IMPLEMENTATION OF RIA CONCEPT AND EYE TRACKING SYSTEM FOR CULTURAL HERITAGE

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Abstract:

This paper assesses possibilities of implementation absolutely new geoinformation technologies for Cultural Heritage. Solutions based on the concept of RIA applications are just new trend of processing and publishing outputs on the internet nowadays. RIA (Rich Internet Application) is a web application, which brings the tools and practices from desktop solutions into interactive web applications for everyone and everywhere. It provides great comfort for users. Especially in fields like cartography, cultural heritage, tourism, archeology, photogrammetry or transport (and in every other where spatial part plays important role) there is a big potential for using it on a large scale. There is a project about an Eye Tracking System focused on these fields at Department of Geoinformatics at Palacky University. The eye tracking system is a device for measuring eye positions and eye movement ("where we are looking"). There is a number of methods and outputs, but the most common are „heat maps" of intensity and/or time. For the visualization of these outputs it is very suitable to use RIA concept. There is a nice usage for Cultural Heritage, for analyze how long and on which part of monuments are people focused on. It can be used and analyzed on a lot of examples – on the sculpture, on the historical building, on the bridge, on the painting, outdoor or indoor. It can analyze how sensitive are people on perception of details on sculpture of David by Michelangelo or how people feel huge space and what they are interested in inside the big cathedrals. It is a great experience to compare accurate survey data with personal interpretation and knowledge about historical monuments, when we compare real and virtual world of cultural heritage.

1. INTRODUCTION

Today we live in the time, where modern technologies and the internet are all about us, in every field of study, including the cultural heritage. As Chen [4] said modern digital technologies for cultural and historical materials are an emerging research field that bridges people, culture and technologies. This paper explains how an eye tracking and RIA (Rich Internet Application) concept can add new approach for the use of digital technologies by other means. The traditional modes of cultural heritage preservation have numerous limitations. Historical and financial value, size and weight, location and lot of more influences are reasons, why we use modern approach like internet technologies for conservation cultural heritage and its historical values for next generation. Especially in fields like cartography, cultural heritage, tourism, archeology, photogrammetry or transport (and in every other where the spatial part plays important role) there is a big potential for using it on a large-scale.

2. EYE TRACKING

Eye tracking is the methodology of measuring and recording the eye movements relative to the head position of an observer or that of capturing the gaze on some visual scene. Eye tracking system is a device for measuring eye positions and gaze movement ("where we are looking"). The meaning of visual scene is wide and it is possible to be related to an analog product (e.g. image, poster etc.) or to a digital product (web page, digital map etc.) that is depicted on a computer screen or projected to a flat surface by an appropriate device.

There are a number of devices, methods and outputs, but currently the most widespread and commercially available method is to use infra-red illumination of the eye and infer gaze direction by comparing the position of the pupil relative to the position of corneal glint (that is, a spot of reflected light from the cornea that exists whenever there is enough ambient light to see) [6]. The most common outputs are “heat maps“ of intensity and/or time and some records of eye movements. Simplified version of “heat maps” is the time-line with temporal aspect – where person is looking first, at second step, then, and then… The methods are based on the generation of an electromagnetic field that is placed around the eye (electro-oculography) and use of a special type of glasses. However, the technique that has been dominated, mainly due to its direct application, is based on the use of devices that are able to record the gaze on the visual scene analyzing eye images. There is a project at Department of Geoinformatics at Palacky University about an Eye Tracking System focused on these fields.

2.1 Psychological influence

There is another problem related to the ocular-centric tendencies of virtual environment designers. They seem to have a focus not just with visual fidelity, but a loyalty to a belief that in perceiving the world everybody sees the same thing. What we see is not necessarily physical reality, but our concept-orientated brain tells us that it is. As soon as reality gets to our brain it has already been filtered not just by our eyes but also by our previous experiences of reality. Virtually everything in our head is put into a conceptual schema, a framework. Without content relating directly to how we perceive the world, an emphasis on formal realism is not creating a virtual reality, but a storehouse of visually represented objects [3]. Because of these reasons, when we can implement eye tracking in a specialized field like cultural heritage, it is necessary to collaborate with psychologist too.

3. RICH INTERNET APPLICATIONS (RIA)

The last trend in the publishing and the subsequent work with data and internet outputs are solutions based on the concept of RIA applications. RIA is a Web application that brings the tools, practices and conventions from desktop platform into interactive web applications for everyone and everywhere, providing greater user comfort. It requires a special environment, for transmission of client requests to the server. In principle it is a web application which is not strictly based on traditional request / response paradigm. Classic current Web site, are created on the client side (X)HTML code, which is directly interpreted by a web browser. Every interaction with such "classic" side of it means sending a new request to the server, which returns a response code in the form of a new site. It is not necessary at the RIA concept.

