A virtual tour as a presentation platform for topographical surveying of an ancient hill terrian

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Abstract

As part of a project of the Deutsches Archäologisches Institut (DAI) two bachelor theses arose with the topic „Erstellung und Visualisierung von Digitalen Geländemodellen von Umm Qays in Jordanien". They had following objectives: the interactive visualization of full spherical panoramas of an area, 3D models of ancient quarries, sectional views, a topographical map and textual information. After data collection in Jordan, data preparation and data modeling at the HafenCity University Hamburg (HCU) the created products will be combined in an appropriate manner and presented visually. This is achieved through a presentation platform based on a virtual tour which has been made in *krpano*(KRPANO Gesellschaft mbH, 2014). Based on 69 full spherical panoramas which include 3D models of ancient quarries and sectional views, the project area is presented in an interactive way. The virtual tour provides the opportunity to get a view over the area without having to enter it. This is supported by its clarity and ease of functionality. Furthermore, with the integrated data the virtual tour is a good basis for future archaeological investigations. With its simplicity the platform could be continuously expanded and updated for future project work.

The virtual tour can be visited on the web at
http://www.hcu-laserscanning.de/vt/ummqays2012/Index.html

I. Introduction

At the project in Gadara/Umm Qays (Jordan), the Deutsches Archäologisches Institut (DAI) and the HafenCity University Hamburg (HCU) work together for the purpose to perform a topographical surveying of an ancient hill terrain in September 2012. Fig. 1 shows that Gadara/Umm Qays is located in the north-west of Jordan.

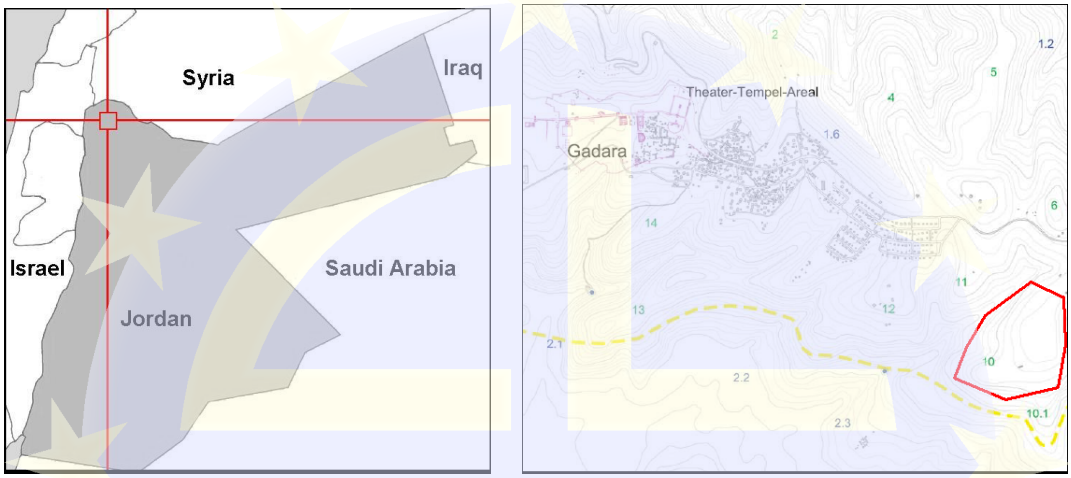

Fig. 1: Location of Umm Qays and of hill 10 (marked red) (modified: DAI, Orient-Department, C. Bührig - C. Hartl-Reiter, 2013) (from left to right).

A major task of geomatics in this project is the acquisition of the territory of hill 10 (Fig. 1, circled in red) with different 3D acquisition methods to derive detailed terrain models and to document the ancient territory geometrically. Based on this data archaeological investigations can be performed, e.g. volume calculations, the determination of stone mining areas and non-degraded areas and their expansion. The survey is used to map the former fields of use and the non-machined areas. The aim is to reconstruct the ancient territory exploration and mining activities. In detail, it should be possible to do size measurements to determine broken stone blocks on the basis of 3D models of individual quarries which are generated from captured image sequences (Fig. 2). With this information, the archaeologists would like to draw conclusions where these stone blocks have been installed.

