Towards a Mobile Tourist Information System: Identifying Zones of Information Relevance

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INTRODUCTION

A gps-enabled GIS acting as a mobile traveller information system is described in Møller-Jensen, 2005. In general terms the objective of the system is to present attribute information of the surroundings to a traveller in motion. It is done automatically and in accordance with the speed and direction taken relative to objects represented in the GIS. The system specification is based on the assumption that the user does not handle the system interactively by clicking on the map (e.g. because he or she is engaged in driving) and furthermore that a stream of relevant information about the surroundings – adapting to the movements of the user – should enhance the travel experience by providing interesting knowledge within a user-specified domain.

The attribute presentation is in this situation subjected to time and space constraints which are a function of the time necessary to present the information compared to the speed of movement and the length of the stretch of road where the information is relevant. Moreover, several objects may be eligible for presentation within the same segment of the travel path. The system specification includes strategies for handling these situations by possibly excluding information or by data generalization on the attribute level controlled by an imbedded ontology. One of the general benefits of the system is its potential adaptation to different languages and knowledge type preferences which may help to provide a better service to tourists with different cultural backgrounds.

At present, the main application of small computers with GIS/GPS capabilities is within mobile navigation. Few papers have described efforts to further utilize the potential ability of the mobile GIS to provide elaborate attribute information about any object that a user interacts with while moving around. Frank et. al. (2004) describes a transformation of the traditional GIS into a Location Based Service by providing mobility, distributiveness and egocentric awareness. The general problem of selecting the physical object for which to receive information in a given spatial context (equal to the human action of pointing) has been examined by Egenhofer (2003). Current solutions are still mostly of an experimental nature and assume availability of special equipment such as directions sensors or advanced pointing devices. Nevertheless, some systems restricted to confined locations such as cultural or entertainment sites have been implemented in practice. IST (2004) describes how GPS-enabled city guides are already used in the travel industry and argues that especially the “culture and history travel market” will be able to benefit from a strategy towards location-sensitive presentation of object information.

The current study focuses on two interrelated issues that need to be addressed as part of an effort to implement a successful information system. The first issue is the selection and categorization of objects for presentation and the second is the definition of the spatial scope of the information relevance for each object (termed the relevance segment). The overall goal is to initiate the presentation when the traveller reaches an appropriate position relative to the object.

This study is mainly related to movements in free air – other considerations may be relevant when focusing on mobile information systems for use inside museums. An important consideration is how to potentially support ’spatial narratives’ by providing guidance that allows the user to visit objects in a desirable sequence e.g. for better understanding of time periods or processes.

OBJECT SELECTION AND INFORMATION RELEVANCE

Is it evident that a distinction exists between providing knowledge concerning – on the one hand – objects that are expected to attract the attention and curiosity of the traveller due to their visible appearance and – on the other hand – providing new knowledge that will enhance the traveling experience of the user by providing information about objects that would otherwise not be noticed – or at least not be associated with the additional information. It is evident that objects that attract attention due to their appearance may also often have equally interesting ’hidden’ properties. Table 1 provides examples of objects that fall into the two categories.

Object characteristics:	Examples:
Visibly interesting (due to appearance)	monuments, churches, towers, castles, vegetation species with distinctive features,
Invisibly interesting (due to history connected with object)	- buildings previously occupied by a famous person, - places of historic events, e.g. battlefields, squares, - historic locations with no landmarks: ’this is where the old gate of the city was located’ - other special points, e.g. the geometric center of gravity of a municipality or country - properties of an urban area (e.g. building period)

Table 1: Examples of surrounding objects with different characteristics concerning attraction.

The first situation can be handled both by interactive systems that require the traveller to request the information and by automatic systems that react to the speed and location of the traveller. The second situation, however, can only be handled by systems that automatically present the information at the relevant speed and location.

It is not unreasonable to assume that a mobile information system focusing on the latter functionality would be able to provide benefits to travellers that would not have been possible without the GPS/mobile-GIS integration. It could ’open up a new world’ of spatially-related information within specific domains specified by the traveller and thereby provide new insight and interests in objects and areas that would otherwise have been perceived as uninteresting. As exemplified in table 1, some of the information that falls in this category may not be connected to a physical object that has any specific relation to the information. It is left to the imagination of the traveller to connect the information to the actual surroundings in such cases.

Are there reasons to treat these two categories of objects differently when it comes to identifying the best place to present the information? Does it play a role whether the object is actually visible from the visitor’s position or not? These two questions are discussed below.

