

# ENRICHING A 3D WORLD WITH SYNTHETIC AND VISIBLE INFORMATION ABOUT THE DISTRIBUTION OF POINTS OF INTEREST

M. Brasebin<sup>a,\*</sup>, B. Bucher<sup>a</sup>, C. Hoarau<sup>a</sup>

<sup>a</sup> Institut Géographique National, Laboratoire COGIT, 2 Avenue Pasteur, 94160 Saint-Mandé, France – (mickael.brasebin, benedict.e.bucher, charlotte.hoarau)@ign.fr

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## ABSTRACT:

This article presents a visual variable proposed to help users navigate in a virtual 3D world. This overlay is presented as a disc composed of independent sectors. Each sector conveys information about aggregated data carried from points of interest (POIs). The different parameters of the sectors express different information in a 3D view: the angle the direction of POIs' group, the color value the density of POIs in this direction and the width of the border their density. This information is quantified the POIs configuration and is updated with users' navigation.

## 1. INTRODUCTION

Most 3D viewers fail to propose local and global understandable information at the same time. In a pedestrian view, a user can see accurately his position but no information concerning his neighbourhood (for instance, areas of interest) unless the user moves. This movement can cause a loss of position and reloading of visualised data. In this paper we present how we extended an initial proposal designed for ubiquitous mapping to propose a solution to facilitate a global apprehension of space during the navigation in a 3D local view.

## 2. GLOBAL APPROACH

### 2.1 Related works

In ubiquitous mapping user scenarios, the user needs to perform various tasks for which levels of details are different (Reichenbacher 2004). Small size of the screens lead to visibility issues when trying to see at the same time focused and contextual information. Proposals exist to solve this issue for instance by distorting the map (Harrie et al 2002) (Yamamoto et al 2009) or by adding visual clues about contextual information on a local view like in 'Framy' (Paolino et al 2007). In 'Framy', borders are added to a 2D mobile map: color saturation of the borders indicates whether there is a high density of points of interest (POI) in the direction of the border. For instance, a dark-red upper right border means that there are a lot of restaurants in the upper right neighbourhood. The border may be divided into several angular parts and the color saturation is calculated with an aggregation function processing the POIs layer.

More recently, (Baldauf et al. 2009) introduced the concept of ambient tag cloud to enhance user awareness about relevant points of interest in his neighbourhood.

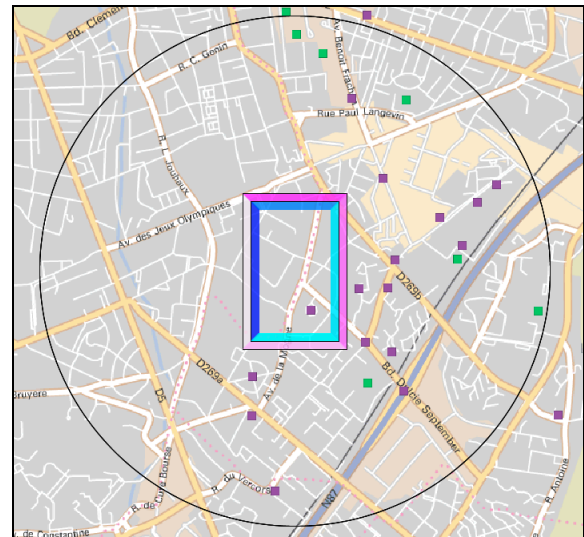


Figure 1. Framy visualisation: color saturation of each border represents the density of a POI layer

### 2.2 Proposal

Our proposition aims at improving different aspects of Framy, in particular to better fit with a 3D world. This proposition has two main components:

- A 3D visual clue representing aggregated information about a distribution of points of interest in the neighbourhood of a user position. These clues cannot be colored borders as in a 2D map because the top border represents the sky. The visual clue proposed in our approach consist in a disc displayed 'visually in front of' the user browsing the local view.
- An aggregation function that calculates ego-centered and synthetic information about the distribution of POIs around a user position. It calculates an angular division of the neighbourhood relevant to the POI distribution –whereas it was arbitrary in Framy–.

\* Corresponding author

### 3. FOCUS ON OUR PROPOSAL

#### 3.1 A 3D graphical clue to represent POIs distribution of a neighbourhood

Visual clues about contextual information are displayed on a disk represented in front of the user position.

We propose to combine two different visual variables in order to discern two different pieces of information (distance and density in our example). The color value is used to indicate the density of POIs and the width of the border to indicate the distance to the nearest POI in the corresponding direction.

