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The Projection Mapping Situational Layer: Tabletop Projection Mapping for Visualisation of Real-time Geospatial Data

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ABSTRACT

This work presents a data-centric approach to the implementation of tabletop projection mapping, utilising the technology for data visualisation purposes with a focus on real-time geospatial data. The goal of the implementation is for multiple users or viewers to acquire a four-dimensional augmented overview of critical operations without the need for additional hardware. To that end, the Projection Mapping Situational Layer (PMSL) is presented as a tabletop projection mapping application where the real-time positions of sea vessels in the Vesterålen district (of Norway) are visualised. Based on this implementation and on its described characteristics, PMSL can be used to facilitate situational and real-time location awareness.

CCS CONCEPTS

• **Human-centered computing → Visualization systems and tools**; • **Software and its engineering** → *Software implementation planning*.

KEYWORDS

augmented reality, projection mapping, sensors, situational awareness, visualisation

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1 INTRODUCTION

Projection mapping, also called spatial augmented reality, aims to seamlessly merge physical and virtual worlds by superimposing computer-generated graphics onto real surfaces [2]. One of its largest differentiators relative to other augmentation techniques is the ability of projection mapping to allow many users to experience augmentation directly without the use of glasses or other devices [2]. The technology has a range of possible applications in public spaces, and it has been used extensively to display content on building facades, on physical objects, and on tabletop surfaces. It has targeted crowd engagement mainly for entertainment, marketing, artistic or awareness-raising purposes [1, 3, 4, 6].

In this work, a data-centric approach to the implementation of tabletop projection mapping is presented, utilising the technology for data visualisation purposes with a focus on real-time geospatial data. The goal of the implementation is for multiple users or viewers to acquire a four-dimensional augmented overview of critical operations without the need for additional hardware. To that end, the Projection Mapping Situational Layer (PMSL) is presented as a tabletop projection mapping application in which real-time positioning data for sea vessels in the Vesterålen district (of Norway) are visualised. To examine suitable visualisation modes further and to support real-time data streams, the historical positioning data for the vessels are also visualised. This application is designed as a proof-of-concept and as part of the Gaia System, which is a tabletop projection mapping system designed for raising environmental awareness in the Vesterålen district and was presented in a previous publication (cf. [1]).

2 SYSTEM DESIGN & IMPLEMENTATION

The PMSL of sea vessels utilises two application programming interfaces (APIs) for collecting data related to sea vessels in the Vesterålen district: BarentsWatch.no[1] provides a real-time data API, while Kystverket.no API[2] is used for collecting historical data (Fig. 1).

These APIs give access to information such as the types of sea vessels, their unique identifiers, size, speed, position and more. In this application, only geospatial information is used, and the APIs are filtered for longitude and latitude coordinates and their respective temporal values.

MQTT publish-subscribe communication is then established to facilitate messaging between the real-time API and the web interface. The web interface utilises the DECK.GL[3] and Mapbox GL JS[4] libraries to create a map canvas and to produce map-based visualisations of the filtered API data.

The sea vessels are visualised as pulsating, coloured dots, based on real-time geospatial data. The historical data are visualised as a timelapse of trajectories, using colourful animated lines that provide a quick overview of vessel traffic in the area and allow for going back in time for up to six months. Both visualisations can be shown at the same time since they do not obscure one another[5] (Fig. 2).

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[1]BarentsWatch.no API: https://www.barentswatch.no/bwapi/
[2]Kystverket.no API: https://data.kystverket.no/
[3]DECK.GL: https://deck.gl/
[4]Mapbox GL JS: https://docs.mapbox.com/mapbox-gl-js/guides/
[5]PMSL video demonstration: https://boletsis.net/gaia/pmsl/

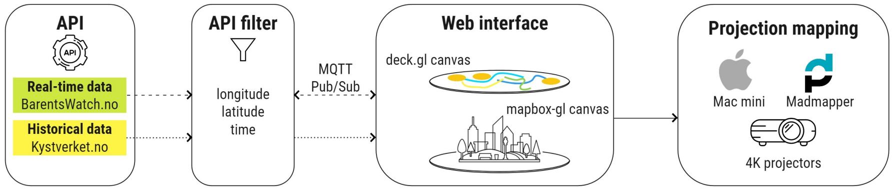

Figure 1: A high-level description of the PMSL architecture for the visualisation of sea vessels.

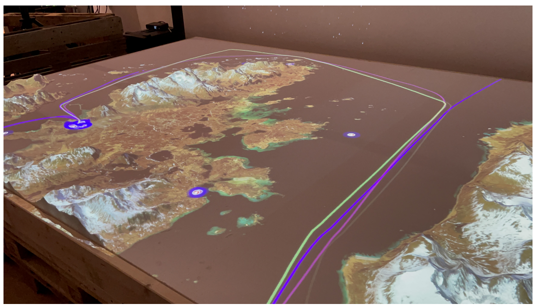

Figure 2: Real-time view of the sea vessels in the Vesterålen district utilising tabletop projection mapping[5].

The web interface (Fig. 3) is then imported into the MadMapper projection mapping software[6] via an Apple Mac Mini device. Finally, four 4K projectors project the output onto the physical tabletop model, which was printed out onto Styrofoam with the dimensions 3.5 x 2.4m.

Interaction with the content is based on a single user or administrator interacting with the projected content through a tablet device with a simple button-based user interface, as described in [1]. For the PMSL of sea vessels, there are two checkboxes, one for live traffic and the other for time-lapsed historical traffic data.

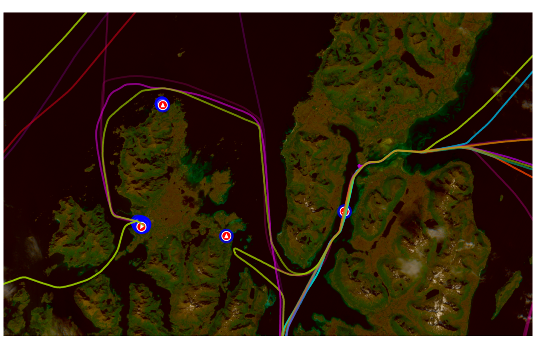

Figure 3: The web interface of the PMSL of sea vessels.

3 DISCUSSION & FUTURE WORK

As a part of the Gaia System, the PMSL of sea vessels is installed and exhibited at the Sortland and Øksnes Museums in the Vesterålen district. Based on informal observations and interviews with museum visitors during the June 2022 opening at the Sortland Museum, the PMSL of sea vessels made a positive impression on museum visitors due to its real-time visualisation and the 'godlike' overview that tabletop projection mapping can offer.

Generally, based on the implementation and characteristics described in this paper, PMSL can facilitate uses relating to situational and real-time location awareness. For instance, it could be used to provide a four-dimensional overview of sensor-based instances of land traffic as part of supervisory control and data acquisition (SCADA) systems and emergency response operations [5].

Naturally, in the PMSL implementation involving sea vessels as presented here, only three dimensions could be visualised, since elevation (i.e., height above sea level) could not be used. Moreover, in this proof-of-concept implementation, the visualisation was of limited scope, meaning that the focus was on geospatial data only. Additional information, such as vessel type, size and speed, was not utilised, while the unique identifiers of the vessels were anonymised. Future work will focus on extracting and visualising additional information from APIs, such as the aforementioned attributes, while allowing interactions with groups of vessels or with each vessel individually. Moreover, the projection mapping output will be upgraded to 8K resolution. Finally, the visualised sea vessels and their attributes will fit into an environmental narrative, which is the final targeted output of the Gaia System.

[6]MadMapper: https://madmapper.com/

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