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Utilizing geospatial operations to enhance the visual impression in AR and VR

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Abstract:

Owing to the performance improvements achieved and the use of low-cost sensor technology, the spread of extended reality (XR) approaches, which include AR and VR applications, has increased considerably recently. Although freely created fictional virtual worlds are usually entirely modelled, mapping the natural world to a virtual representation can only be achieved through geodata, as the aimed authenticity requires high geometric accuracy. Today, various approaches exist to integrate 3D city models statically in XR applications regarding official geodata and Volunteered Geographic Information (VGI) (Keil et al., 2021) and multiple popular game engines (Höhl, 2020). As a result, 3D city models are growing in popularity in XR applications. Among other fields, especially in planning and stakeholder engagement, XR approaches turned out to be used most, and use-cases are comparably easy to implement, as Davila Delgado et al. (2020) concluded in their systematic survey of experts from industry and academia.

In addition to 3D city models, to some extent, spatial functionality like pathfinding (Hu et al., 2012) has been integrated by game engines. However, the latter's functionality in geoprocessing, meaning performing spatial operations like checking for intersections or creating a buffer, is still somewhat limited. As a result, geoprocessing takes place in the preliminary phase of the data preparation (Psaltoglou and Vakali, 2021) and hence is unavailable at runtime. Consequently, visualizations like diagrams relying on geoprocessed spatial-temporal data cannot reflect changes induced by stakeholder interactions in XR applications.

Therefore, the ongoing research project aims to develop a prototypical implementation integrating spatial operations. In the prototype, geoprocessing at runtime is supposed to enable visualizations (like diagrams referring to the 3D city model metrics) to dynamically reflect user interactions with singular objects georeferenced via a single point coordinate. For example, in an urban planning scenario for climate change mitigation, a certain minimum number of trees might be required to be placed in a predefined area extent. Another instance where geoprocessing might improve the XR applications is the visualization of restrictions during user interactions with objects in the 3D city model. As an illustration, GeoJSON encoded data might provide areas in the 3D city model as polygons in which proximity object placement might be prohibited. Thus, specific user interactions in the application have to be disabled, and limitations have to be visually indicated to users. We used the programming language Swift for the prototype implementation. However, we expect the general approach to apply to game engines like Unity and Unreal.

As a result, the prototype serves as a proof of concept for enabling geoprocessing at runtime in XR applications. Furthermore, the prototype provides examples of how applications can benefit from dynamically visualized metrics with concrete example visualizations. We expect that the latter can be extended with more complex spatial operations in actual use cases.

The presentation will provide an overview of the current state of the prototype implementation and indicate to what extent visualizations in XR applications benefit from geoprocessing at runtime. Moreover, the presentation concerns the general transferability, requirements, and potential limitations.

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