RELEVANCE ZONES - VISIBILITY OR PROXIMITY

A major consideration is how to define the zones of information relevance for each object represented in the system. In case of road-based traveling this concept refers to specific stretches of road – in the following termed R-segments. Attribute information about an object could be presented anywhere along its corresponding R-segment(s). See also figure 1.

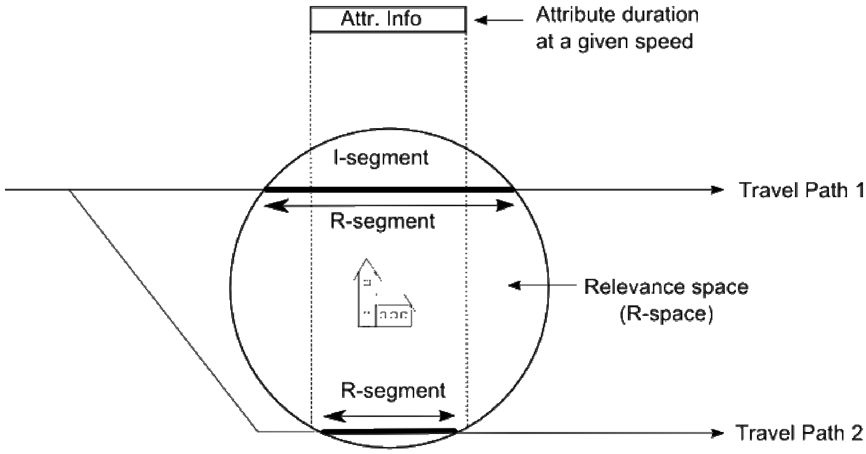

Figure 1: Locations of R-segments and I-segment illustrated for an object surrounded by two roads. R-segments indicate the stretches of road where information presentation is relevant. The I-segment is related to the speed of a specific traveller and indicates the road travelled during the presentation.

The actual location for the presentation (termed the I-segment) depends on the speed of travel and whether the duration of the presentation relative to the length of the R-segment allows for it. If aiming for an automatic procedure, R-segments may be identified using either proximity analysis, visibility analysis or both. Visibility analysis determines the stretches of road from which the object is visible while proximity analysis identifies stretches of road within a certain Euclidean distance. The two types of analyses are discussed further below.

Table 2 illustrates a relevant distinction between a situation where the traveller is able to see an object and a situation where this is not the case either because the line of sight is blocked or because there is no physical land mark to see as discussed above. Visibility analysis is appropriate in all cases of visible objects while proximity analysis is used to handle the situation where the traveller is close to the object without being able to see it.

Object characteristics:	Visible object	Invisible object
Visibly interesting (due to appearance)	object catches attention of traveller and creates curiosity that is satisfied by attribute information (object visibility analysis is relevant)	line of sight is blocked from the current traveller location: system makes traveller aware of object presence and provides attribute information (proximity analysis is relevant)
Invisibly interesting (due to history connected with object)	system makes traveller aware that a nearby common object is of interest by providing attribute information (object visibility analysis is relevant)	line of sight is blocked or there is no physical land mark (proximity analysis is relevant)

Table 2: Object types, visibility and relevant method for computing R-segments.

A given (visible) object may be visible from some road segments and close to -but invisible from- other road segments. Since the system must handle any user location (and travel speed), it follows that it is necessary to perform both visibility analysis and proximity analysis for all objects. An exception may be the objects that do not have a physical land mark and only appear as GIS points that mark a historic event. In this case one may either rely on proximity analysis or perform the visibility analysis by introducing an 'imaginary' physical object placed at the specific point and of a suitable size and shape.

VISIBILITY ANALYSIS

The basic task of identifying stretches of road that are near to a given object is a fairly straight-forward GIS process: Standard buffer zones may be applied to extract the road segments within a specific Euclidean distance. The distance chosen must reflect the physical appearance of the object, the type and significance of the information and the density of objects within the area. The current presentation, however, focuses primarily on various aspects of the visibility analysis based on the experiences from a case study.

The aim of the study is to analyze whether the visibility-based R-segments can be identified automatically using raster-gis methods. The first step is to establish a digital surface model of the area. It is recognized that a digital surface model based on laser scanning may be appropriate for these tasks but none were available for the area at the time of the study. A digital terrain model has been used instead. A number of physical objects of varying height and size have been identified in the area. The areas from which each object is visible have been calculated using the function 'viewshed' in ArcMap (ESRI,2006). The visibility areas are subsequently overlayed on the road map to provide the visibility boundaries. Figure 2 shows the results of a sub region of the study area.

