Ambient Persuasive Guiding Measures: Influencing pedestrian walking behaviour at bottlenecks in the London Underground

Gerrit Boehm, Phil Shaw, Magnus Moar

Middlesex University, London, United Kingdom
{G.Boehm, P.Shaw, M.Moar}@mdx.ac.uk

Abstract. This paper presents solutions for particular problems commuters encounter during the walking phase of their journey in public transport facilities. Commuters get obstructed or have collisions at bottleneck situations making their walking inefficient and stressful. The notion presented in this paper is to reinforce existing infrastructures with embedded *ambient persuasive technologies* acting as *psychological guiding measures* to enhance pedestrian flow.

Keywords: Ambient persuasive technologies, psychological guiding measures, avoidance maneuver, anamorphic graphics.

1 Introduction

In 2010/11 the London Underground carried a record number of 1.1 billion passengers per year [1] and it is projected to grow to 1.5 billion by 2020 [2].

This constantly growing number of passengers imposes a great impact on the operational system of the London Underground. This increasing passenger flow will require improvements to infrastructure and information design in transport facilities not just to improve the efficiency of pedestrian flow, but also the quality of travelling through the setting, i.e. with less stress and more comfort.

An interrupted pedestrian flow (as people obstruct or even collide with each other), for example at blind corners, has an impact on the overall commuter flow and individual stress levels. These areas act as bottlenecks, which together with other delays in the overall journey are trigger points for causing stress and frustration.

The following study aims to develop *ambient persuasive technologies* [3, 4, 5] embedded into the environment, which act *as psychological guiding measures* [6] for a more effective *self-organisation* to improve the pedestrian flow and the quality of walking. It is argued that persuasive power is most efficient if applied as an ambient intervention; embedded in the built environment aiming to make suggestions at the right moment and place, without causing irritation to the users involved [3, 4, 7].

2 Ambient Persuasive Guiding Measures

The goal of this study is to develop ambient persuasive technologies (APT) acting as psychological guiding measures (PGM), which provide commuters with the required support at the right time, in an unobtrusive, non-coercive way for a more managed pedestrian flow. We have designed several such measures:

Anamorphic Graphics. This is the notion of using anamorphic graphics to assist pedestrians to organise themselves more efficiently at bottlenecks by strategically placing illusions of physical barriers to change their walking behaviour. These anamorphic graphics, although actually flat and static, appear to be dynamic as they morph into different 3D shapes depending on the viewing angle (Figure 2). They are designed to morph into the intended form right at the moment and place the graphic is needed most. For example, an illusion of 3 triangular divider protruding from the wall aiming to change commuters' behaviour to walk as close as possible around corners from one side – based on the notion of *cutting corners* [8] – to minimise collision avoidances.

Parallax Motion Display. This PGM is concerned with the potential of dynamic, responsive information. The notion of *responsive graphics* is based on the principle of the zoetrope. This is a rotating cylinder with vertical slits and a series of images on its inside, which produce the illusion of motion, when viewed in quick succession through the slits. However, in this study the animation can be seen on a linear display, generated through body movement, rather than a rotating device. The notion is that motion displays, which are self-generated through body movement, draw more attention than static graphics. Also, due to the fact that the graphics apparent movement is actually generated by the pedestrian's movement, it provides a certain interactivity and playfulness which might make it more likely to be accepted and followed as guidance instructions.

Digital Hagioscope. This APT is concerned with the enhanced perception for collision avoidance around narrow corners or walls. It is based on the notion of a hagioscope, which is an architectural wall opening, mainly found in churches, allowing a direct view of the altar, if for example obstructed by a wall. The concept is, that instead of constructing an opening in the structure of a corner, which might affect stability, two LCD screens receiving signals from appropriately positioned cameras are installed showing the view of the opposite side, giving an illusion of transparency at the edge of the corner to prevent collisions.

