User requirements

WP1 deliverable – Mapping the Via Appia in 3D – NLeSC & SPINlab VU University Amsterdam – by Rens de Hond

This path finding application aims to develop an integrated set of generic tools which enables researchers to generate a 4D Geographic Information System (4D GIS) in which highly detailed features can be spatially stored, visualized and analysed. Its field of application is monumental archaeology for which the NWO funded project "Mapping the Via Appia" serves as use case.

The archaeologists of the Mapping the Via Appia project[1] have indicated how they want to use the intended end product of this path finding project. They want to be able to relate archaeological objects that are scattered around the archaeological area. The system should make it possible to group archaeological objects that are related via queries and thematic three dimensional maps, based on information like material, chronological data, size, and style. Reconstructions of different phases of the archaeological monuments placed in the 4D GIS environment are an important manner to gain insight in the overall picture of the development of the Via Appia through the ages. By placing historical pictures from different periods in the 3D environment, archaeologists are able to map deterioration and erosion of the archaeological remains.

This document describes the user interface and the integrated functionalities and tools that enables non-computer specialist archaeologists to create a 4D GIS that fulfils their needs.

Interface

Fig. 1 is a fictive screenshot of what the interface should look like, and more importantly, what functionalities and tools should be integrated. The interface should make it easy for archaeologists to find all 4D GIS tools in one place, should make them accessible, and should enable the archaeologists to create, use, and edit a 4D GIS in a user friendly way.[2] As stated, this interface is purely fictive. It would be wise to use an existing open-source GIS or 3D program, and to extend it with plugins when necessary for the realisation of the following functionalities.

[1] Prof dr Eric Moormann, dr Stephan Mols, and dr Jeremia Pelgrom.

[2] Suggestions for existing programs that could serve as a base for a user interface are CloudCompare and, to a lesser degree, MeshLab and Google Earth. See coming 'Evaluation of existing tools' document.