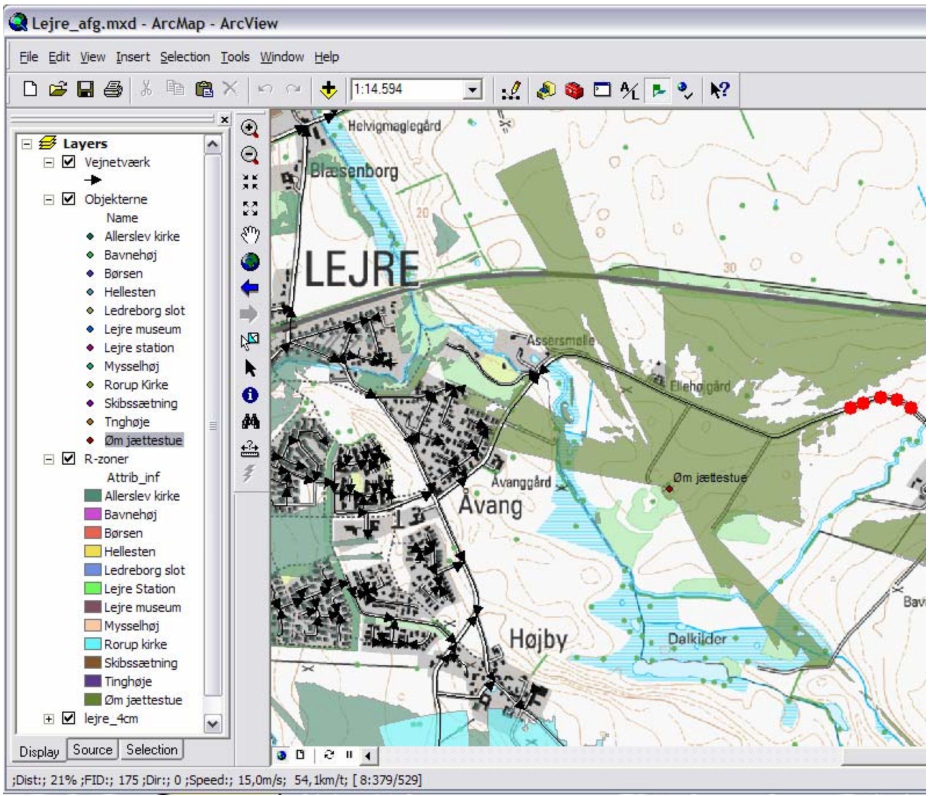

Figure 2: The green areas 'radiating' from the object "Øm jættestue" (ancient passage grave) in the middle indicate areas from which the object is visible.

RESULTS

The results indicate a number of issues to be addressed:

1. The visibility areas take very irregular shapes due to the many small hills in the area, see figure 2. As a result, the R-segments identified by the overlay process are split into several parts with gaps in between. In some cases, these gaps are small relative to the total length of the R-segments, and should probably be ignored during the process of identifying the place to start presentation. A robust algorithm for eliminating gaps within this context is required.

2. As it is the case in fig 1, an object may be visible from several roads. A large R-segment on one road would allow for a longer information which would not 'fit' onto another road with a shorter R-segment given the same travel speed. In this case the traveller must either move slower or the length of the information must be adapted to the shorter R-segment in the design phase.

3. When is the appropriate time to actually present the information? The current system works under the assumption that the midpoint of the R-segment is the best time to place the I-segment. Field experiments have shown that this is not necessarily the case. In many cases, it seems more in accordance with user preferences to present the information when the object is first spotted, i.e. at one

of the extreme ends of the R-segment. A process involving manual assessment would probably identify other specific points within the R-segments to be the best anchor points based on local conditions concerning road direction, object shape and angle that would be difficult to incorporate into the GIS analysis.

4. Comparing with real life experiences, it is clear that the actual visibility of an object depends on more than the terrain morphology between the observer and the object. Permanent or temporal man-made objects and vegetation play an important role that is difficult to account for through an automatic method. The raster-based visibility analysis would probably provide more suitable results if performed on a laser scanned digital surface model which will be the subject of future research.

5. It is worth comparing the concept of visibly interesting objects for tourist information with the concept of salience of features applied by f.ex. Klippel & Winter (2005) and Nothegger et al. (2004) within the context of automatic identification of landmarks for providing navigation support. One difference is the need for the route description algorithm to find objects on-the-fly that – for some reason - “stand out” relative to their close surroundings, while the objects represented in the tourist information system would be a priori classified as of absolute interest within a specific domain. It may be highly relevant, however, to consider applying the methods for identifying feature salience within the information system context also in order to find objects that will attract the attention of travellers exclusively due to their appearance within the local neighbourhood.

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