# INTERACTIVE NAVIGATION
# THROUGH DISTANCE ADDED VALUED PANORAMIC IMAGES

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**ABSTRACT:**

Most people have problems to understand the scenery of a city using just topographical maps and descriptive city guides. Especially maintaining the route by comparing the current position using the map and to get directions where to go by a written guidance is quite complicated. One possibility to increase the interaction between the map and the user is to use a handheld navigation system, in which a GPS receiver or another kind of locating tool is used to pinpoint the current location of the user in the map display. This approach solves the 'where am I' and 'where to go' questions and even the 'how to get there' problem when supported by a road-database. But the user still has to translate the information projected on the map to the real world and visa versa. This paper addresses a way out of this problem by avoiding the need of map information processing by applying panoramic images as the 'background' layer to display upon certain geometric features, guiding directions, and information labels. The company Cyclomedia provides the panoramic images or so-called Cycloramas. We give some directions how to use terrestrial laseraltimetry to decide which information can be augmented within the Cyclorama and which not because real world features do obstruct it.

## 1. INTRODUCTION

Aerial images are the base component for topographical mapping and for the creation of digital terrain models of the earth surface and the environment build upon. With the introduction of airborne laseraltimetry it is now possible to derive the altitude of the terrain in a more direct approach.

Many examples exist of stunning 3D-fly-throughs and Virtual Reality (VR) environments in which the aerial images are draped on the DTM's. These 'height-added aerial images' can be augmented with abstract, height extruded polygon representations of terrain features as stored in a GIS. This kind of combined GIS/VR systems will help and stimulate the user to explore, identify and analyze the area of interest in a more natural way than topographical maps can offer. A proof of concept of this thought is described in [Verbree, 1999], understood by [MinSun, 2002] and made available within the K2VI system approach [K2VI, 2004]. One of the more exciting new features of K2Vi is real-time shadow analysis. It is now possible to select an object in K2Vi and analyse the shadow it is casting in real-time, see figure 1.

As Kolbe addresses [Kolbe, 2004] one has to support pedestrians in the tasks of orientation and wayfinding with appropriate visualizations of their location, the surrounding, and background information. City plans and guides are intended for this purpose, but it is known that lots of people have problems to understand the scenery of a city by these abstract and descriptive, tools alone.



Figure 1: 3D-GIS/VR Analysis: Real time Shadow

Research is undertaken to solve this problem by creating a kind of virtual environment with the purpose to walk through a realistic model of the city. Some uses the 'height-added aerial images' for this purpose. But there is a main disadvantage in using these aerial images and airborne laseraltimetry derived DTM's within real or virtual environments with this intended purpose in mind. These DTM's are by default 2.5D, which limits the representation of the 3D environment in a natural way. The city model obtained gives buildings a blurred, vague and formless impression and thus unrealistic when observed from a pedestrian's perspective. Even a high-resolution image with a footprint draped on a high-resolution DTM with a corresponding cell-size will result in a kind of Christo wrappings, as shown in figure 2.

Figure 2: 'Christo Wrapping of Centre of Amsterdam

## 2. CYCLOMEDIA CYCLORAMA PANORAMA'S

In conjunction to the solution of Kolbe we have studied [Anrooij, 1997] the application of panoramic images as a solution for the map information process. A special approach in this solution is the use of the so-called Cyclomedia full-color panoramic images or Cycloramas [Cyclomedia, 2004]. The intention of Cyclomedia is to cover the Netherlands with Cycloramas to support all kinds of geo-information systems and services. In 2004 the Cycloramas of almost 140 out of the near 500 municipalities of the Netherlands are available with a spatial interval of one Cyclorama for each 10 - 20 meters along all public accessible roads in urban areas. Cycloramas are recorded by a very special fisheye lens with a vertical view of 30 degrees below the horizon (figure 3).


Figure 3: Cyclorama in panoramic perspective

To get a more usual representation the Cyclomedia Image Viewer has the option to show the panoramic images as if it was recorded from a central perspective (figure 4).