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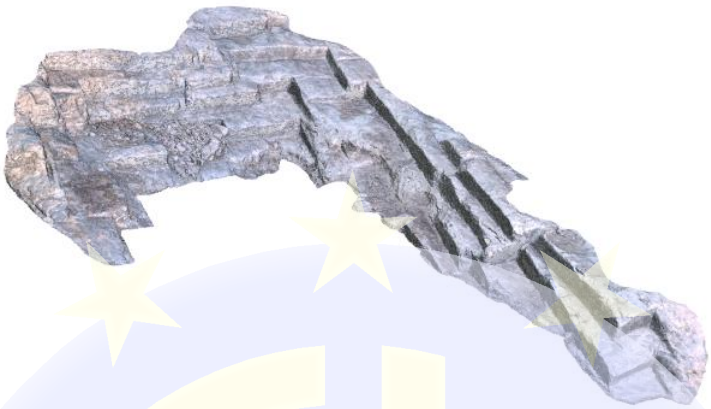

Fig. 2: 3D-model.

This paper focuses on visualizing the determined data in an appropriate way to present it to interested visitors on site. The visitor should be able to get an overview and information about the study area by using the presentation of the data without even entering the area. Based on these requirements, the aim is to produce a corresponding presentation platform in form of a virtual tour, which contains all required information. The basis of the virtual tour are full spherical panoramas, which are linked by the software *(*KRPANO Gesellschaft mbH*, 2014)*. The performance and implementation of the tasks of geomatics in this project are realised in two bachelor theses with the title *"Erstellung und Visualisierung von Digitalen Geländemodellen von Umm Qays in Jordanien"*.

II. Acquisition of data

The survey of hill 10 lasted eleven days. At first, the whole project area is gathered by kinematic GPS surveying. Afterwards, the 69 panoramic photographs are made distributed across hill 10. Furthermore, the location of the quarries is detected with a topographical survey by a total station. Chosen quarries are taken photogrammetrical with a reflex camera. At the HCU the processing of data material is done. A digital terrain model (DTM) is created by the collected GPS data to construe contour lines from this DTM for a topographical map. Based on the topographical measurement by the total station and these contour lines, a topographical map on a scale of 1:1000 is created in *AutoCAD*. The 360 degrees panoramas are processed with the software *PTGui(*NEW HOUSE INTERNET SERVICE B.V.*, 2014)*. It is done on the basis of the full spherical panoramic photographs. The three dimensional point clouds are generated from the photogrammetric photography of the selected quarries. Therefore, the software products *Bundler* (SNAVELY, 2009) and *PMVS2* (FURUKAWA & PONCE, 2010) are used. The subsequent processing of the generated point clouds is done in *Geomagic*

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Studio (GEOMAGIC, 2013). In this software tool

- the different parts of one quarry are scaled and put together,
- the entire point cloud of a quarry is cleaned up and filtered,
- the georeferencing is done,
- the point clouds are meshed to a 3D-model and
- A 3D-pdf file is created for each quarry.

The sectional views of the 3D-models are also created in *Geomagic Studio*. These products are brought together in a virtual tour.

III. Presentation platform – virtual tour

For an appropriate presentation of the created products, the data collected will be visualised in a virtual tour. The virtual tour will be the result of the connection between panoramas. The full spherical panoramas are displayed by using the *krpano Panorama Viewer*. The *krpano Panorama Viewer* is designed to run the application in a browser. *Krpano* is based on a flexible and dynamic xml script which allows the implementation of own ideas and properties (KRPANO Gesellschaft mbH, 2014). Besides the viewer, there are *krpano* tools that can automatically generate panoramas or virtual tours. The following sections describe the structure of the virtual tour as well as their content. First of all, the idea of the virtual tour will be explained in more detail. Finally, the structure of the xml files is explained.

A. Idea

The virtual tour of the project area around hill 10 serves as a presentation platform for the created products which helps the user as a guide. At the same time it provides insight view over the area without having to enter it. Furthermore, an integration of the presentation platform in the archaeological exhibition of the local museum is planned. In addition to the presentation purpose, the platform will provide a basis for future archaeological projects. Based on these conditions, a presentation platform is created with the virtual tour as a base, which is discussed in more detail in the following section.

