Enhancing Pedestrian Safety through In-Situ Projections: A Hyperreal Design Approach

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Figure 1: Hyperreal prototype setup to evaluate drone-based pedestrian crossing projections in virtual reality.

ABSTRACT

This paper presents a conceptual application of drone-based in-situ projections to support people when crossing busy roads that lack dedicated pedestrian crossings. To overcome technical, legal and risk challenges of evaluating these kinds of speculative pervasive display applications, we introduce the concept of hyperreal prototypes. We describe the layers that contribute to a hyperreal prototype and how such prototypes allow the evaluation of HCI solutions in high-risk scenarios in a virtual-reality environment.

CCS CONCEPTS

• **Human-Centered Computing** → **Interaction Design**.

KEYWORDS

pervasive displays, in-situ projections, hyperreal prototypes, pedestrian safety

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1 INTRODUCTION

The pervasive displays community has developed a significant body of work that investigates the role of public displays in urban life, e.g. to support navigation [2] or for retrieving real-time public transport information [3]. At the same time, advances in technology are driving the exploration of new types of public displays, such as free-floating midair displays enabled through drone technology [7]. More recently, researchers have started exploring the use of drones to project contextual information directly into the environment [1, 5], with the aim to create mobile, situated displays. Although, this area of research is still at a highly experimental stage because of technical limitations (e.g. battery life, visibility of projected content) and legal restrictions, such in-situ projections offer a number of conceptual advantages, which warrants an investigation of their use in urban scenarios. In particular, in-situ projections allow for the deployment of public displays without having to carry out costly changes to the physical infrastructure. However, designing novel applications is challenging, as the use of drones in public space is mostly prohibited, and evaluation in a real-world context poses safety risks to the participants [1]. As

a consequence, researchers often fall back on concept videos and virtual reality (VR) simulations, however, those suffer from a lack of realism in terms of interaction and representational fidelity [1]. To address these limitations, we introduce the concept of hyperreal prototypes, using 3D 360-degree video recordings of a real urban situation that is augmented with dynamic rendered overlays. We first describe a conceptual pedestrian safety application, before outlining the conceptual layers of hyperreal prototypes.

2 CONCEPTUAL APPLICATION

Building on the recent shift towards pulverized urban displays [4], we investigate the conceptual application of drone projections for improving pedestrian safety in urban environments. We chose this application area, as pedestrians are particularly at risk of being hit by a car in dark environments [6], which makes the use of a projection-based solution a viable option. Compared to smartphone-based solutions [8], in-situ projections provide barrier-free access to information (i.e. not being limited to smartphone users) while at the same time reducing potential risks associated with pedestrians interacting with a smartphone while crossing a road. Drones with their ability to sense the environment from a birds-eye view, could make precise calculations when it is safe to cross a road, and provide this information via real-time projected visualisations to pedestrians on the ground.

3 HYPERREAL PROTOTYPE

The notion of "hyperreality" refers to the fusion of physical and virtual realities, and the inability to distinguish them. Using our conceptual pedestrian safety application, below we describe the conceptual layers of hyperreal VR prototypes (Figure 1), elevating the representational fidelity of purely 3D model-based VR simulations.

First, hyperreal prototypes use **3D 360-degree video recordings** of real urban situations to increase a sense of realism in users. For our application, we video-recorded a busy, multi-lane street, which is lacking a pedestrian crossing, despite a popular nearby park. Importing the recorded videos in Unity[1], the scene can be augmented through **dynamic overlays**: this includes 3D-modeled objects (i.e. in our case, drones that carry a projector and sense the environment) and 2D visualizations created in Processing[2] (i.e. in our case, dynamic visual crossing patterns). Creating and streaming the visualisation via Processing, allows to a) quickly explore various design concepts, and b) visualizations can be dynamically adapted to the traffic situation in the real-world video, which we label with markers to request the matching visualisation sequences from Processing. **Navigating** in the 360-degree video is supported through the VR system (e.g. HTC Vive[3]), allowing the user to rotate around their own axes. To overcome the limitation that comes with the inability to walk in 360-degree videos, we currently experiment with zooming into the video to simulate a feeling of moving forward or backward. More sophisticated solutions could include taking shots at various positions, e.g. through a camera slider or a mobile robot. The final layer of hyperreal prototypes refers to **interaction** modalities: while interacting with objects in the real-world video is not feasible, controller- and gesture based interactions can be used to let users directly interact with the dynamic overlays. This allows, for example, to explore gesture-based interactions with the 3D-modeled drones, e.g. to request a nearby guidance drone. Developing multiple VR instances based on simultaneous video-recordings at different positions, in the future, we also plan to consider the evaluation of social interactions, i.e. having multiple users interacting within the same simulation environment.