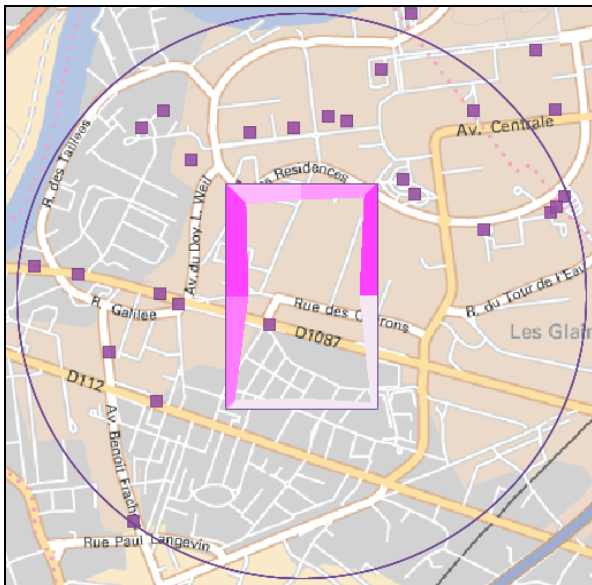


Figure 2. Combining color and width of the clues

Others visual variables have been combined with the color value: the transparency and a black contour. Two solutions have been implemented in a 2D environment: one with four portions and the other with height portions.

Tests have focused on the efficiency of double visual impact and the intuitiveness of the semiotic:

- The transparency has been ruled out because it disturbs the comprehension of the color value.
- The black contour has been eliminated because it is misinterpreted as a barrier by many users.
- The width of the border has been selected because of its efficient visual impact.

Tests have two main consequences: the highlighted necessity of considering the POIs' distribution to decide for the angular division of space and the geometric transformation of the clues to a 3D disk, with a fixed maximal radius, which is a more suitable shape to represent angular information in a 3D environment.

#### 3.2 An ego-centered aggregation function

In pedestrian navigation, angles of interest for decision making are set by the possible streets to walk. In virtual navigation however, we consider that users are not constrained to walk on streets but can fly up the buildings. We aim at describing his neighbourhood in terms of relevant directions without navigation restrictions on these directions.

A specific aggregation function has been designed to calculate relevance score, specific to angular divisions and favouring clusters (a direction is more interesting if it has two close POIs than if it has two distant POIs). Such a function has been implemented through an agglomerative hierarchical clustering. Specific merging rules are necessary firstly aiming at limiting the angular spread of a cluster around the user position secondly aiming at avoiding angular overlay of clusters. Other methods have been tested to adapt to specific distributions of POIs. In the case where the distribution is rather homogeneous, we propose to use another layer of POIs, like remarkable landmark (Eiffel tower, Montmartre ...). This layer is used to calculate angular divisions: a division is associated to each site and its angular width is inversely proportional to the distance of the site from the user position. After doing this, too small divisions are merged. Then for each division an aggregation function of POIs in this division is calculated.

$$\alpha = \theta * (d1 \div (d1 + d2))$$

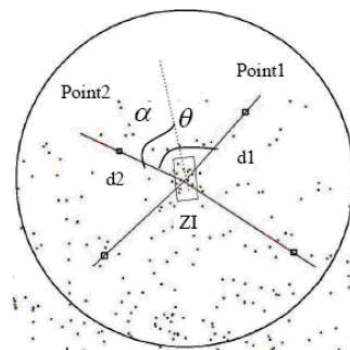
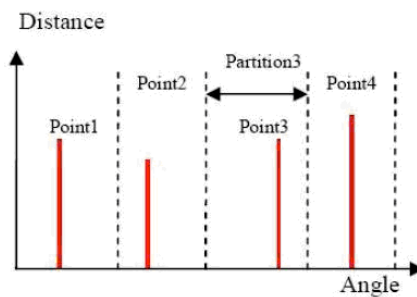


Figure 3. Angular division from a set of POIs

### 4. RESULTS

Our implementation contains two main modules: a 3D web Client for the visualisation and a 2D spatial analysis module to process POIs layers in the server.

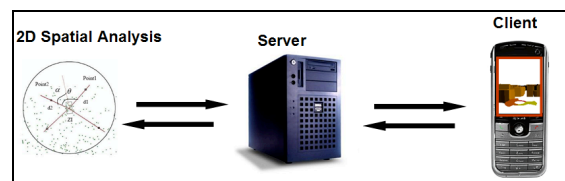


Figure 4. Architecture of the proposed solution

All parts of the architecture are implemented on the GIS platform Geoxygene developed at the COGIT Lab (Bucher et al 2009). GeOxygene is open-source and based on ISO/OGC specifications to describe features and geometries. It contains spatial analysis libraries and a specific 3D module to display and manage 3D data (Brasebin 2009).

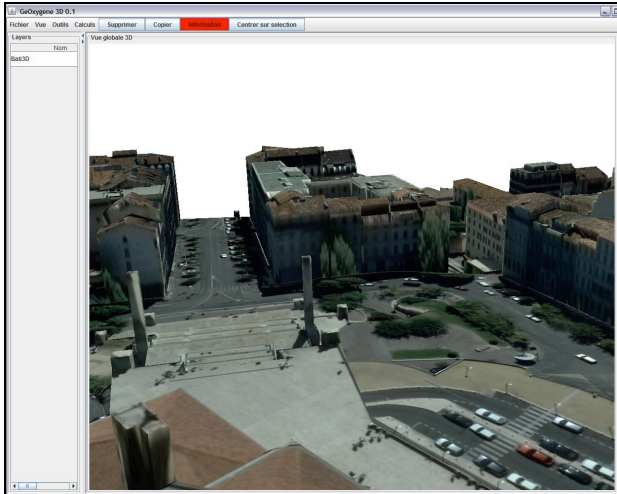


Figure 5. Bati3D database on Marseilles

POIs layers used in our work are religious places, museums and public parks from IGN database and IGN BATI-3D® dataset are used to represent buildings in 3D. These textured buildings are available in CityGML or 3DS format.

