

Modelling Street Safety in an Urban Environment

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1. Introduction

In the context of public transportation, “*the provision of a permeable public space contributes to an inclusive journey environment*” (Azmin-Fouladi 2007). In fact, over 11% of the public would travel more if they felt safer on the transport system (Department for Transport, 2004, cited in Azmin-Fouladi 2007). However, when planning or modelling an urban environment, architectural vision and planning principles often take precedence over the way buildings and urban features make people feel. Questions such as: *does the built environment provide a feeling of safety and security? how do such feelings contribute to an accessible transportation system? which urban features determine these perceptions?* are not generally considered.

Our research aims to redress this imbalance by providing planners and local authorities with the means to identify potential barriers to the permeability of public space. It is argued that the removal of negatively-impacting features and the resulting increase in perception of safety will increase the use of public transportation. This paper presents work in progress of which there will be two key outputs: the generation of an Index of Permeability (IoP) for the urban environment and the operationalisation of this through the application of an Isovist.

2. Background

This project forms part of AUNT-SUE (Accessibility and User needs in Transport for Sustainable Urban Environments). AUNT-SUE is collaboration between London Metropolitan University, University College London and Loughborough University along with partners in the public and private realm with the aim to develop and pilot policies, methods and tools to support accessible transport planning and inclusive transport. The ultimate aim of this collaboration is to develop a tool kit that will help support decision makers, establish benchmarks and incorporate inclusion into policies. (AUNT-SUE, 2007). Three key aspects are considered in the context of an inclusive journey environment – quality, safety and physical accessibility. Work carried out by Imam (2006 cited in Azmin-Fouladi, 2007) focuses on accessibility. The research presented here thus relates to quality and safety of the journey.

Although “identifying perceptual variables including elements that contribute to the fear of crime, sense of place/identify/ownership, community cohesion and place attachment requires wide-scale public consultation” (Azmin-Fouladi, 2007), this must be carried out within the context of a pre-determined range of urban elements, to focus the research in the required direction. The first step of the research thus involved an extensive review of literature to identify factors influencing a person’s perception of urban space. These included both those contributing to a positive feeling about an area, such as a high number of ground floor windows being used for commercial purposes, and negative factors such as evidence of vandalism or graffiti. Additional considerations include the number of non-ground floor windows and their use, street furniture (lights, rubbish bins, bollards), the presence or absence of CCTV, buildings and garden upkeep, and the heights of boundaries such as walls, fences.

Figure 1 and Figure 2 show examples of a negatively perceived area, having high boundaries and no overlooking windows. Figure 3 illustrates an area having wide-open spaces, low walls and a well-kept

frontage, contributing to a positive feeling about the space. (All photos are taken in our current test area of Somerstown, London).



Figure 1 - A road with a high, long boundary one side and a building with very few windows looking down onto it. (Azmin-Fouladi 2007)



Figure 2 - A shop front with covered windows. Poor natural surveillance of the surrounding area is hypothesized as a contributing negative factor to people’s perceptions of their environment (Azmin-Fouladi 2007)



Figure 20 - Some positive urban features such as well-kept frontage and promenades (Azmin-Fouladi 2007)

2. Creating an Index of Permeability (IoP)

2.1. Identifying and Capturing Relevant Features

Our methodology first breaks down the urban landscape into its constituent elements, as identified by the first stage of this research including walls, fences, litter, graffiti and natural surveillance. Ordnance Survey MasterMap™ provides topographic mapping, which was then associated with local authority data for details of street furniture. This data is supplemented by data recorded in the field for the other urban elements. All data is held in a spatial database and each element type is assigned a weighting depending on its perceived importance to the permeability of an urban space.

2.2. Creating the Isovists

An isovist is a “region of space which can be described by the shapes obtained from people’s vision if they rotate through 360 degrees” (Benedikt 1979, cited in Davies *et al.* 2006). They are thus particularly appropriate to model the space that can be seen from a particular point (a perspective point), and hence to identify the specific urban elements that are visible to the pedestrian.

In the case of the IoP, the boundary of the isovist is formed by tracing the boundary of the buildings that are visible from the selected point. This boundary is identified through the generation of a series of rays, which are then intersected with the building polygons forming part of the Ordnance Survey MasterMap™ Layer. Although traditionally isovists delineate the space visible through 360 degrees (Figure 4a), it is also possible to create an isovist focussed in one particular direction of travel (Figure 4b).



