Location-Based Augmented Reality for Setting-Out

Cédric Dind
Master's Thesis, HS 2019
Institute for Cartography and Geoinformation, Chair of Geoinformation Engineering, ETH Zurich

Supervisor: Prof. Dr. Martin Raubal
Advisors: Fabian Göbel, David Rudi, Dr. Peter Kiefer
External advisor: Fixposition AG, Acht Grad Ost AG

1 Motivation

Although there exists research on accurate location-based geodata display in augmented reality (AR), there is a lack of research on the usability of AR in location-based surveying tasks like setting-out.

The conventional method of setting-out with a GNSS system works by iteratively searching for a point based on distance correction values and it is not optimal for marking the points.

2 Research Questions

1. Is it feasible to develop a location-based augmented reality system that enables a user to set-out points in a real working environment?
2. How does such a system perform in terms of usability and user experience aspects? How does it perform in terms of the perceived workload?
3. How does such a system perform in the above stated aspects compared to a conventional setting-out method with a GNSS system?

3 Methods

The prototype location-based augmented reality (LB-AR) system is based on the MR Glasses Microsoft **HoloLens** and an RTK-GNSS **positioning system**. It allows to visualize points with coordinates at their correct position in the real world and to set-out those points hands-free with a marker recognition based measurement method. Figure 2 displays the AR target point visualizations and figure 3 the menu of the HoloLens application for setting-out.

To evaluate the LB-AR system, a qualitative study with six surveyors has been conducted. The study contains a **setting-out task** with the LB-AR system where the time and the number of set-out points get logged, the **UEQ** to measure the usability and user experience, the **NASA-TLX** to compare the perceived workload of the system to a conventional GNSS system and a **structured interview** with open questions. Figure 1 contains the material used in the study.

Fig. 1. Study material: HoloLens, Positioning system prototype, measurement marker, marking crayon

4 Application Design

Fig. 2. Target point visualization in AR

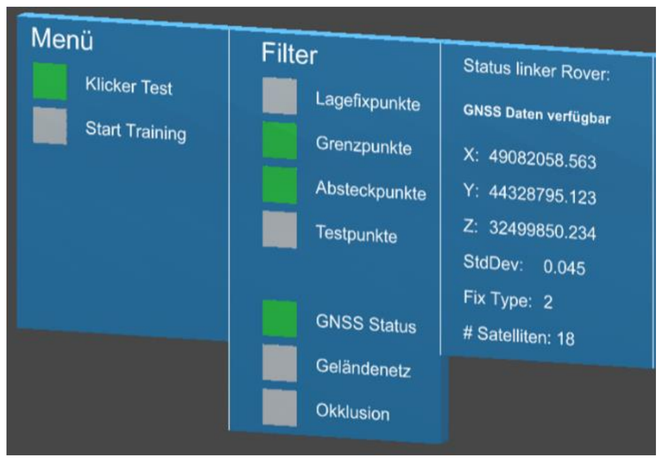

Fig. 3. Menu panels, from left to right: Study task, Query, GNSS status

5 Results

Figure 4 depicts the UEQ results. The highest value reached *Stimulation* with 2.4 and the lowest *Dependability* with 1.4.

From the three NASA-TLX dimension that received high weights from the participants, the LB-AR system was better at *Physical demand* and the conventional GNSS system better at *Performance* while *Mental demand* was approximately the same for both.

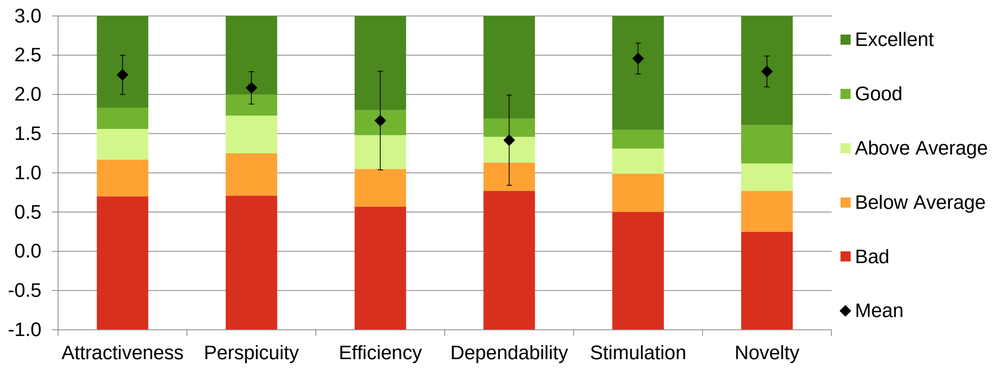

Fig. 4. UEQ results (mean values; confidence interval p=0.05; benchmark scale from bad to excellent)

During the interviews the participants stated 71 times positive aspects and 31 times negative aspects and problems. On the positive side the feature to query points, the speed and the convenience of the system stand out, on the negative side the bad environmental perception (e.g. of incoming traffic) while wearing the system is important to mention.

6 Conclusion

The study showed overall good scores for the usability and user experience of the LB-AR system for setting-out. The perceived workload from the novel system on the user is lower than from the conventional GNSS system, but the differences are not significant.

The interviews showed that the novel system is more attractive, perspicuous, stimulating and efficient but less dependable.
The users are exited by the system and emphasize its convenience.

Partners FIXPOSITION acht grad ost