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B. Structure

The basic idea of the virtual tour of hill 10 is to provide the user an overview over the area with its peculiarities. For a non-local user the project area looks steadily while viewing the various panoramic shots. For this reason, the virtual tour is making sure that the user is able to get orientation at any time by using various tools. The intended principle of clarity and ease of functionality is in line with that. Based on these guiding principles, the entire structure of the virtual tour as well as their content is aligned.

When starting the virtual tour of hill 10 an overview map appears which is derived from Bing maps (NOKIA & MICROSOFT CORPORATION, 2014). This puts the user in the position to orient himself based on the location of hill 10 by its surroundings (Fig. 3). On the map the respective towns and places are provided with their names, which appear later in the virtual tour. This also helps to orient.

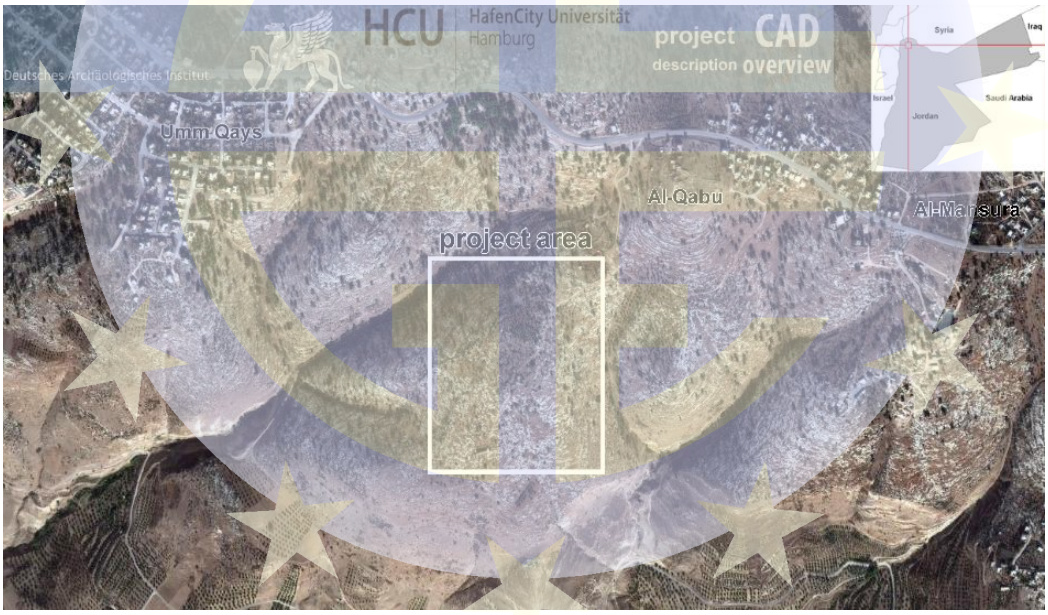

Fig. 3: Entry into the virtual tour.

In addition, a country overview map is placed in the upper right corner, where the location of the project area can be seen in Jordan. The Fig. 3 also shows that the institutions which are involved in the project are listed with their logo at the top of the screen. In an Internet-based use of the virtual tour the websites can be reached by clicking on the logos of the institutions. Furthermore, there are two more buttons. The *project description* button is linked with a text, which is displayed after clicking the field. The textual information in the virtual tour will be discussed in section III.C.5. The *CAD overview* button shows the generated topographic plan, which serves primarily as a working basis for future archaeological investigations in connection with the virtual

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tour. This bar with the logos and the two buttons is also available in the panoramas to ensure a steady access.

The project area is characterized by the white frame and the heading *"project area"*. The framework also serves as a link to the first panoramic of the virtual tour. The designation of a link button is also illustrated by the appearance of the lettering *"Enter Virtual Tour"*. This is displayed when the mouse pointer is on or within the white frame. In the virtual tour, this feature is used in other situations in a similar way. In addition to this function, more visual components are used to alert the user to the information stored in the virtual tour. For this, the mouse pointer changes to the hand icon on any interactive button which is known from everyday computer use. In addition, some buttons are transparent when they are inactive. When the mouse is passing they are activated and the transparency is canceled. This presentation option is to show the user that the selected button is highlighted with an action. After opening the first panorama, which is linked to the project area field the actual scope of the virtual tour can be seen (Fig. 4).