Platform Distribution Display. This APT is concerned with the distribution of commuters on a platform. Data about how many passengers are in the individual train carriages is collected, using video detection and sensors (kinect) to estimate the capacity of each carriage of the in-coming train. This information will be displayed on the LED screens, currently used on the London Underground to indicate the time of the next arriving train, allowing commuters to distribute themselves on the platform accordingly to where the least crowed carriage will stop. An alternative solution might be to use ambient lighting to direct people to the desired area where the least crowded carriage will be.

3 Experiments

This paper focuses on the first, most basic set of *ambient persuasive guiding measures* – anamorphic graphics designed with the intention to *nudge* [9] pedestrian's walking behaviour in a subtle way at corners to minimise collisions and avoidance maneuvers. The notion of influencing people's path at a corner derives from the fact that straight, head-on walking lanes allow people an optimised monitoring the oncoming person and to display their intentions in order to avoid each other. However, a corner will prevent monitoring the entire field, limiting the ability to scan oncoming pedestrians, thus increasing the likelihood of being involved in a collision [10, 11]. Hence, in order to reduce the chances of this happening it is necessary to investigate ways to improve this area, using measures that allow people an earlier *body scan* [12, 13] at points where the view is limited or reduced - without having to construct new architectural elements, but instead augment the existing infrastructure.

The initial experiments were designed to find out whether the proposed PGM's are actually able to influence the way people walk around corners. The study was conducted over a duration of 5 days. In total 22 participants (10 female, 12 male) took part. The experiments focused on 5 interventions: 2-D Line, 2-D Curve, 3-D illusion (wall), 3-D illusion (floor), 3-D object (floor) all designed to influence people's walking behaviour at about 1.2 metres before the actual corner (see Figure 1). The closer a person is to the wall to which he/she will turn at this point, the less he/she can see whether someone is coming from the other side, increasing the likelihood of a collision or sudden avoidance maneuver. Hence, each additional centimeter way from the wall will allow the pedestrian to see further around the corner to allow making appropriate path choices.

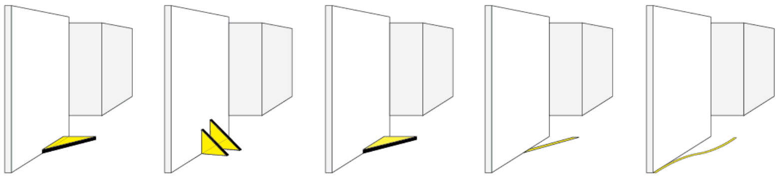

Fig. 1. Illustration of the 5 main interventions situated at a corner.

All experiments were designed to investigate how interactants perceive, comprehend and react to non-verbal, floor-based signals. The experiments were conducted in a controlled setting at the Pedestrian Accessibility and Movement Environment Laboratory (PAMELA) in collaboration with University College London, UK (UCL) [14]. PAMELA is a controlled multisensory research facility providing a platform consisting of 60 configurable modules (1.2m x 1.2m) that can be adjusted to simulate different environmental conditions. For the experiment an artificial corridor environment was built made out of an unroofed 2m (h) x 1.2m (w) x 2cm (t) honeycomb cardboard panels.

4 Methodology

A combination of video ethnography (observations and video-analysis of the footage) and a post-questionnaire to assess participant's attitudes was used creating a qualitative and quantitative approach.

Latin Square. During the experiments 2-4 participants, coming from each side are asked to walk through the artificial corridor to simulate a pedestrian counter flow. The participants were divided into groups (A, B and C). Each group underwent the same set of experiments, but in a different order to avoid possible bias. The Latin square method was used to rotate the layout of the setting as well as what intervention the group of participants would encounter first in order to avoid people learning the route.

Video observations. A video ethnographic approach is commonly used in the field of behavioral studies and was adapted to this study. 8 cameras were used to observe people's walking behaviours around corners, i.e. how they approach, manoeuvre and perceive corners. Overhead cameras were used to capture any potential trajectory change. Horizontal views were used to observe certain hot spots where potential avoidance maneuvers are likely to occur. This allowed documenting the experiment from various positions allowing a thorough retrospective analysis of the study.

Post-Questionnaire. After completing the experiments each participant was asked to fill in a short questionnaire to acquire more information regarding the effectiveness of the interventions on people's attitude towards walking in public transport facilities.