(a)

(b)

Figure 4 (a) - Single 360 Degree Isovist (b) Single 200 Degree Isovist (created using OS MasterMap 2007 Crown Copyright)

2.3. Calculating the Index of Permeability for a single Perspective Point

The isovists are used to identify the urban elements that can be perceived by a pedestrian standing at a particular point, and the weightings for each element summed to create the Index of Permeability for that point. A high value implies good permeability. Where appropriate, the horizontal and vertical dimensions of each element are also factored into the calculation (for example, a long high wall generates a lower weighting than a long low wall). A large pavement café rates more highly than a café with no outside space. The Index also takes into account the distances of a particular element from the pedestrian – for example, streetlights further away are assigned a lower weighting than those in the immediate vicinity.

2.4. Creating a Surface of Permeability

To create a Surface of Permeability, a series of perspective points is generated in a grid across the roads and pavements of the test area. Isovists are then created for each of these points, and used to generate an Index value (Figure 5).

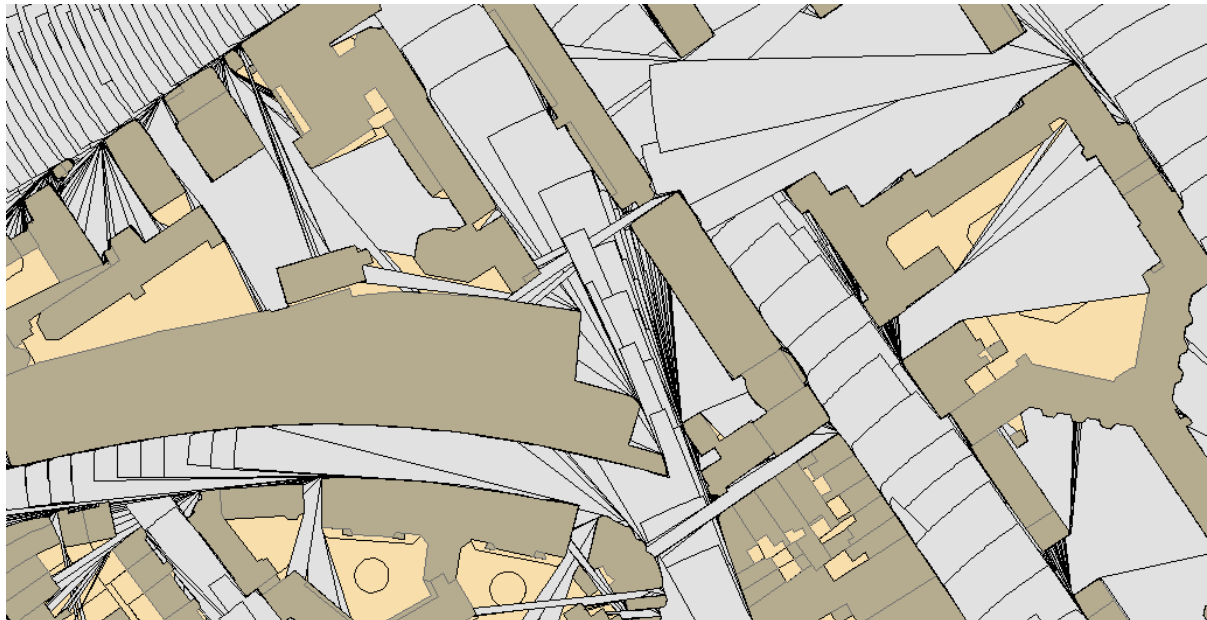


Figure 5 - Multiple Isovists from different Perspective Points on OS MasterMap base data. (Created using OS MasterMap 2007 Crown Copyright)

The Surface of Permeability is then determined by interpolating between the points. Figure 6 shows preliminary results obtained using a 5m grid of perspective points, and then using an inverse distance weighting interpolation over the nearest 5 points. As can be seen, the influence of streetlights (black diamonds) on the resulting surface is positive, whereas graffiti points (black triangles) contribute towards a more negative Index of Permeability.

