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Geovisualisation of animated tides in coastal area with an OpenSource OpenGL platform

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Abstract

In this paper, we present a geovisualisation system of coastal area and the animation of tides. We introduce a new methodology with data selection, data stylisation and data rendering, in 2D and 3D on an OpenSource and OpenGL platform. Finally, we discuss about architecture and results.

Keywords: Geovisualisation, animation, coastal area, tides, OpenGL.

1 Introduction

Geovisualisation of coastal area and one of its major spatio-temporal phenomenon – tide – is very challenging because: (1) coastal area observation is difficult, underwater and upon water observation techniques are different and produce heterogeneous data, including airborne and bathymetric LiDAR surveys (Light Detection and Ranging); (2) coastal area elements are constantly in motion, in time and space, e.g. tides, waves, sands, implying uncertainty and imprecision in data; and (3) animation of spatiotemporal dynamics, particularly tide cycles, is tricky and brings difficulties to geovisualisation design adapted to uses and users of the coastal area.

In this paper, we propose and discuss about animated geovisualisation of the coastal area and its improvement by representation of water level dynamics in a realistic way. These improvements are based on, first, the use of close-to-reality data such as Digital Elevation Model obtained with LiDAR data to depict more accurately coastal elements and thus enhance the perceived realism, and, second, on the manipulation of the rendering engine (style) with abstraction (maps) and realism (photorealism images) in an existing OpenSource and OpenGL platform, in 2D¹ and 3D².

2 State-of-the-Art

Animated geovisualisation is related to the visualisation of continuous or pseudo-continuous geographical spatio-temporal elements [1, 5]. As an example of animated geovisualisation of the coastal elements, we can mention rising water levels simulation [8], and sandbank movement monitoring [6]. Animated visualisations are increasingly used due to new rendering capabilities (fluid visualisation and data quality). Leskens et al. [7] demonstrate animation importance, which enhances the good perception of the result of a

scenario. This demonstration is based on a user study on geovisualisation of a flood (crisis event). Resch et al. [11] conclude on the importance of the dynamic representation, including its temporal dimension from the evaluation of their 4D (3D+t) geovisualisation system of marine data. However, Rensink et al. [10] point out the limitations of animations in terms of information transmission efficiency, and especially on the perception of changes. In conclusion, animations have to be used sparingly to keep focus on the main purpose of the visualisation. None of these existing geovisualisation platforms brings together stylisation tools, animation functionalities, 2D/3D +t rendering engine. Moreover, we claim for OpenSource solutions.

3 Method

We introduce a methodology to improve the realism of animated tide geovisualisation in the coastal area, characterized by a seaside and a landside, separated by the sea/land interface. The major spatial and temporal phenomenon of this area is the tidal phenomenon, requiring information at any time t of the water depth (observation or prediction) and the position of the sea/land interface.

We have the following objectives: (1) to visualize and simulate the tidal phenomenon with water depth perception and (2) to obtain a coherent rendering over land and sea (same level of stylisation on both sides), in order to facilitate the understanding of the visualisation. We choose to explore rendering possibilities of water depth with inspiration of common styles corresponding to the levels of abstraction provided by nautical and topographic maps, or, the level of photorealism provided by ortho-imagery.

We have used and improved the OpenSource GIS platform and its OpenGL rendering engine developed within the project ANR Mapstyle³ [2]. For water depth rendering, we have implemented and improved in the rendering engine the ColorMap parameter of RasterSymbolizer from the Symbolology Encoding standard from the Open Geospatial

¹ <http://ignf.github.io/geoxygene/> last access 2016/05/09

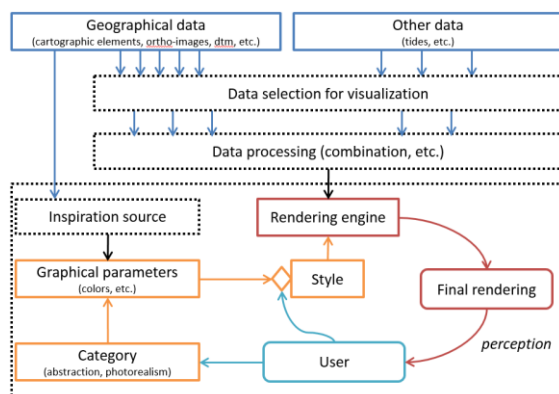
² <http://www.itowns-project.org/> last access 2016/05/09

³ <http://mapstyle.ign.fr/> last access 2016/05/09

Consortium [9] for assigning colours, colour palettes and colour gradients to values or interval of values, e.g. water depth values. The colour interpolation option of the ColorMap parameter has also been implemented and provides a continuous rendering across multiple depth values, contrary to layer tints, which are commonly used in existing visualizations but not realistic.

The general methodology of our implementation is presented in Figure 1 and is based on well-known architecture [3] with data to visualise (dark blue), stylisation (yellow), rendering (red) and user (light blue). We focus our work on the sequence of these different parts and especially on data selection, data processing and stylisation with inspiration sources (map abstraction or photo-realism) [4].

Figure 1: General methodology of our geovisualisation system



4 Results and Discussion

We present three types of animated geovisualisation of water depth based on tide information: (1) a 2D cartographic map (*abstraction*), (2) a 2D ortho-photorealistic image (*photorealism*) and (3) a 3D immersion (*3Drealism*). Figure 2 shows these three results at different tidal stages (low, medium and high level). Demonstration videos are also available⁴.

We can observe in (1) that we have a perception of water animation with displacement of water surfaces in a 2D cartographic map. In (2), we have more realism with better perception of submarine topography due to natural colour interpolation. Finally, in (3), we can note that the third dimension gives more interaction possibilities (displacement in 3D) to users and increases the comprehension of the tide phenomenon in producing more realistic sea animations.

During the workshop, it will be interesting to discuss about both methodological aspects, architecture and results, and especially the problem of temporal representation of the tide phenomenon: some thoughts will be provided about required tools to develop to give better interaction between users and

renderer to manipulate time (speed, etc.) and stylisation (colours, highlights, stream, etc.).

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Figure 2: Geovisualisation examples at different tide stage, from left to right, at (a) 0m (low tide), (b) 4m and (c) 8m (high tide) and from up to down, (1) a 2D cartographic map, (2) a 2D ortho-photorealistic image and (3) a 3D immersion.

