Cognitively Grasping Topography with Tangible Landscape

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Revisions

Editor: Provide more details in related work section that differentiates your findings from related work.

Reviewer 1: For a journal article, a more detailed discussion would be appropriate... What were the results/conclusions of such prior evaluations?

We have added a detailed literature review to subsection **1.2 Tangible interfaces for geospatial modeling** that details relevant TUIs and user studies. We discuss TUI including Project FEELEX, the XenoVision Mark III Dynamic Sand Table, the Northrop Grumman Terrain Table, Relief, Recompose, inFORM, Tangible CityScape, Urp, the Collaborative Design Platform, Illuminating Clay, Tangible Geospatial Modeling System, SandScape, Phoxel-Space, the Augmented Reality Sandbox, Hakoniwa, the Augmented REality Sandtable, Inner Garden, and Tangible Landscape. The review of previous systems also includes conclusions from prior studies and evaluations. We describe what is different about Tangible Landscape at the end of subsection **2.1 Concept**.

Editor: Add details on the system implementation... Please add physical dimensions, capturing distances, lag, what contributes to 2 sec. delay?, etc.

In subsection **2.3 Implementation** we explain how the process of calibration, scanning, filtering, terrain modeling, and analysis works.

In subsection **2.4 System resolution, accuracy, and speed** we describe Tangible Landscape's capturing distance and lag, describe the range of physical model sizes, quantify its resolution and assess its accuracy and speed. The accuracy assessment and benchmarks are presented in Fig. 7, Table VI, and Table VII.

We discuss the effect of lag on interaction briefly in **2.2 Design** and in more detail in **6.3 Reflections on the design process**.

We added a diagram of the system setup with measurements to **Appendix A**.

We briefly outline potential applications in subsection **2.6 Applications**.

Editor: Clarify user study details.

In subsection **3.1 Methods** in the paragraph **Participants** and Table VIII we describe the participants and their experience with GIS and 3D modeling.

In the paragraph **Experimental design** we describe the methodology for the Coupling experiment in more detail including time limits, counterbalancing, and interviews.

In the paragraph **Digital modeling** we discuss in detail the choice of 3D modeling software comparing the pros and cons of different programs.

Reviewer 2: How was the time constraint of 10 minutes chosen?

We briefly explain the time limit in subsection **3.1 Methods** in the paragraph **Experimental design** and again in the paragraph **Digital modeling**.

How proficient in Rhino were your participants?

After describing the participants in subsection **3.1 Methods** in the paragraph **Participants**, we recomputed the analyses to in order compare novices versus experts. We used pairwise comparison to compare their performance (See Fig. 17).

Subsection **3.2 Results** presents the new results with new Tables X-XVI comparing novices versus experts. In these tables we changed the color table for standard deviation and cited its source – Color Brewer – and references in publication.

Table XXIII in Subsection **4.2 Results** presents the new results comparing novices versus experts for the difference experiment.

Table XXVII in Subsection **5.2 Results** presents the new results comparing novices versus experts for the water flow experiment.

It would be very interesting to find out more about the qualitative feedback from users.

More feedback from interviews and observations are discussed in the subsections **3.2 Results**, **4.2 Results**, and **5.2 Results**. Table XXVIII compiles select comments from interviews.

Generalize on your findings.

In section **6 Discussion** we discuss the new results comparing novices' and experts' performance and process, draw generalized conclusions, and hypothesize about the implications.

To clearly address the research questions, the discussion is broken in discrete sections – subsection **6.1 Coupling physical and digital models** and subsection **6.2 How tangible geospatial analytics mediate users 3D spatial performance** – addressing the questions.

The revised results and discussion are reflected in the **8 Conclusion**.

Longitudinal results: As the functionality outlined in the study experiments has been part of the Tangible Landscape system for many years, the paper should balance the results of this short study with qualitative observations of experts that have been using it over a longer duration, and how their use patterns shift.

The authors' experiences and observations are discussed in subsection **6.3 Reflections on the design process**. We discuss system lag / speed, digitizing hands and arms, and unstructured versus structured users experiences.

Best practices if spatial modeling is the target goal.

Subsection **6.4 Design guidelines** outlines best practices for design TUIs for spatial modeling.

Suggestions for Online Appendix Content

We added videos demonstrating each of the experiments and showcasing applications with Tangible Landscape as supplemental content.

We have also added code and data for running the experiment as supplemental content.