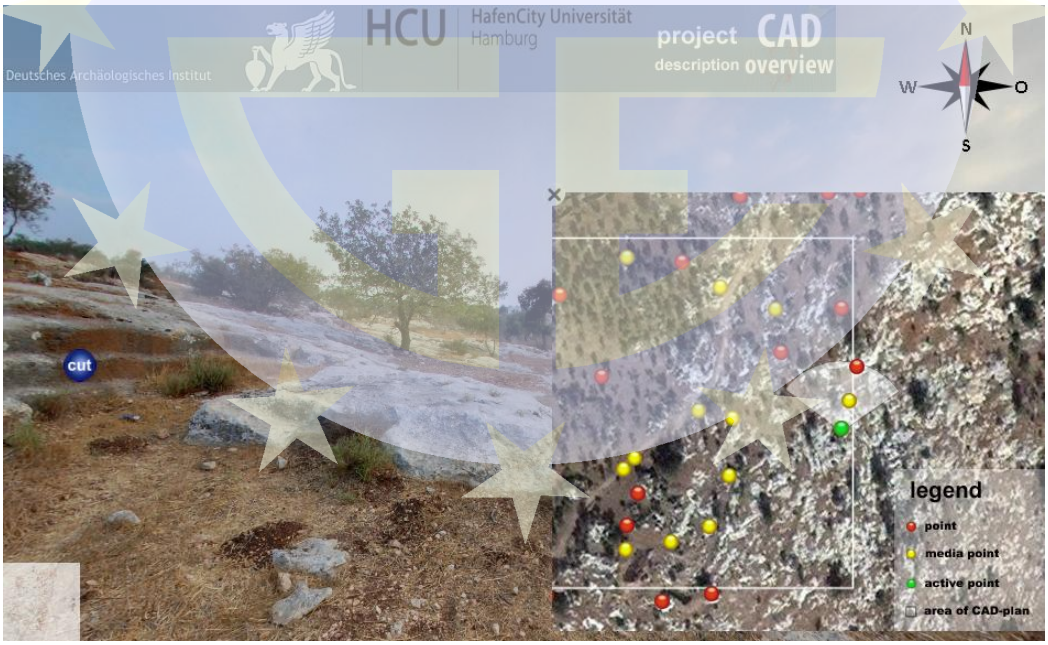

Fig. 4: Virtual tour after opening the first panorama.

Fig. 4 shows the view of the panoramic point of 39 to the north. In addition, a map is open at the start of the first panorama in the right half of the screen. The map contains all 69 panorama standpoints and serves as an overview for the user, where he currently is within the project area. Besides that changing the viewpoints is possible through that map. In the lower left corner of Fig. 4 there is a minimized map, which can be opened by clicking on the button. So the user has the possibility to have a clear view of the

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viewable area (Fig. 5). Both maps can be minimized by using the *cross* button. The maps are discussed in detail in a subsequent section.