Figure 4: Cyclorama in panoramic perspective

The recording location of a Cyclorama is known within meter accuracy and the zero-direction of the panorama picture is chosen along the driving direction of the car, which is used as the recording platform (figure 5).


Figure 5: Cyclorama Recording Platform

In fact, the Cyclomedia concept has originated from the land-surveying method for gathering and processing topographic data, called FRANK, as described in [Beers, 1995]. Although the application of panoramic images taken by a fish-eye lens for mapping purposes is clearly demonstrated and confirmed, spin off products like the image viewing and linkage within a GIS environment is shown to be of more economical benefit.

## 3. AUGMENTING INFORMATION WITHIN CYCLORAMA'S

Thanks to its geometrical base and its leveled recording, it is possible to measure within the Cycloramas. But it is also feasible to integrate the Cyclorama with other spatial models, offered by GIS and CAD. One example (figure 6) demonstrates the augmentation of conduit-pipes and cables.
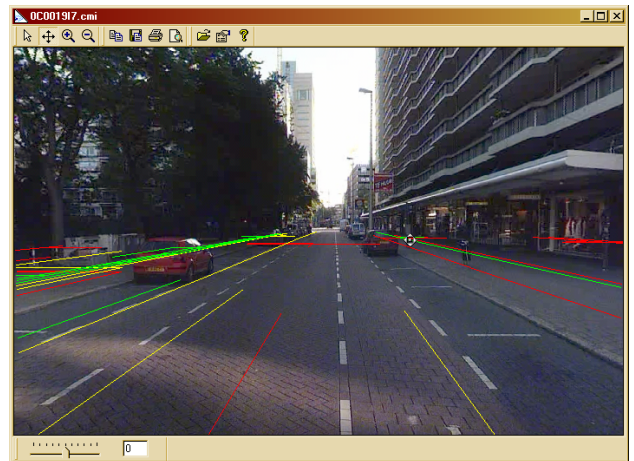

Figure 6: Cyclorama augmented underground mains

Besides this geometric augmentation by the Cyclorama can function as the 'background layer' to display information labels, guiding directions, and position hotspots of other Cycloramas in the neighborhood. Figure 7 shows a GIS supporting Cyclorama's. One can choose to point one or more Cyclorama's to a certain address or to a point indicated within the map. By

this, the user will get a far better impression of the scenery of the part of the city the user is interested in.
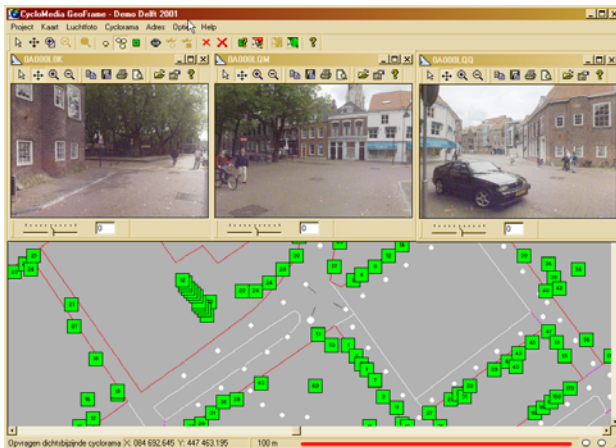

Figure 7: GeoFrame Application focused to centre of attention

In augmenting the Cyclorama with geometric or descriptive information one issue, among a lot of others, has to be solved. Drawing features or labels at places not visible from the current point of view will result in an unrealistic and disturbed picture. This problem arises especially when augmenting the recording positions of other Cyclorama's within the one queried. This option is used in a web-based interactive navigation application, now offered for testing purposes. Figure 8 shows some screenshots.


