Cognitively Grasping Topography with Tangible Landscape

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Cover letter

Dear Editors,

I would like to submit this paper to ACM Transactions on Computer-Human Interaction. This paper reviews existing research and design work about tangible interfaces for spatial modeling, describes the design of a new system, and describes a series of laboratory-based user experiments using quantitative and qualitative methods to assess 3D spatial performance.

Relationship to similar publications about Tangible Landscape. This paper describes the third generation of Tangible Landscape, a tangible interface for geospatial modeling. The first generation of this system was described in the paper *GIS-based environmental modeling with tangible interaction and dynamic visualization* [Petrasova et al. 2014] and the second generation of the system was described in the book *Tangible Modeling with Open Source GIS* [Petrasova et al. 2015]. These publications described the design of the systems, the technical implementation and the underlying algorithms, and detailed case studies, but did not include user experiments. The coupling of Tangible Landscape with VR has already been described in a demo paper titled *Immersive Tangible Geospatial Modeling* that has been accepted for ACM SIGSPATIAL 2016 [Tabrizian et al. 2016]. There have been substantial innovations in the third generation of this system including faster interaction, new modes of interaction, and a fully open source implementation. While these technical and design innovations are described for the first time in this paper, the user experiments are the most unique, innovative part of this research.

Relationship to similar publications about user experiments. The user experiments described in this paper address important basic research questions about spatial performance in tangible interaction. The experiments used novel methods such as geospatial modeling to spatially analyze and quantitatively assess 3D spatial performance. Two of the three user experiments described in this research are based on pilot studies – *Embodied Spatial Thinking in Tangible Computing* [Harmon 2016] and *Tangible Landscape: cognitively grasping the flow of water* [Harmon et al. 2016] – with fewer participants, less sophisticated methods, and only preliminary findings. The methods and results described in this paper differ substantially from these pilot studies. New methods include statistical transformations, cellular statistics, morphological analysis, differencing, and 3D visualization. This research also includes qualitative methods that were not used in the pilot studies.

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