The impact of illumination on pedestrian route choice using virtual reality experiments

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Crowd management gained in importance over the last decades for various reasons. For example, the number of mass events for religious, sportive or festive gatherings is increasing. As a consequence, urban spaces are becoming more crowded, while these spaces are not always suited to manage these increasing crowds sufficiently.

Crowd management measures are deployed by crowd operators to manage the increase crowd flows in such urban spaces, while maintaining the efficiency of the environment and the comfort levels of the pedestrians. Some of these crowd management measures are non-intrusive, i.e. measures that alter the pedestrian behavior without the pedestrians realizing that they are being managed. This study focuses on a singular type of non-intrusive crowd management measures, namely illumination. Earlier research already showed that pedestrian behavior is influenced by illumination in emergency situations, especially the tendency of pedestrians to follow the brighter path. However, there are only a few studies looking into the impact of illumination on pedestrian behavior in non-emergency conditions. That is, the current insights about the impact of illumination on choice behavior are inadequate to effectively utilize illumination as a means for crowd management within standard scenarios.

For that reason, the objective of this study is to I) determine whether illumination has an effect on the pedestrian route choice under non-emergency conditions and II) quantify that effect when it is there. The study presents a large scale virtual reality (VR) experiment, in which participants use a head-mounted display VR system (HTC Vive Pro 2) including a hand controller to control their motion.

Participants were asked to find the exit of a virtual maze twice, in which they repeatedly had to make a choice between two almost identical paths in terms of visual appearance at a T-intersection. At every intersection, the lighting conditions of the two paths are varied individually. The brightness of the lights was varied during the first run of the virtual maze, while the lighting color was varied during the second run. The experiments are designed with a combination of between-subject and within-subject, and are conducted with a heterogeneous participant population (64 participants between 18 and 35 years old). During the experiments, both the trajectory movement and the head rotation data are collected from the VR system. Afterwards, all participants answer an extensive survey featuring questions on personal characteristics, prior gaming and VR experience, and VR immersion (i.e. realism of VR environment, simulation sickness and feeling of presence within VR environment).

The findings of the VR experiment indicate that green-colored paths have a strong impact to lure pedestrians toward a certain path, while red-colored paths are mostly avoided by the participants. It has also been found that pedestrians prefer to follow the brighter path, though the observed preference is much smaller than expected.

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