Video Analysis. The video analysis software ELAN was used in order to make observations and annotations at the moment the action occurred, making it possible to determine subtle behaviour and trajectory changes more easily. The 0.4m x 0.4m tiles of 1.2m x 1.2m modules were used as a grid to measure the deviation of the participants.

5 Results

The initial findings were expected to yield insight into the perception, reaction and effectiveness of (analogue) PGM's to provide viable data for the main study. The study presents the average trajectory deviation for each intervention (in cm), i.e. the amount of space people have been shifted away from the wall measured from their original position and to what extent the design was effective (see Figure 2). For example, if the original position of a person was 40cm away from the wall to which he/she would turn, the use of a 3-D illusion would shift a person, on average 20cm further, which means 60cm away from the wall compared to no intervention.

Intervention	Average Deviation	Effectiveness	P-value
2-D Line [N= 17]	4 cm	41%	0.0123
2-D Curve [N=32]	15 cm	84%	0.0001
3-D illusion (wall) [N=25]	20 cm	84%	0.0001
3-D illusion (floor) [N=22]	20 cm	82%	0.0001
3-D object [N=22]	24 cm	91%	0.0001

Fig.2. Average deviation of each intervention including their effectiveness to influence people's walking behaviour around corners.

The findings showed that 91% of people changed their paths to avoid the 3-D object (9% stepped over it). In comparison 82% of people changed their paths to avoid the illusion of the same object. Hence, this shows that an illusion of a physical object placed at a corner can influence people's walking behaviour to almost the same extent, but without the risk of creating a trip hazard for people coming from the opposite side.

References

1. TfL: Annual Report and Statement of Accounts, <http://www.tfl.gov.uk/assets/downloads/corporate/tfl-annual-report-2010-11-final-interactive.pdf>

2. Railway-technology: London Underground Major Regeneration Scheme, <http://www.railway-technology.com/projects/london/>

3. Davis, J.: Towards Participatory Design of Ambient Persuasive. In: Persuasive 2008, <http://www.pervasive2008.org/Papers/Workshop/w2-03.pdf> (2008)

4. Mathew, A.P.: Using the Environment as an Interactive Interface to Motivate Positive Behavior Change in a Subway Station. In: CHI'05 Extended Abstracts on Human Factors in Computing Systems, pp. 1637--1640 (2005)

5. Rogers, Y., Hazlewood, W.R., Marshall, P., Dalton, N., Hertrich, S.: Ambient Influence: Can Twinkly Lights Lure and Abstract Representations Trigger Behavioral Change? In: UbiComp'10 (2010)

6. Helbing, D., Molnar, P., Farkas I.J., Bolay, K.: Self-organizing pedestrian movement. Environment and Planning B: Planning and Design, Vol.28, No.3, pp. 361--383 (2001)

7. Fogg, B.J.: Persuasive Technology: Using Computers to Change What We Think and Do. Morgan Kaufmann, San Francisco (2003)

8. Kovacs, L.B., Galle, P.: The logic of walking in urban plaza. Environment and Planning B: Planning and Design, Vol.21, No.2, pp. 159--177(1993)

9.Thaler, R.H., Sunstein, C.R.: Nudge: improving decisions about health, wealth and happiness. Penguin (2009)

10. Rymill, S.J., Dodgson, N.A.: Psychologically-Based Vision and Attention for the Simulation of Human Behaviour. ACM (2005)

11. Yokoyama, M., Okano, Y., Fukushima, S., Furukawa, M., Kajimoto, H.: The Device of Visual Stimuli for Pedestrian Clash Avoidance Using Peripheral Vision. In: Augmented Human 2011, Tokyo (2011)

12. Collett, P., Marsh, P.: Patterns of Public Behaviour: Collision Avoidance on a Pedestrian Crossing. Semiotica, Vol. 12, No. 4, pp. 281--300 (1974)

13. Goffman, E.: Relations in Public. Microstudies of the Public Order. New York, Harper and Row (1971)

14. PAMELA, <http://www2.cege.ucl.ac.uk/cts/arg/pamela2/laboratory/>