[1]https://unity.com/, accessed April 2019
[2]https://processing.org/, accessed April 2019
[3]https://www.vive.com/, accessed April 2019

4 CONCLUSION AND FUTURE WORK

Although still limited by technological and legal constraints, drone-based projections provide a potential alternative to smartphones and fixed public displays for communicating information in an urban environment, in particular in low-light situations. In this paper we presented two conceptual contributions to the fields of HCI and pervasive displays. First, we described a conceptual drone-based projection application to support people crossing a busy road without the presence of a pedestrian crossing. Second, we introduced the concept of hyperreal prototypes, which combine 3D 360-degree video recordings with dynamic overlays, represented in VR in a way that allows participants to navigate the environment and to interact with the in-situ projection application. In our future work, we plan to run a user study to evaluate the efficacy of hyperreal prototypes for simulating speculative interactive applications in urban environments.

REFERENCES

[1] J. R. Cauchard, A. Tamkin, C. Y. Wang, L. Vink, M. Park, T. Fang, and J. A. Landay. 2019. Drone.io: A Gestural and Visual Interface for Human-Drone Interaction. In *2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*. 153–162. https://doi.org/10.1109/HRI.2019.8673011

[2] Jorgos Coenen, Niels Wouters, and Andrew Vande Moere. 2016. Synchronized Wayfinding on Multiple Consecutively Situated Public Displays. In *Proceedings of the 5th ACM International Symposium on Pervasive Displays (PerDis '16)*. ACM, New York, NY, USA, 182–196. https://doi.org/10.1145/2914920.2929906

[3] Marcus Foth and Ronald Schroeter. 2010. Enhancing the Experience of Public Transport Users with Urban Screens and Mobile Applications. In *Proceedings of the 14th International Academic MindTrek Conference: Envisioning Future Media Environments (MindTrek '10)*. ACM, New York, NY, USA, 33–40. https://doi.org/10.1145/1930488.1930496

[4] Marius Hoggenmueller, Luke Hespanhol, Alexander Wiethoff, and Martin Tomitsch. 2019. Self-Moving Robots and Pulverized Urban Displays: Newcomersin the Pervasive Display Taxonomy. In *Proceedings of the 8th ACM International Symposium on Pervasive Displays (PerDis '19)*. ACM, New York, NY, USA. https://doi.org/10.1145/3321335.3324950

[5] Pascal Knierim, Steffen Maurer, Katrin Wolf, and Markus Funk. 2018. Quadcopter-Projected In-Situ Navigation Cues for Improved Location Awareness. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. ACM, New York, NY, USA, Article 433, 6 pages. https://doi.org/10.1145/3173574.3174007

[6] National Highway Traffic Safety Administration. 2017. Traffic Safety Facts. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812681, accessed April 2019.

[7] Stefan Schneegass, Florian Alt, Jürgen Scheible, Albrecht Schmidt, and Haifeng Su. 2014. Midair Displays: Exploring the Concept of Free-floating Public Displays. In *CHI '14 Extended Abstracts on Human Factors in Computing Systems (CHI EA '14)*. ACM, New York, NY, USA, 2035–2040. https://doi.org/10.1145/2559206.2581190

[8] Tianyu Wang, Giuseppe Cardone, Antonio Corradi, Lorenzo Torresani, and Andrew T. Campbell. 2012. WalkSafe: A Pedestrian Safety App for Mobile Phone Users Who Walk and Talk While Crossing Roads. In *Proceedings of the Twelfth Workshop on Mobile Computing Systems & Applications (HotMobile '12)*. ACM, New York, NY, USA, Article 5, 6 pages. https://doi.org/10.1145/2162081.2162089