Evaluation of Spatial Data Layer Compositing Techniques in Interactive VR Environments

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Index Terms—Geo-visualization, Urban Data Visualization, Visual Analytics, Virtual Reality, Interaction, Evaluation

I. INTRODUCTION

Urban data or geo-visualization typically involves projecting layers of spatial data and features on a 2D or 3D base map, normally a topographic or road map. Often, data from several thematically different layers needs to be correlated to form a wholistic understanding of a place in order to make informed decisions. Other than switching layers, there exist composition techniques to display several layers simultaneously, the two most common being juxtaposition and superimposition.

In this project, we propose an investigation into different modes of juxtaposition, specifically in an interactive virtual reality environment, which we believe offers advantages such as a very large interactive space and a greater sense of immersion.

II. USER EXPERIMENT

The aim is to empirically evaluate the benefits and trade-offs of compositing techniques that specifically exploit the possibilities an immersive 3D space offers and to explore user behavior in a controlled task-based experiment, which could aid designing future visualization systems for urban data analysis and other map-based tasks.

The general task is to select the optimal placement for a new school in a city of out potential candidates shown by markers, by correlating four different data layers relevant to that task—environmental, demographic and traffic data, as well as information on existing school facilities. Real cities will be used as the base maps, and fictional data layers will be created to make that determination easier for the participants.

Each participant will complete tasks with each system and different city models, the combinations of which are permuted. Other than performance, user behavior will be measured by their interactions with the software and through eye tracking, while questionnaires will be used to judge their workload and acceptance of each system. Structured interviews could reveal individual insights.

III. COMPOSITING TECHNIQUES

To be as comparable against each other as possible, designing the techniques under investigation required care. Each system features the same interfaces and general visualization, the differences existing only on the spatial arrangement.

The user tasks take place on an urban scale, so flat maps are used for familiarity, though elevation data is utilized to shape the maps into a more “realistic” and thus more engaging and immersive form.

The first system projects one large map view in front of the user, filling the comfortable viewing space. Controls exist for instantly switching between data layers, while the markers (candidates and currently chosen position) persist. This provides the largest and most detailed view of data maps, but the compositing takes place in the participant’s memory.

The second system presents a grid of all available data layers next to each other, with controls to swap their positions on the grid. Navigation (panning and zooming) and marker positions are mirrored across all four maps. This provides an immediate overview of all available data, albeit in smaller views.

The third system presents all layers vertically stacked above each other, all in the same size and scale, and vertically coherent. Users can swap the order of the stack and change the distance between layers, as well as the slant angle for better viewing. While the perspective distortion could have a negative impact, this system adds a spatial coherence to the overview of all data already present in the second system—vertical lines could be drawn that connect markers placed on the maps, aiding in comparisons.

IV. CONCLUSION

In conclusion, this experiment is designed to evaluate the potential of immersive visual analytics to help understanding spatial data, and also to propose methods of displaying multi-layered geo-data in immersive environments, such as in digital city models in VR or physical locations with augmented reality.