Literature Review 2

Primary paper:

Altering User Movement Behaviour in Virtual Environments

BibTeX:

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@article{Simeone:2017:AUM:3070909.3071043,
  author = {Simeone, Adalberto L. and Mavridou, Ifigeneia and Powell, Wendy},
  title = {Altering User Movement Behaviour in Virtual Environments},
  journal = {IEEE Transactions on Visualization and Computer Graphics},
  issue_date = {April 2017},
  volume = {23},
  number = {4},
  month = apr,
  year = {2017},
  issn = {1077-2626},
  pages = {1312--1321},
  numpages = {10},
  url = {https://doi.org/10.1109/TVCG.2017.2657038},
  doi = {10.1109/TVCG.2017.2657038},
  acmid = {3071043},
  publisher = {IEEE Educational Activities Department},
  address = {Piscataway, NJ, USA},
}
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Secondary paper:

Virtual Proxemics: Locomotion in the Presence of Obstacles in Large Immersive Projection Environments

BibTeX:

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@INPROCEEDINGS{7223327,
author={F. A. Sanz and A. H. Olivier and G. Bruder and J. Pettré and A. Lécuyer},
booktitle={2015 IEEE Virtual Reality (VR)},
title={Virtual proxemics: Locomotion in the presence of obstacles in large immersive projection environments},
year={2015},
volume={},
number={},
pages={75-80},
keywords={virtual reality; anthropomorphic object; immersive projection environments; inanimate object; obstacle avoidance behavior; shared immersive projection spaces; user walking behavior analysis; virtual obstacles; virtual proxemics;
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virtual static obstacle avoidance; Analysis of variance; Collision avoidance; Glass; Legged locomotion; Trajectory; Virtual environments;Visualization;H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems — Artificial, Augmented, and Virtual Realities;I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism — Virtual Reality},
doi={10.1109/VR.2015.7223327},
ISSN={1087-8270},
month={March},}

Summary:

Sanz et al. [Sanz et al. 2015] analyzed the potential changes of the user's locomotion behavior when avoiding virtual and real obstacles. They prepared anthropomorphic and geometrical shapes of visible obstacles and designed it as a repeated-measures within-subjects design. They specified the geometrical object was a cardboard box that has the same height, depth and shoulder width of the human obstacle. In the experiment, Sanz et al. designed four independent variable for walking a distance through the interaction space: the obstacle (cardboard box, human), the nature of the obstacle (real, virtual), the orientation of the obstacle ($\omega \in$ {0, 90} degrees) and the direction of the trajectory. There are 4 (orientation), 2 (nature), 2 (direction) trials with real human obstacle, as well as 2 (orientation), 2 (nature), 2 (direction) trials with the box-shaped obstacle. Each combination performed four repetitions. 17 Participants were asked to fill a SUS questionnaire before the experiment started in order to collect demographic information. For methods that Sanz et al. used to analyze, the first one is three hypotheses: 1. the slower walking speed, the larger avoidance distance and clearance with virtual obstacles; 2. greater clearance when with human obstacles, because of social distances added; 3. the orientation of the human obstacle will cause changes in the clearance distance while the orientation of the box obstacle won't. The second is the Walking Speed. The third is the Maximal Lateral Deviation. The fourth is Clearance Distance. In the discussion part, all three hypotheses were supported by analyzing the records as the conclusion. In the end, Sanz et al. gave some consideration for future experiments in the fields of locomotion and behavioral dynamics.

Simeone et al. [Simeone et al. 2017] investigated the responsive behavior of people when the Virtual Environment (VE) is different from what in realistic environment. They prepared two categories of the alteration, the first one is the *aesthetic* design of the environment's surface area; the second one is the *immaterial* objects mixed with physical and virtual shapes. They designed a counter-clockwise route that along with three specific locations in a room. They asked participants to perform three laps in totally twelve environments: four environments are for getting a base line (two for real

world and virtual replica at the start of the experiment and two for the end), four environments were outdoor *aesthetic* mismatch between the real surface and the virtual surface, and four environments were indoor various types of *immaterial* obstacles that have physical proxies for virtual objects. In details, the outdoor environments consisted of the base line (grassy area), the *path* VE, the *water* VE, and the *ice* VE. The indoor environments consisted of the base line (the walls, floors and furniture), the *object* VE, the *walls* VE, and the *dark* VE. In order to understand how and why participants made such decision for those environments, authors arranged them to fill an SUS questionnaire on presence between the switch of each environments. There were eighteen participants totally, Simeone et al. also recorded their demographics details. After descript the experiment components, authors listed the methods what they used to analyze. The first is their initial assumption that participants' virtual trajectories tend to conform to real ones while the VEs are substitute that all physical objects mismatched with virtual counterparts of approximately the same size. The second one is trajectographical metrics that have three measures: *Deviation*, *Area of Deviation* and *Curvature*. The third is Kinematics data such as total distance and time that can used to get the average speed. In the result part of the paper, Simeone et al. used above method to analyze combined with the questionnaires and got a confirmation that both the *immaterial* objects and the design of the surface effect the behavior of participants in a significant way, especially the presence of *immaterial* objects. In the end, authors concluded the behavior into two categories: adherent and non-adherent. And therefore they come up with some implications for VE design of future VR. For adherent behavior, there are two main motivations: the routine behavior associated with the past real life experiences and the fear of adverse consequences. For non-adherent, there are three main motivations: pragmatism, a desire to test the boundaries of the system, and the misunderstanding of the visual stimuli. In implications part, authors extracted that the design of unambiguous aesthetic alterations impact users behaviors and proper alterations can be used to guide user route.

Relationship:

Simeone et al. cited Sanz et al.'s paper that Sanz et al.'s results indicate participant tend to use a greater clearance (circa 5 cm more) when dealing with virtual obstacles than with physical ones. They are related in the behavior of participants in the virtual environment. People behave realistically in situations happening in VE. As a common part, both of Simeone et al. and Sanz et al. are use the Kinematic metrics to analyze their collection. In Simeone et al.'s result, there is a stronger effect of the altered indoor VEs. For example, in the Objects and walls, the result is longer in length and

completed more slowly. In Sanz et al.'s result, the walking speed is higher in real environment than in virtual.

There is an interesting fundamental concept in Sanz et al.'s paper that is different with Simeone et al. In Sanz et al., proxemics is a fundamental concept related with the personal space that is considered portable territory around an individual that others should not invade. As a result, clearance distance is higher when orientation is 0° or 180° compared to 90° and 270°. Because the elliptical shape of the personal space. The orientation of the human obstacle for the 180° and 270° follow a clockwise rotation for left to right. Therefore, 0° or 180° seems like someone obstruct you in your route and your personal space is invaded. In Simeone et al. they used the area of deviation to analyze the records, and got the outcome that participants exhibited larger radii of curvature in the altered VEs than in the baseline ones, which indicate straighter paths. The mean trajectories of the VEs in the *Objects and Walls* show an almost rectangular shape, with an average deviation of circa 60 cm. In a word, one is the portable territory around a participant and the reason of have higher clearance distance, one is the area of deviation and the result of collision avoidance.