Figure 6 and Figure 7 show typical results of our approach. The visual variables convey three different pieces of information:

- The angle of the sector: direction of a group of POIs calculated using the aggregation function,
- The color value: density of POIs in this angular division,
- The width of the disk portion: proximity of the nearest POI in this angular division.

The disk is updated in accordance with the position of the camera.

In order to be more interactive, sectors are independently clickable to get the number of POIs in a direction or to move directly to the nearest POI in this direction.

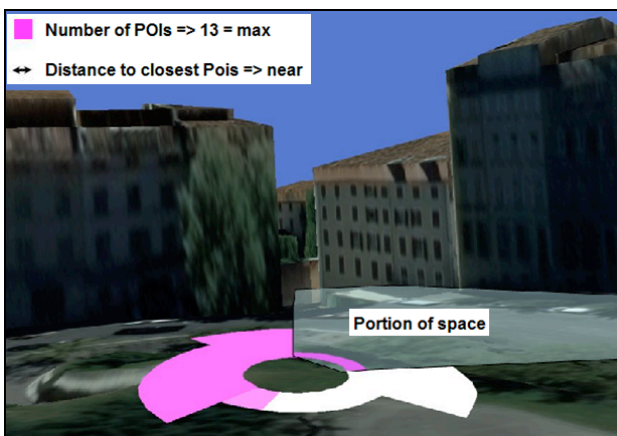


Figure 6. Interpretation of the visual variable

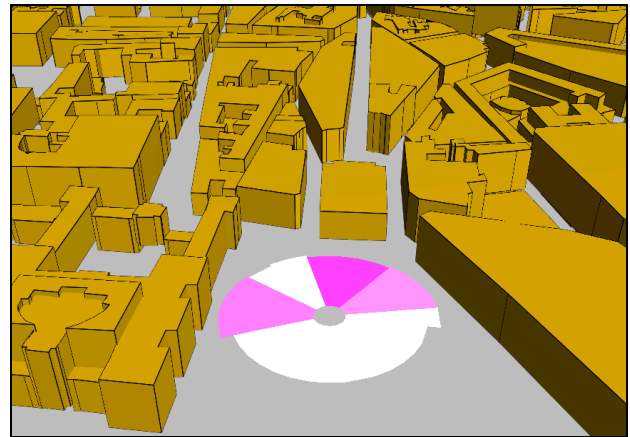


Figure 7. The visual variable in a non photo-realistic world

Figure 8 presents different kinds of POIs positions with their influence on the visual variable, observed from above. POIs are classified in 4 groups. The sectors of this figure are only limited to directions where POIs are. That forms an incomplete disc.

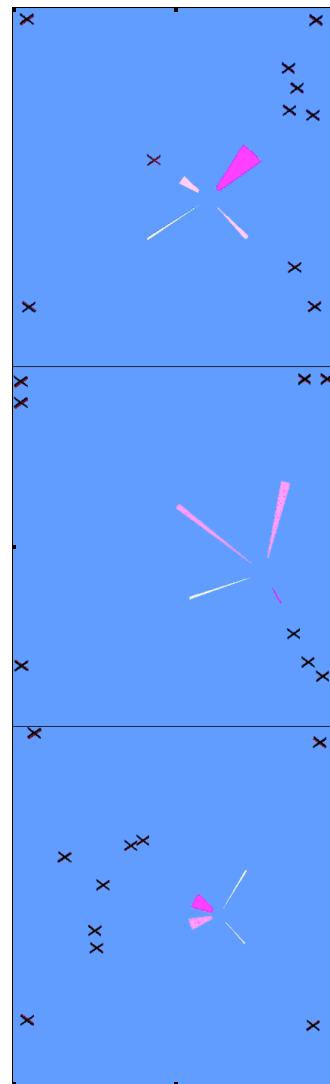


Figure 8. Different configurations of POIs positions and visual variable updates

## 5. CONCLUSION AND PROSPECTS

We have presented an application, which simplifies the navigation of a 3D world by providing some awareness of contextual information beyond the local view. A visual clue containing 3 pieces of information is used to inform the user about the distribution of POIs around his position.

So far, only the graphical variables were validated by user tests but not the entire application. Further work should include more user tests in real conditions with a mobile device.

Application domains for this proposal are not limited to tourism. It also has potential applications in crisis management; in that case, POIs can be vulnerable buildings, injured people or other rescuers patrolling in the neighbourhood.

Among future improvements to this proposal, one concerns the aggregation function: to compute distance on a network or according to accessibility to better fit terrain reality.

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