Ego-city

Automatic textual description of urban ambiences' factors

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Abstract. *The dual experience of the city provided by our connected devices can be used to create an alternative representation of the city. This paper presents a method to automatically translate the physical parameters, from a morphological analysis of the space surrounding the user along a path, into a textual description. As these physical parameters are those perceived by the pedestrian, this description can be used to provide a navigation system based on ambiences' factors. The methodology and a case study of this approach are presented showing a promising and innovative wayfinding solution.*

Keywords: space perception, urban ambiences, user centered, textual translation, path description

Introduction

Dual experience of the city

Our everyday experience in the city is constantly shaped by our relation between living beings and urban environments. This experience is now more than ever augmented by digital technologies, such as mobile devices, that provide an ubiquitous connection to a virtual world. To wit, mobile technologies are leading to new means to interact, analyse and even create the urban environment (Bilandzic and Foth, 2012).

Geolocalisation and GPS-based pedestrian navigation systems are handy solutions for experiencing familiar and unfamiliar urban environments. They allow us to get access to real-time travel data of multimodal transportation systems, and therefore to efficiently manage our itineraries through the city, to obtain collaborative tourism information, location of urban services and real-time information about nearby cultural events, and to share photos, texts, videos linked to specific positions. However, wayfinding algorithms, core features of these systems, are often based on street network analysis and therefore describe a path using turn-by-turn directions. They rarely take into account the elevation of the terrain, the three-dimensionality of the urban morphology, the effects of the climate components on the urban experience influencing wayfinding. Some research have investigated new means for improving the wayfinding experience by focusing on recognisable landmarks, visibility modelling and vegetation canopy, introducing a user-centric approach, specifically for impaired persons, or using crowdsourcing solutions in order to define and suggest optimised paths according to a qualitative evaluation (Quercia, Schifanella, and Aiello, 2014; Rodriguez-Sanchez et al., 2014; Bartie, 2011; Raubal and Winter 2002; Rehrl, Häusler, and Leitinger, 2010; Millonig and Schechtner, 2006).

This paper proposes a first step towards an ambience based wayfinding algorithm by transposing the duality between egocentric city - connected city to alternative representations based on:

- the experienced urban environment centered on the pedestrian position;
- the anticipated urban environment describing attributes and geometries of the facades surrounding the pedestrian;
- the egocentric perception shared with other people.

The textual representation of the space

Starting from these forms of representation, the research aims at exploring and suggesting a textual description of the user path taking into account the characteristics of the actual morphology of the urban environment. This description could be used to improve wayfinding experience by using perceivable elements in the path.

Through movement, it is possible to provide an effective description of the urban environments (Cullen 1961), hence, we decided to analyse each significant variation on a given pedestrian itinerary taking into account the properties of space around the pedestrian, with a particular attention to the shift between two contiguous spaces crossed by him/her. These transitions along the path and between spaces are then automatically translated in a qualitative textual format that goes beyond the traditional, and not always clear, directional and metric information provided by the traditional navigation devices (Haque, Kulik, and Klippel, 2006). In other words, to translate the numerical values obtained from our simulations in a more comprehensible language based on the anticipated spatial perception.

The automatically generated text, describes the itinerary by taking into account several parameters perceived (here and now), or that will be perceived (there), by the pedestrian (i.e. sun, slope, direction, degree of openness). Our method can be used not only to describe *a priori* the path that a pedestrian will follow (as a traditional navigation system), but also to describe the same path (and why not share it!) *a posteriori*, as it is described in the following sections.

Methodology

Pre-processing

The needed pre-processing operations have been done using the Geospatial Data Abstraction Library GDAL/OGR. Specifically the clipping of the Digital Elevation Model (DEM) to the given region of interest has been obtained through 'gdalwarp' and the clipping of the buildings' vector-based layer through 'ogr2ogr – clipsrc'. To generate 3D vector contour files from the input raster DEM, the 'gdal_contour' command line has been used and the resulting polylines have been simplified using 'ogr2ogr – simplify'. Then, the contour polylines have been imported in SketchUp and, thanks to native 'Sandbox From Contours', they have been converted into a

Terrain Model (Triangulated Irregular Network). Lastly, building objects have been draped on this Terrain model and extruded to the elevation values given as attributes.

Isovist 3D as a common basis

The tool of the Isovist 3D, defined as the volume of space visible from a given vantage point in every direction (Benedikt, 1979), has been implanted in SketchUp and used to carry out all the geoprocessing operations, whether to assess the amount of sky vault visible from each pedestrian position, or to identify corresponding surrounding facades (potentially able to be enlightened by direct solar irradiation).

Position indicators

The studied path is subdivided in a set of equidistant punctual positions each one qualified by two different indicators: the slope of the terrain and the angular measurement of the direction (azimut) of the user.

Surroundings configuration indicators

The surrounding configuration indicators provide the contribution of surrounding masks (depending on the urban fabric). Four different indicators are part of this group: the evaluation of the direct sunlight exposure (sunny-shaded assessment), the measure of the lighting-level on the surrounding facades (as a ratio between the number of sunny facades and the number of all viewable facades - assuming a field of view of 124 ° in the direction of the user, and the maximum distance range of 50 meters) the degree of space's openness obtained from the Sky View Factor (SVF), and the ratio of narrowing-widening of the urban fabric (through the difference of SVF values between two consecutive positions).