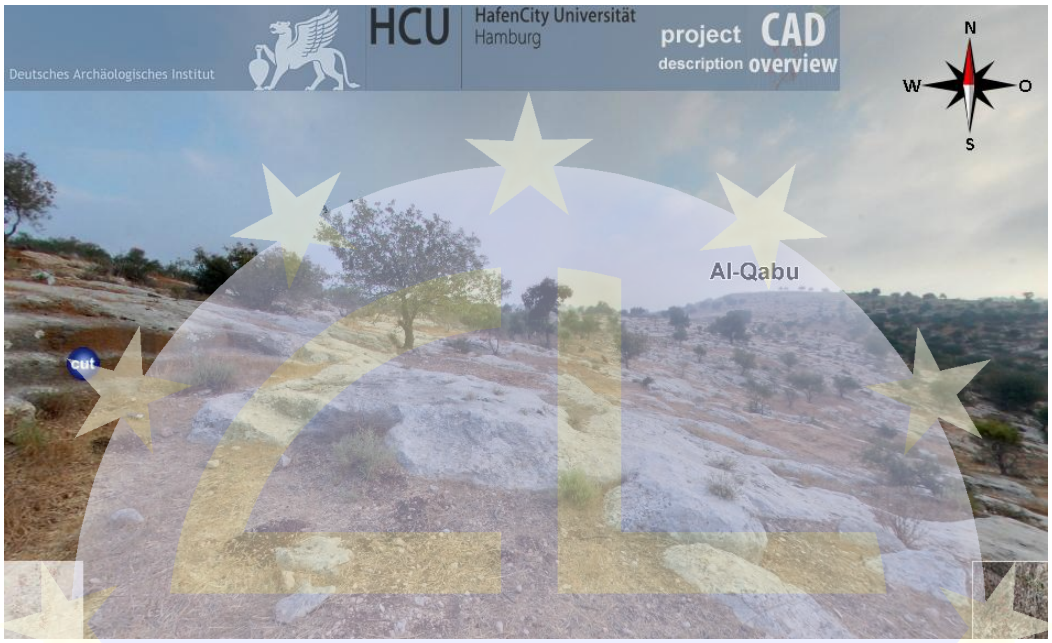

Fig. 5: Representation of the first panorama with minimized map.

In Fig. 5 the word *Al Qabu* can be seen, which was previously hidden behind the open map. Besides the map the word serves as a further guide for the user because he already knows the location of this area from the homepage of the virtual tour. The compass in the top right, shown in Fig. 5, is also a function for orientation. With a change of a panoramic standpoint the view is always oriented to the north. The large quantity of orienting means is necessary in order to get around when visiting the virtual tour on hill 10. There is also a button called *cut* in the middle of the left edge of the image of Fig. 5. This Button contains information about a section of the situated quarry. This will be explained in more detail in section II.C.4.

By holding down the left mouse button and then moving the mouse, the user can explore the open panorama horizontally (360°), vertically (180°) and is able to zoom in. The user also finds a nadir logo on the bottom of every panorama, which contains the contact details of the author of the virtual tour and the countries overview map (Fig. 6). In addition, the nadir logo is used to mask the tripod. The handling and the description of the actual content of the virtual tour is done in the following section.

Fig. 6: Nadir logo.

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C. Content

After the basic structure of the virtual tour of hill 10 has been explained, the integrated products and information in the virtual tour, as well as the concrete handling and the control by the user, will be clarified.

1. Map

The control within an open panorama is explained in the previous section. However, the aim of a virtual tour is to link several panoramic positions with each other. So far, it is only known that the change of the viewing standpoint to another panoramic view via the map in the right half of the screen is possible which is shown in Fig. 4. Therefore, the operation of this map and the context of this map and the minimized map in Fig. 4 will be explained in this section. For clarity, the two maps are shown in Fig. 7.

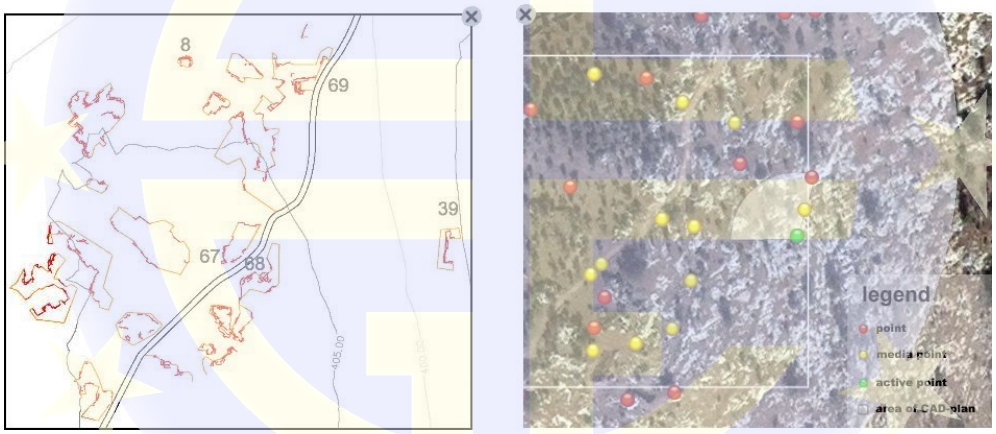

Fig. 7: CAD map and overview map in the virtual tour (from left to right).