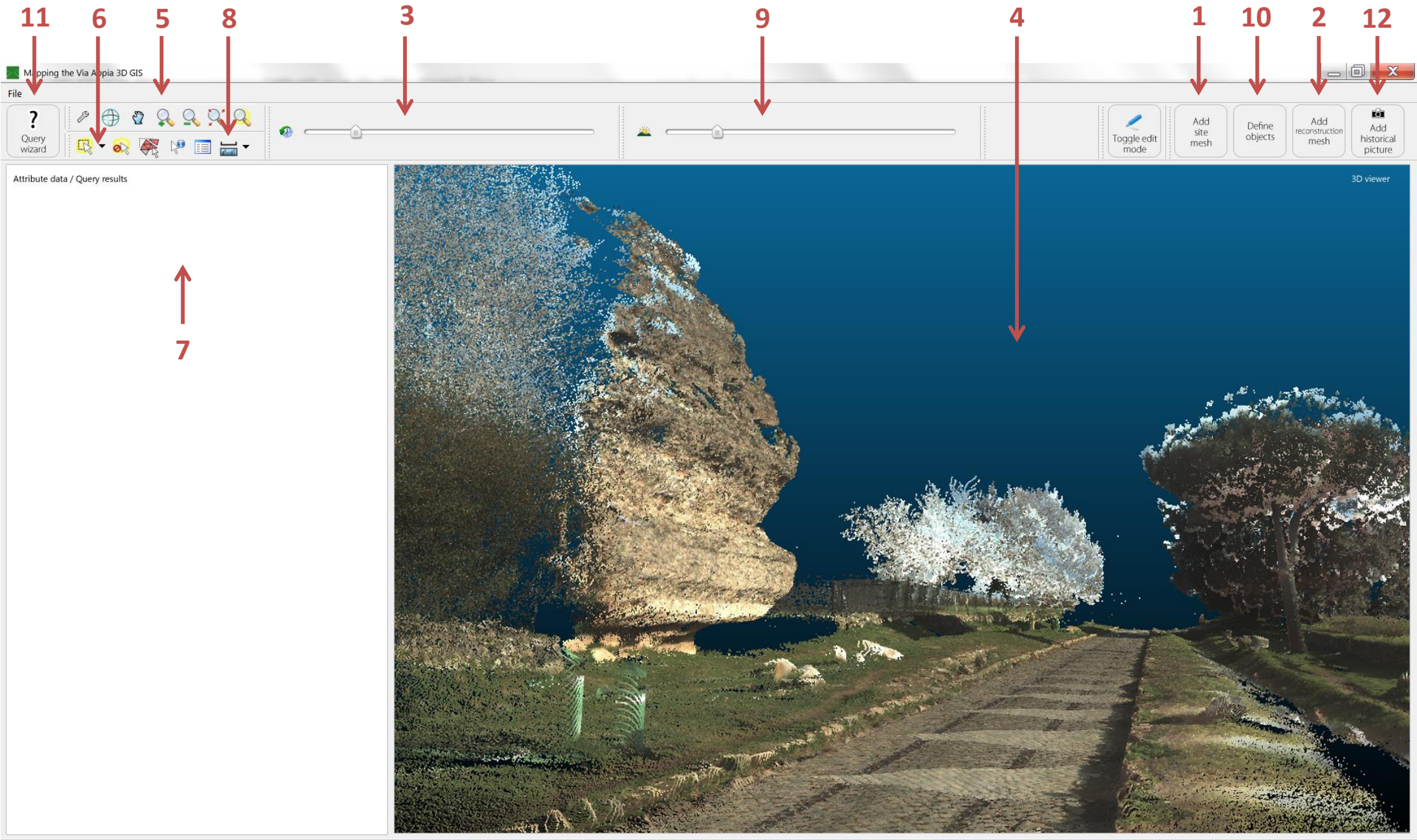


Fig. 1. Fictive screenshot of the interface that integrates the tools and functionalities necessary for an archaeological 4D GIS.

3D Contents

The system will contain the Fugro DRIVE-MAP point cloud as a base map. Second, detailed point clouds of the sites will be aligned to this DRIVE-MAP cloud (1). It should also be possible to align a textured mesh of a site as well, and to switch between point cloud or mesh display of a site. Third, it should be possible to import and align meshes of 3D archaeological reconstructions of the sites once they have been produced by the archaeologists (2), and to switch between the display of the current state of the site and reconstructions of multiple phases in the history of the site via a time/history scroll bar (3).[3] The detailed point clouds of the sites will be linked to a database both on a site level and on an object level (data can be attached per site, but separate information can also be linked to a part of a site, which is called an object).

Basic functionalities

The interface should contain a 3D viewer (4) with basic 3D functionalities like zoom, pan, orbit, perspective toggle, standard views, etc. (5). Furthermore, it should be possible to select features (6), both on the level of sites and of objects. In a text window (7), the attribute data of a selected site or object or the results of a query can be viewed. Essential is a 3D measurement functionality (8), which enables archaeologists to take measurements on the 3D representations (point clouds *and* meshes) of the archaeological remains.[4]

Besides a scroll bar that makes it possible to switch between reconstructions of different phases of the archaeological area (3), another scroll bar should enable the user of the 4D GIS to simulate the position of the sun and shadows on a given date in history (9).[5]

It is very important that archaeologists can edit the contents of the 4D GIS as the archaeological projects continues over the years, and more sites are being identified. The interface should contain easy ways to add point clouds and meshes of sites (which are then automatically aligned) (1), to define objects within those sites by segmentation, and to add and align meshes of archaeological reconstructions.

[3] Good example in Google Earth, See coming 'Evaluation of existing tools' document.
[4] Good examples in MeshLab, CloudCompare and 123D Catch. See coming 'Evaluation of existing tools' document.
[5] Good example in Google Earth, See coming 'Evaluation of existing tools' document.

Automatic alignment functionality[6]

The detailed point clouds of sites (created through image-based modelling using 123D Catch) must be aligned to the DRIVE-MAP point clouds that serves as a base map. Since there are an estimated 2000 archaeological sites in the case of Mapping the Via Appia, just as much point clouds must be aligned to the DRIVE-MAP point cloud. Therefore it is important that this happens as automatic as possible. Besides a point cloud, 123D Catch also delivers a textured mesh. This mesh should be aligned as well, so that the user can switch between the display of point cloud or mesh while viewing a site.

Segmentation functionality

Since data can be assigned to a site as a whole and to separate parts of it, it should be possible to segmentate the point cloud of a site and to define the so-called objects (10).[7] They receive a separate object number, by which the object features can be linked to the database.