A perceptual semantic language

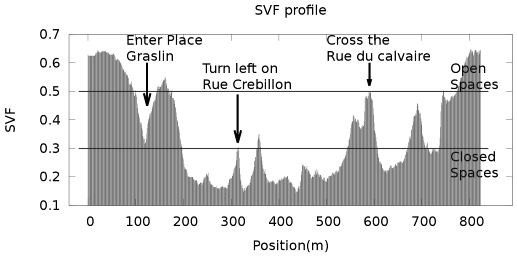

Figure 1. SVF values along the path. Values below the defined threshold of 0.3 are comparable to closed spaces whereas values above 0.5 correspond to open spaces.

We defined various threshold values for the aforementioned quantitative indicators in order to provide different qualitative categories for a series of intervals. The threshold values have been defined according to urban rules (e.g. accessibility design guidelines). Thus, a specific lexicon has been provided in order to translate the numerical values in a more natural and clear information. An example is provided in the diagram Fig. 1, it corresponds to a systematic assessment of SVF along the position indicators of the given path. As one can notice, two different thresholds have been emphasised: SVF lower than 0.3 is empirically equivalent to a closed space, whereas SVF greater than 0.5 is empirically equivalent to an open space.

Case study

We tested our method along an 800 meters long path located in the nineteenth-century center Nantes (Fig. 2). The path is characterised by a varied morphology (various slopes, change of direction and openness levels) that helps us to test the effectiveness of the proposed approach. The starting point is located in Cours Cambronne and the destination in Place Bretagne. In this first exploration we did not consider the vegetation, due to the fact that the virtual model used does not contain this information, and the path was chosen accordingly.

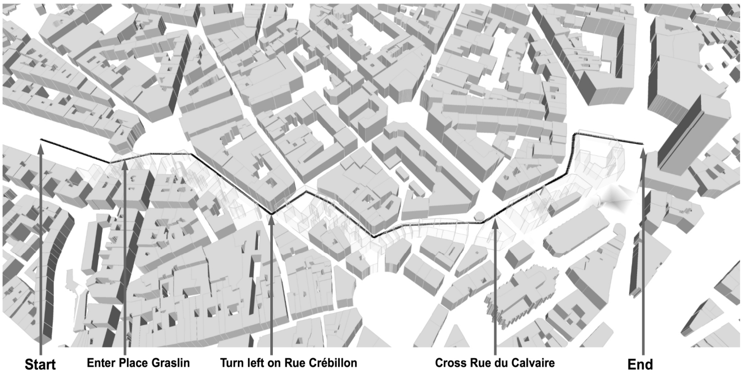

Figure 2. Path in Nantes (black path), the starting point in Cours Cambronne is on the left, and the destination in Place Bretagne is on the right.

In Fig. 3 (right) is presented an extract of the textual description of the path. It corresponds to the arriving at Place Graslin Fig. 3 (left).

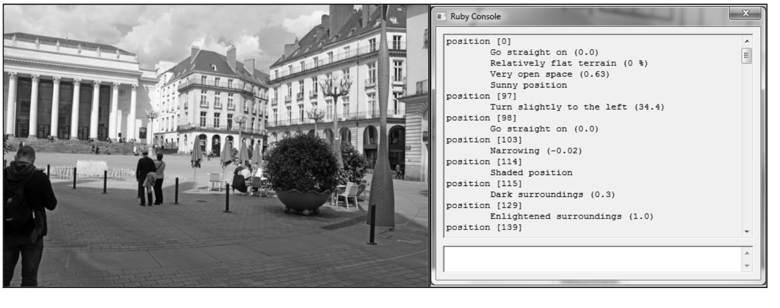

Figure 3. A sample of the path, arriving at Place Graslin with the textual description, on the right.

Discussion

We presented in our study a method to provide qualitative textual translation of the numerical values obtained from spatial-morphological simulations of the urban environment based on an egocentric position. Through this method, we can obtain some clues to describe the experienced urban ambiences on a defined path. We conducted our study using standard IGN dataset that are part of the French Large Scale Reference system. The wide availability of this kind of input dataset in the whole national (and even European) territory makes corresponding method easily replicable.

Some limitations can be highlighted in our study that will be the object of further investigation. The first limit regards the virtual model used in the analysis. The dataset used in our simulations provide only the information about the elevation of the terrain and the volume of the buildings. This data does not allow us to take into account the effects of the facades or the materials in light propagation. Moreover, the location and representation of features affecting the visual perception from a pedestrian's point of view, such as urban furniture and vegetation, are still difficult to obtain and they need to be manually modelled, as well as dynamic components such as other pedestrians or vehicles. Lastly, another simplification that we assume in our study regards the sky's model, approximated to a clear sky, and the effect of the climatic components.

Conclusion

In this first exploration, we used a simplified urban digital model, further investigation will be conducted taking into account other important elements of the urban environment such as the vegetation, the urban furniture, and the detailed characteristics of the facades such as materials, colours, and relief in order to refine and enrich our textual description. The environmental components, thus far limited to sunlight, are other relevant aspects that will further expand the usages of our method (e.g. to describe the itinerary during a rainstorm or during heat wave phenomena).

Beyond these basic enhancements, we may integrate our method in a proper mobile application in order to evaluate, with users, its potentialities and limitations, besides a traditional turn-by-turn navigation system. By analysing all possible paths into the city, it will be then possible to provide wayfinding algorithm really based on ambiences' factors to improve traditional navigation systems.

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