Figure 8: Interactive Navigation based on Cyclorama's

We have researched how to avoid the mismatch by performing a visibility analysis: the line of sight between the recording position and the point under target is not to be intersected. In this solution [Anrooij, 1997] the intersection is checked within a large scale 2D-geodatabase of the area under study. This approach has its limitation, because the need of a matching representation as given by the 2D-geodatabase and the real world as captured by the Cyclorama. Each spatio-temporal mismatch will result in an error in the visibility analyses and thus in the visualization of feature or label within the Cyclorama. Another topic of his research was how to resolve the question to present direction marks or pinpoints of recording positions while respecting proper cartographic rules within the Cyclorama's. Figure 9 gives some examples on how to obey the perspective and distance of the symbols presented.

Alessandra Scotta describes in her MSc-thesis 'Visual Reality and object identification on spatially referenced panoramic images' [Scotta, 1998] the linkage between a Cyclorama and the information 'behind' the panoramic image as stored in a GIS.


Figure 9: Perspective and distance conformed symbols

The standard approach is to present and query the information like addresses, cadastral information etc. through a map-interface. For this purpose her research was about the use of Cycloramas as an alternative interface. One way to reach that goal is point two Cyclorama's to the same object. Given the recording positions of the Cyclorama's and the two directions measured within the Cyclorama's one can easily determine by a forward intersection the coordinates of the object pointed on. This coordinate is passed to the GIS and the requested information is shown. Another possibility is to pin point directly within the Cyclorama to the object one wants more information about. This option has the advantage of using only one Cyclorama, but the disadvantage that only one direction is known and thus it is not identified which object intersected by that line is the one under focus. A possibility is to calculate within the GIS all intersecting objects and select the nearest one.

## 4. DISTANCE ADDED PANORAMIC IMAGES

To avoid the calculation of whether or not obscured features and labels based on inaccurate or over time mismatching GIS-data we will adopt the idea of 'height added aerial images' within panoramic pictures or Cycloramas.

Airborne laser data will be most of the time be modelled by a GRID or TIN as a closed surface. This surface is used as the 'background' layer to drape with aerial images or other textures. But one can also choose to keep the laser data as a point dataset and add the distance to the recording platform to each point. When this point set is viewed from the recording position and each point is enlarged in respect to its distance a kind of an orthophoto visualisation is produced.

The same idea can be applied for panoramic pictures. Not the photo itself is the model to handle, but each picture element is attached with its distance to the recording location. When these pixels are enlarges according to this distance and when observed from the recording place - which is always the case with panoramic pictures - the cloud of loose 'distance-pixels' will give the impression of being the panoramic picture itself.

Terrestrial laserscanners will produce a kind of a 360 degrees look around digital terrain model around its tripod. We can combine this panoramic DTM with a panoramic image or Cyclorama taken at the same location to create the 'distance

added panoramic image'. The registration of the panoramic DTM with the Cyclorama will be a quite complicated procedure, but once we have this result it is rather straightforward to determine whether or not to draw a geometric feature, a label or a hotspot within the Cyclorama. If each picture element is attached with the corresponding distance to the recording position the line-of-sight calculation is reduced to compare this range to the distance of features or labels to project within the panoramic image.

## 5. CONCLUSIONS AND RECOMMENDATIONS

We have demonstrated the correspondence of Digital Terrain Models draped with Aerial Images and distance added Panoramic Images. Both will indicate whether or not to depict augmented information within the image. The required distance information can be obtained from tripod laseraltimetry data, which is registered accurately to the image. Once this spatio-temporal matching Digital Distance Model for each panoramic image is available a full range of applications will come available. We expect applications where the distance added panoramic image will become a true background layer for presenting geometric and descriptive data as the main tool in all kinds of Location Based Services. One could see the advantage of devices, which present the user the nearest Cyclorama available, oriented to the viewing direction. Especially when this kind of devices adopts itself to what the user is planning to do by augmenting the Cyclorama with the requested information (i.e. time tables, pop-up labels, points of interest, guiding directions) it will replace the abstract maps and tourist city guides.

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