The right map shown in Fig. 7 is similar to the map on the home page by bing maps, which is provided by NOKIA & MICROSOFT CORPORATION (2014). The size of the overview map corresponds exactly to the area, which is located on the home page in the white frame. It contains all 69 Panorama standpoints. However, in the illustrated map only a few standpoints are displayed. For simultaneous viewing of all points of view, the map would assume the dimension of the screen, but this would contradict the principles of this virtual tour. So with the selected size there is a balance between clarity, orientation and ease of use. Thereby, the map is designed as a scroll map which means that all standpoints are available through scrolling on this map. The user is able to view different vantage points by pressing and holding the left mouse button to move the map in the desired direction.

The colour coding of the points are explained in the legend of the overview map. A red point indicates a position that does not contain any additional information. For all positions that are marked with a yellow spot, additional information can be found in

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the panorama. The green point indicates the currently selected panoramic viewpoint. Furthermore, the user sees radar on the map, which appears on the current position and indicates the direction of the current view and the size of viewing angle is. The radar is matched to the compass. To change the panorama, the user only has to click on one of the points. By passing a standpoint with the mouse, the number of the panorama and, if available, an indication of the attached media is displayed. So the complete handling of the virtual tour is done over this map. The white frame in the map indicates the tachymetrical measured area and also represents the connection to the shown CAD map in Fig. 7.

The CAD map includes the tachymetrical measured area. In addition, this map is a detail of the topographical plan, which is deposited under the *CAD overview* button. The use of the CAD map as add-on map is meant for better orientation of the user in the field of measured quarries. For this, the map includes the total station recorded quarries, which are neither in the start map nor in the overview map precisely identified. In addition topography is omitted to focus on the quarry structures. Besides the presentation of the tachymetrical measured area in the CAD map, it also contains the numbers of the panorama standpoints where 3D models of quarries are deposited. When opening the first panorama, the CAD map is minimized in order to not overload the viewer with information. This map can be maximized or minimized by the user.

2. CAD-plan

For a better understanding of the dimension of hill 10, the topographic plan is available at a scale of 1:1000 on the *CAD overview* button. The topographic plan will be opened in a new tab of the browser. The 2D map serves mainly as a tool for future archaeological work. It is also a basis for investigations on volume calculations and the determination of stone mining and non-mining areas, as well as their size. The mapping of areas allows the reconstruction of working trails.

3. 3D-models

Besides the visualisation of the project area the virtual tour functions as presentation platform. The generated three-dimensional models and cuts of the quarries are integrated there. The material is inserted at the corresponding panorama positions (Fig. 8).

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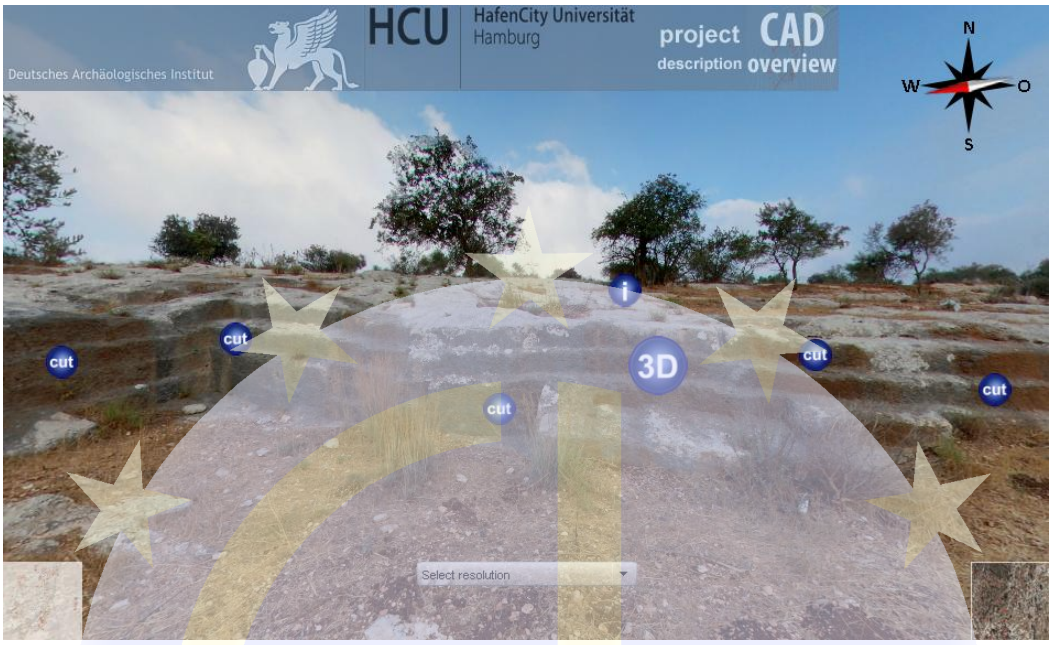

Fig. 8: Included material in the virtual tour.

