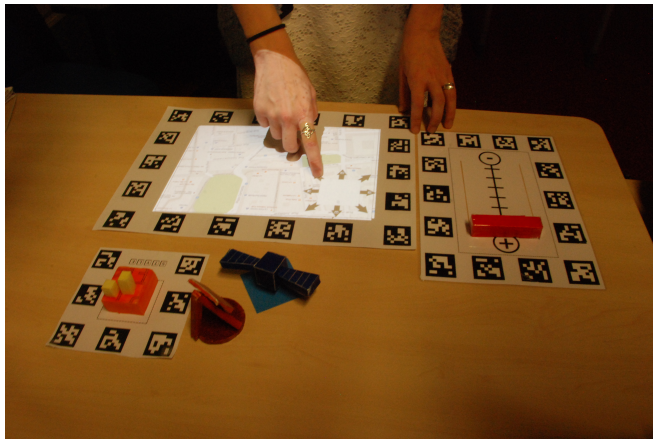
SyMAPse: Design and Evaluation of an Augmented Reality Map

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Abstract
Interactive geographic maps are today widely available, but remain mostly limited to standard interaction contexts. We introduce SyMAPse [3], a spatial augmented reality map, in which a virtual map is projected onto a physical piece of paper. In a preliminary study we compared interaction techniques based on multi-touch, tangible and spatial modalities for three common map functions: zooming, panning, and changing the basemap. Our results suggest that object-based and spatial interaction may be advantageous over multi-touch in our augmented reality setup. We are currently investigating the rich interaction possibilities provided by this augmented reality setup.

Keywords
interactive maps; tangible interaction; projection mapping; multi-touch; interactive paper; augmented reality

ACM Classification Keywords
H.5.2 [User Interfaces]: Input devices and strategies; H.5.1 [Multimedia Information Systems]: Artificial, augmented, and virtual realities

Introduction
While geographic maps have traditionally been paper-based, interactive geographic maps have now

become totally ubiquitous. They are largely available through online services on both fixed and mobile devices. These electronic maps provide unique features such as route calculation, visualization of traffic and incidents, changing basemap styles, and also offer specific interactive capabilities such as zooming and panning.

While, some map tools - such as GoogleMyMaps [a] or OpenStreetMaps [b] - even allow users to contribute to the content, users generally still like using traditional paper maps for map annotation. Yet, these features are very interesting for users of digital maps who can thus obtain individualized maps that are tailored to their needs.

Moreover, in the context of smart cities, public agencies and local governments start to use this type of support for enabling citizens 1) to be better informed (e.g., on urban construction or renovation projects), and 2) to express their views and thus contribute to the emergence of the city of tomorrow.

Furthermore, the existing interactive maps remain mostly limited to standard interaction contexts based on traditional screens and input devices such as mice, keyboards or multi-touch inputs (tablets, smartphones). Alternative interaction techniques have so far been scarcely explored (see for instance [2]; [6]).

We suggest that spatial augmented reality - which consists in turning physical objects into interactive displays through the use of projection [1] - and tangible interaction - which is about interacting with the digital world through the use of physical artifacts [7] - are promising approaches for interaction with geographic maps. In the SyMAPse project [4], we have designed a prototype that combines physical paper maps with projection. This prototype is based on the PapARt augmented-reality framework [5]. This augmented map prototype provides three map functions: zooming, panning and changing the basemap. In a study with 36 visitors in the Cap Sciences science museum in Bordeaux (http://www.cap-sciences.net/) we compared multi-touch, tangible, and spatial interaction techniques for these three map functions. Our results suggest that tangible and spatial interaction are advantageous over multi-touch in our augmented reality setup. The prototype also allows users to select a map excerpt and to draw on the paper sheet using regular pens. Our prototype has been exposed at the Living Lab of Cap Sciences in Bordeaux as part of a smart city project. We invited users to express their opinion regarding the city of Bordeaux and thus to contribute ideas to the city of tomorrow.

In our future work we are continuing to explore the rich interaction possibilities provided by this augmented reality setup, for instance by using electronics and MakeyMakey for the implementation of the tangible interaction.

[a] https://www.google.com/mymaps
[b] http://www.openstreetmap.org

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