Database connection & query functionality

The archaeologists of the Mapping the Via Appia project gather data on the archaeological remains in several categories, like material, date, style, interpretation, building technique and decoration. This data can be assigned to a site as a whole or to segments of a site, called objects. This information is being stored in a Microsoft Access database. The data from this database must be linked to the corresponding features in the 4D GIS by site or object number.

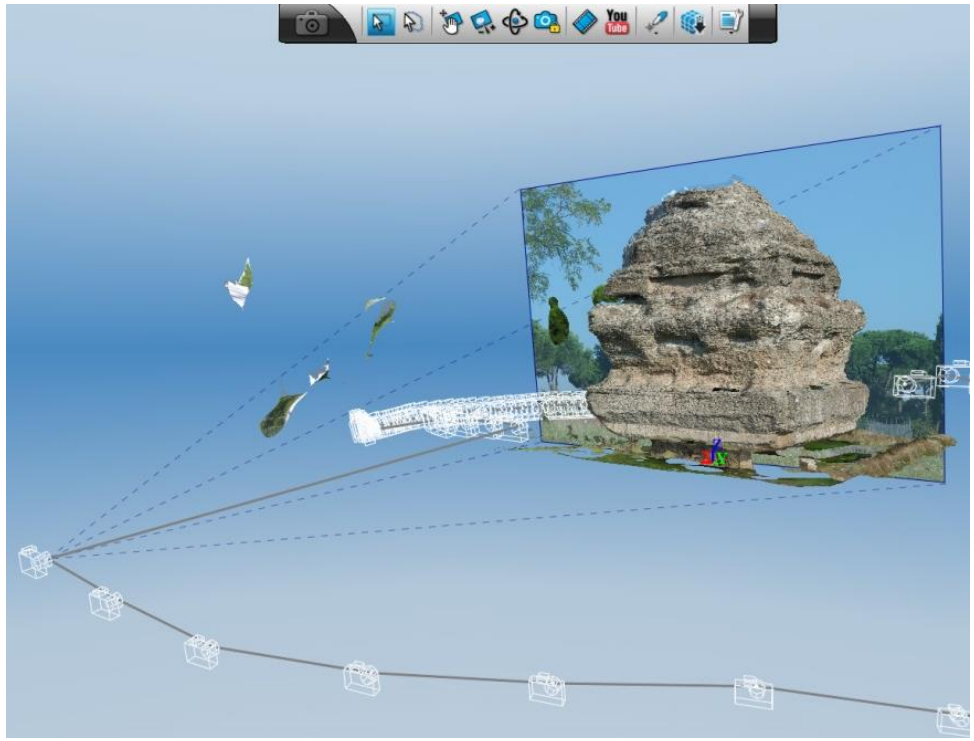
In order to spatially analyse the archaeological remains and to create 3D thematic maps, the non-computer specialist archaeologists must be able to perform queries based on this data (11).

[6] Alignment tools that are not fully automatic can be found in CloudCompare and Meshlab, both open-source programs. The PointCloudLibrary contains a registration library with alignment algorithms. See coming 'Evaluation of existing tools' document.

[7] Useful examples might be in CloudCompare and 123D Catch. The PointCloudLibrary contains a segmentation library with alignment algorithms. See coming 'Evaluation of existing tools' document.

Historical pictures functionality

To analyse historical pictures, they must be imported into the 3D scene of the 4D GIS in a frame that can be positioned in the right spot. A corresponding viewpoint must be attached to the picture, so that when moving to this viewpoint, the historical picture appears to blend in with the 3D scene (12). It should be possible to adjust the opacity of the picture. The way 123D Catch shows the pictures and the corresponding positions of cameras in the 3D environment is a good illustration of this functionality (fig. 2). The idea is also well illustrated by these artworks that merge old photos with photographs of their modern-day settings (fig. 3 and 4).



^ Fig. 2. 123D Catch displaying a 2D frame with a photograph in a 3D scene, with attached viewpoint.

> Figs. 3 and 4. Old photographs blending in with their modern-day settings (http://www.flickr.com/groups/lookingintothepast).

Reconstruction model functionality

There should be a functionality to import textured or coloured meshes of archaeological reconstructions of the monuments (obj, collada or any other common 3D file format). These models are produced in software like SketchUp and Blender. Once imported, the models should be aligned to the present-state point cloud. This can be a largely manual functionality.