In the respective panoramas the user will always find three different buttons, which are located on the quarry structure. The *i*-button offers some textual information and the *cut*-buttons include sectional views. A *3D*-button enables the user to open a three-dimensional pdf-file with a 3D-model of the respective quarry. Before opening, the user has to choose the resolution of the model over a button located down in the middle (Fig. 8).

A high resolution as well as a low resolution are up for selection. The high resolution corresponds model-dependent to the full number of triangles, but not exceeding 2.5 million. The intent of a pdf-file with high resolution is the use for detailed analysis of the quarry structure. In case of the low resolution the number of triangles is limited to 10 percent of the whole object. Therefore, this pdf-file allows getting an overview about the model. After choosing the resolution the file opens in a separate tab of the browser.

The user sees the object in nearly the same direction as he does within the panorama. With a click, on the file the 3D-mode is activated. For an easier orientation the model is displayed in the same direction as before.

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4. Cuts

The *cut*-buttons in Fig. 8 are a linked to cuts of modelled quarries. Some of these are projections. The position of the *cut*-buttons in the panorama is nearly the same as the buttons they have in the 3D-model. After activating one of these buttons a pdf-file that includes information, opens in a separate tab. The pdf-file shows the cut himself in the upper part and where it is located in the quarry in the lower part of the file. In Fig. 9 both components are displayed side by side. However, a projection is shown itself. Each file of a cut includes a grid to imagine the size of the object and the cut.

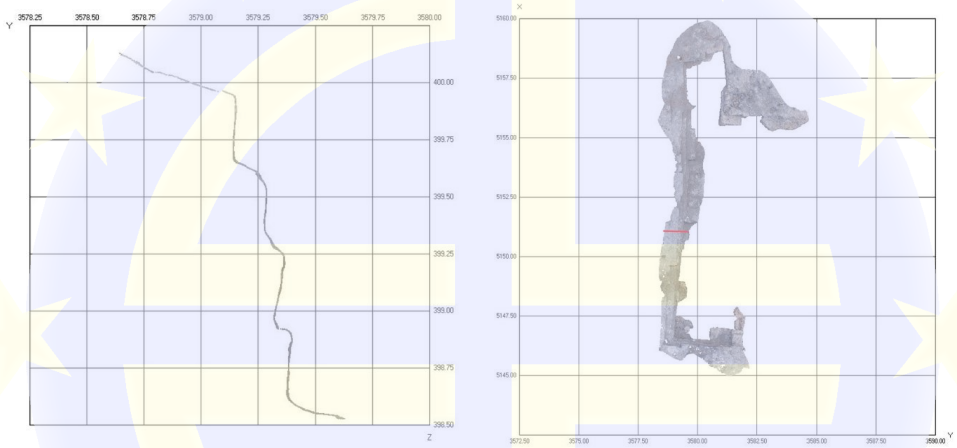

Fig. 9: Sectional view (left) and position of the cut in the model (right).

5. Texts

Besides the variety of visual information the user also gets contentual aspects in terms of integrated texts. These texts are in the German language and written by the head of the project Dr. Claudia Bührig. On the one hand, it is a project description, callable about the button *project description*. On the other hand, at the writings *Gadara* and *Al Qabu* textual information about these places are linked.
In panoramas with included information to a three-dimensional model, also textual information is located. It is available by clicking the *i*-button (Fig. 8). This text describes the ancient exploitation of quarries in general. Fig. 10 shows the presentation of such textual information.