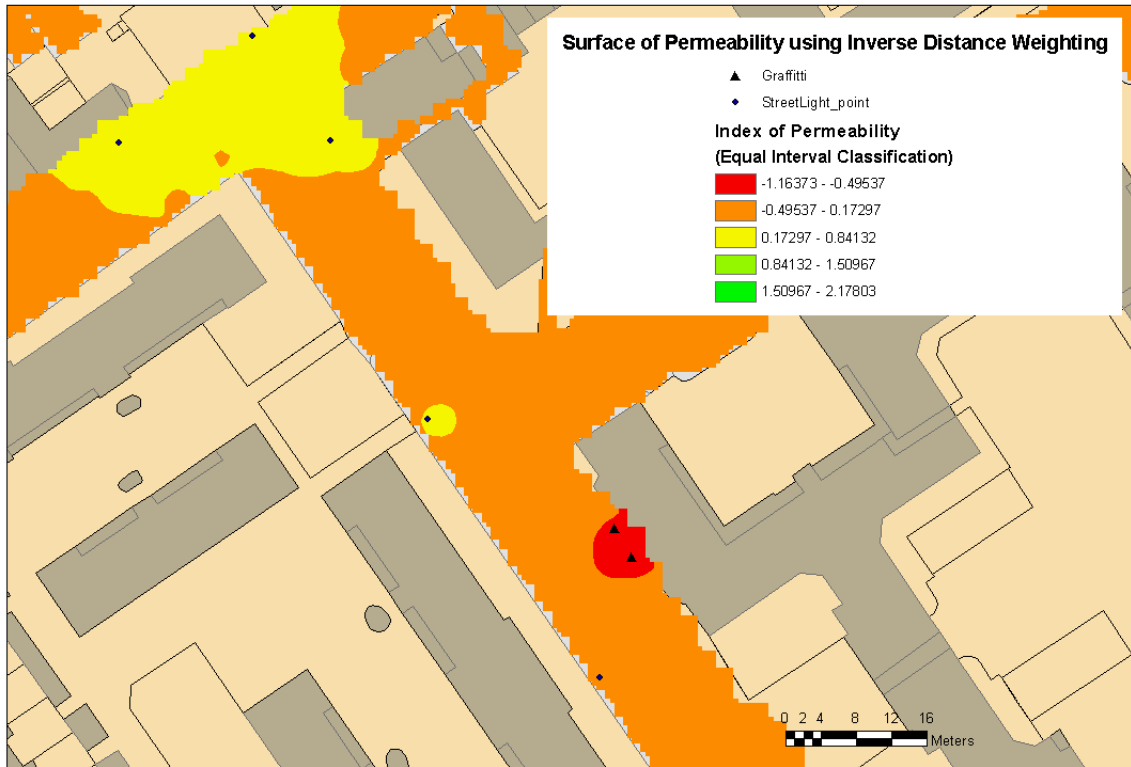


Figure 6 – IDW Surface of Permeability for part of Somerstown (Created using OS MasterMap 2007 Crown Copyright)

It is also possible to model a route or journey a pedestrian might take, for example from their house to a bus stop. Isovists can be placed at regular intervals along this route to uncover areas causing concern to the individual, and investigate the permeability of a particular route.

4. Next Steps

Modelling the effects of urban features on peoples' perceptions is a complex and potentially inaccurate and subjective task. Our implementation of the Index of Permeability innovates in its use of a commonly available desktop GIS software package (ArcGIS), providing a one-click tool for visualising perceptual data with a spatial dimension. This offers advantages over existing approaches such as *PERS* (Pedestrian Environmental Review Software), particularly in the range of urban elements. The creation of isovists entirely within the GIS contrasts with the method proposed by Rana (2005), which makes use of externally created Binary Space Partition trees to index the data.

The method used to calculate the IoP is also flexible, allowing urban elements to be added or removed and their weightings to be increased or decreased in importance. This in turn provides the ability to create a localised IoP, taking into account available datasets and local concerns. The incorporation of Isovists is of particular benefit as it provides the opportunity to model a field of vision with considerably more accuracy than a simple GIS buffer.

As mentioned, the urban elements incorporated into the Index generation process have been derived through literature review, to form the basis of a more focussed discussion with local communities. Thus, the next step in our research involves testing the method and resulting Permeability Maps with the general public by means of focus group meetings. This will allow us to confirm or refute the importance of the selected features and the accuracy of the surfaces obtained.

In the longer term, this method will form part of an AUNT-SUE toolkit to model the whole journey environment. Three potential applications can be identified in this context. Firstly, the method can be

used to locate problem areas. The generation of IoP surfaces allows the hotspots (representing poorly perceived areas) and focus on these areas to see which particular features are causing the problems. It could also form the basis of a more complicated Decision Support tool whereby modelled objects could be actively placed or removed from areas, and the effects could then be compared to allow the optimum decision to be made.

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7. Biography

Claire Ellul has recently completed a PhD on Topological Relationships between 3D Objects, and is currently working as a Post-Doctoral researcher at London Metropolitan University and University College London. Prior to commencing her PhD, she spent 10 years working as a GIS consultant and software engineer.

Ben Calnan is currently a researcher at the Cities Institute at London Metropolitan University where he is working on urban perception modelling for the AUNT-SUE consortium (Accessibility and User Needs in Transport for Sustainable Urban Environments). Before this he completed a Masters in GIS at University College London in 2005.