function and further development would be required. The message could be in the form of an audible message or a by a vibration in the trigger fob.

2. Latched demands for trigger fob users. There is a potential hazard when blind users of signalised crossings are unaware that the pedestrian demand has, for whatever reason, been cancelled without their knowledge. It would be beneficial if a latched demand was inserted by trigger fob users irrespective of the operational conditions of the crossing for other users.

3. Personalised signal timings set to the needs of the user. The trial participants with mobility impairment all reported problems with not receiving enough time to cross at signalised crossings, in general. It is possible that the highly impaired could benefit from an extended

crossing time inserted by the use of the trigger fob specific to their needs.

4. Temporary enablement of audible signals irrespective of timetabled events. Some traffic signal installations are timetabled to disable audible facilities between certain hours. This was reported as problematic by one of the trial participants. It could be beneficial to allow the enablement of audible facilities to trigger fob holders who would benefit from this facility, mainly blind pedestrians, at times when they would normally be disabled.

5. Inhibition of location message during green man / audible crossing period. A major drawback of the prototype system is the possibility of a conflict between the audible crossing signal given during the green man period and the location message. This conflict should be removed in any final system specification.

6. Permanent demand for some users. Some people with disabilities will be unable to operate a trigger fob. In this instance, the trigger fob could be set to insert a pedestrian phase demand permanently. This would have a consequence of signalised pedestrian demands being inserted when the user is passing the crossing but not necessarily wishing to use it to cross the road. This consequence could be considered acceptable owing to the probable low number of occurrences of the scenario.

7. Fault monitoring. The system would benefit from acquiring a fault log to allow monitoring. However, the fault conditions to monitor require consideration; logging permanent demand for example is not desirable.

8. User specific languages for the message. There is the possibility of programming the system to be language specific depending on the fob.

9. Use of mobile phone. At present the system operates using a trigger fob. There may be the possibility for the system to migrate to a mobile phone platform in the future.

Discussion with traffic signal equipment supply companies indicate that there are no technical impediments to developing a system to provide these features

11. SUMMARY

People with disabilities can experience difficulty in locating the pedestrian push button unit and then crossing the road during the duration of the crossing period. Furthermore, some pedestrians with disabilities may experience difficulty reaching the pedestrian push button and/or pressing it. There is a potential benefit from equipping the crossing with the technology to detect vulnerable pedestrians and call the green man without requiring that they press the button.

Radio Frequency Identification Devices (RFID) can be used to allow communication between pedestrians with disabilities and the crossing equipment to automatically activate a location message and input a demand for the green man.

Transport Scotland, with the assistance of the City of Edinburgh Council, commissioned an on-street trial to test the use of RFID technology at signalised crossings as part of its *Roads for All* initiative. The technology used was based on the RNIB React talking sign system.

The trial equipment provides pedestrians with disabilities a location message and a remotely activated pedestrian phase demand by use of the RNIB React trigger fob, which does not require the user to physically press the push button at the crossing. The system is primarily aimed at blind and partially sighted users, pedestrians with mobility impairment, and pedestrians who find it difficult to physically press the pushbutton.

A prototype unit was installed at the Craigmillar Park Puffin crossing at Suffolk Road, Edinburgh. The trial site equipment was commissioned on 6th May 2011.

Thirty people participated in the trials, twenty six were blind or partially sighted and four were mobility impaired.

The trial participants undertook a pre-trial questionnaire before using the crossing to ascertain experience of existing signalised pedestrian crossings and gauge attitudes towards the existing technology used at signalised pedestrian crossings.

The experiences of the participants in the trial were captured by a post-trial questionnaire.

The trial produced a proof of concept for the use of RFID equipment at signalised pedestrian crossings. In general, the trial equipment proved to operate successfully and was popular with the users. The trial can conclude that the system has the potential to add benefit to disabled pedestrian's experience of using signalised road crossings.

12. THE WAY FORWARD

Following the successful proof of concept from the trial, RNIB have invested in developing improved trigger fob technology which could address the problems encountered with regard to the variability of the trigger fob detection. The enhanced RNIB React technology platform also enables a confirmation message to users once they have activated the green man phase, a function requested by half of the trial participants in the post trial questionnaire.

Transport Scotland has agreed to fund an extension to the trial to test these developments.

The objective of the trial will be to take a further step towards the development of a fully working system that delivers the potential of RFID technology at signalised crossings to disabled road users.