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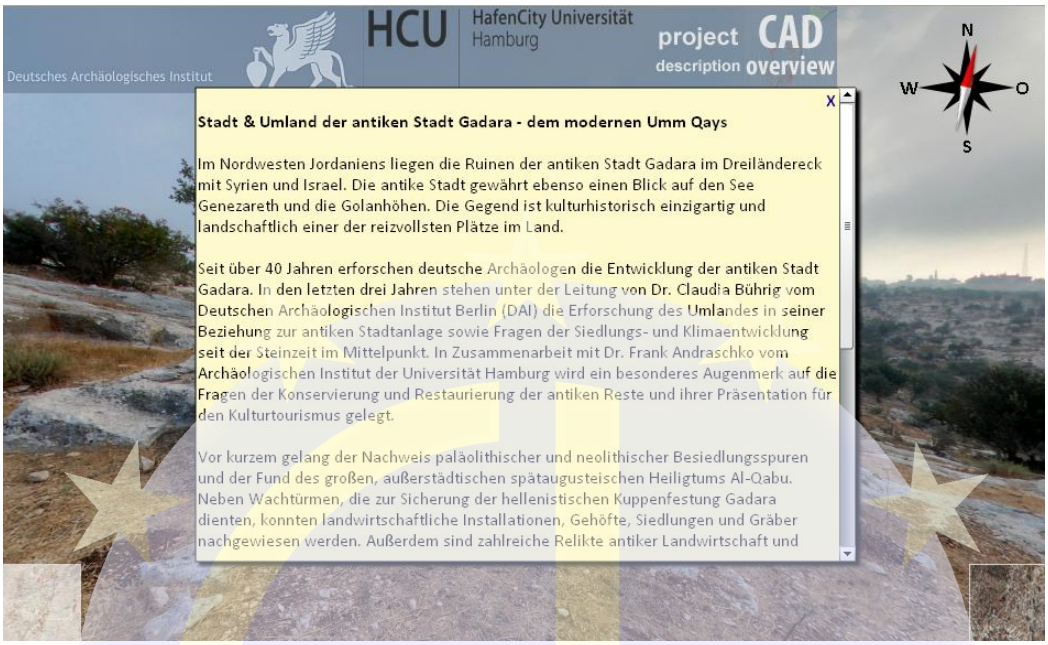

Fig. 10: Textual information of the virtual tour.

D. Programming structure

Clarity by programming the virtual tour is necessary to be sustainable. In this way adding any panoramas to the tour is quiet easy. For this reason the spherical panoramas are not processed as a virtual tour in krpano but rather as single panorama. For each panorama *krpano* creates a separate xml-file, which can be easily implemented in the existing programming. Furthermore, the chosen xml-structure enables inexperienced programmers to make modifications themselves.

The virtual tour gets started with the file *Index.html* which recalls the file *master.xml*. This file includes the activation of two other xml-files. One of these is *startkarte.xml*, where the user enters the virtual tour. In the second file, named *grundeinstellungen.xml*, all properties for each panorama are deposited.
This file combines all necessary xml-files. Because of clarity and simplicity each component of the virtual tour has an own xml-file. The modularity enables fast editing and changing of components. These components have separate xml-files:

- compass,
- nadir logo,
- font,
- writings of places,
- texts of project description and ancient exploitation of quarries,

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- logo of institutions,
- CAD plan and
- general map.

The main control during the performance happens with *karte.xml*. This xml-file represents the general map of the virtual tour where the user can switch between the panoramas. At the beginning of this file the construction of the map is defined. Therefore, the components are a map frame, a close button, the legend, a minimized map and the map itself. Each component includes actions depending on interaction of the user.

Afterwards, each of the 69 panorama positions are located in the general map. Furthermore, the starting of the respective panoramas is defined. When the user activates a hotspot, the referenced xml-file is executed, which means to open the panorama. Additionally, the file *karte.xml* includes further definitions:

- closing the map,
- fading the map, when it is unused,
- shifting the hotspot colour after a position change and
- functionality of the radar.

IV. Conclusion

The result is a presentation platform, which combines the different products based on a virtual tour. With the virtual tour the data presentation is very user-friendly. The platform enables the visualisation of the project area without entering the area. Based on the clear structure of the presentation platform a steady enlargement and revision is possible. Therefore the conditions for an update with data from future work are complied. Experiences during programming the platform have shown that the virtual tour should be started with the web browser Internet Explorer.

The virtual tour can be visited on the web at
http://www.hcu-laserscanning.de/vt/ummqays2012/Index.html

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