RIA was born with Flex technology from Adobe in 2004, and received publicity in 2007 when it was released as open source. The basic idea is to use Flex for Flash user interface. Using RIA framework gives powerful tools for another development and open new ways to support “revolution” of Cultural Heritage [9].

4. MODERN TECHNOLOGY IN CULTURAL HERITAGE

Recognizing that significant cultural and historical materials are not merely data, we advocate an organized, continuing collaboration between subject specialists and technologists to establish sustainable and enduring digital archives of the world’s cultural heritage and to provide universal and ubiquitous online access for advanced research as well as for all levels of public education [4].

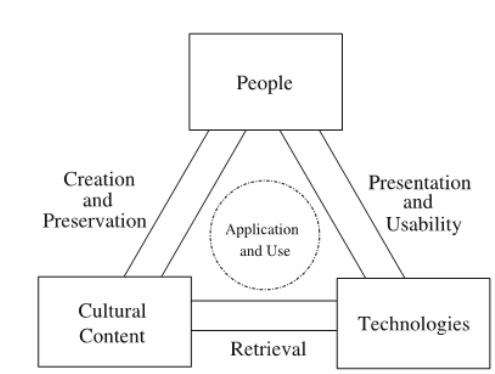

Figure 1: Conceptual model of the proposed research directions; according to Chen [4].

The conceptual model (Figure 1) illustrates the relationships among people, cultural content, and technologies. Nowadays are modern technologies an integral part of historical and cultural studies as well. It allows new way how to people create, manage, and perceive the content of their cultural heritage. Almost every research in last 20 years, in all fields of study, is based on using new modern technologies and there is great opportunity to use it in study of cultural heritage. As Chen [4] says, the area between content and technologies is the efficient and effective retrieval of the content using technologies.

The most common use technologies for cultural heritage are digitization of cultural artifacts which provide digital image for science and research. There are a lot of ways hot to "digitalize" monuments: photo, video, laser, 3D scanning, X-rays, infrared or UV scanning etc. But what is most common output? Some image, web page or specialized application, which are displayed on the monitor, in digital form. And the re is one important thing today, what is necessary to say. The standard platform for placing and sharing these outputs is only internet today. According to Chen [4] graphical user interfaces (GUIs) are needed for expressing both verbal and nonverbal queries and just internet allows great opportunity.

5. WHY IMPLEMENT RIA AND EYE TRACKING?

When a visitor enters a room of museum or cathedral for the first time, usually receives a general place presentation followed by one that directs the visitor's attention to the exhibit the system hypothesizes most interesting for her. The same example is on the paintings or statues – which part is the most important for visitors? Only eye tracking technology enables researchers to examine how users navigate search [12]. Psychology and how people make decisions are play aspect which play big role and just eye tracking allow objective assessment without any subject imbalance. Gathered data and outputs from eye tracking device are visualized as "heat-maps". Analysis of these heat-maps recommends shows position where visitors looking during first seconds, where they spend more time, what is more interesting for them. And for the visualization of eye tracking outputs is very suitable to use RIA concept.

Computer-based visualization is widely used and very important for scientist. RIA allows new approach to visualization and gives wide possibilities than ever before. Generally we can say that RIAs are current high-end of interactive multimedia applications on the Internet. Breure et al. [2] divided internet application focused on cultural heritage into three groups: low-end, middle, high-end. Of course, that RIA belongs to high-end group.

While eye-controlled applications can be displayed in physical museums, their true potential is unleashed in combination with inexpensive Web cam-based eye tracking. Now there is only one restriction for wide expansion – high price of devices. On the other side web cams are already a standard feature of modern laptops, and based on the number of previously described open-source programs, it is only a question of time. Interest in these methodologies is not trivial and may have huge commercial implications. For example Apple Company has recently acquired the largest eye tracking equipment manufacturer Tobii [6].

5.1 Museums, paintings, monuments, statues …

There is a nice usage for Cultural Heritage, for analyze how long and on which part of monuments are people focused on. It can be used and analyze on a lot of examples – on the statue, on the historical building, on the bridge, on the painting, on the interior of cathedral etc. It can analyze how sensitive are people on perception of details on the painting and statues, for example on David Michalengelo´s David in Florence, The Last Supper by Leonardo da Vinci in Milano, or Thomas Cole's The Course of Empire (Figures 2 and 3) . On the one side everyone immediately can deduce, which part of painting or statue is most attractive. On the other side it is very specialized field and for scientific research study is require cooperation with psychologist.

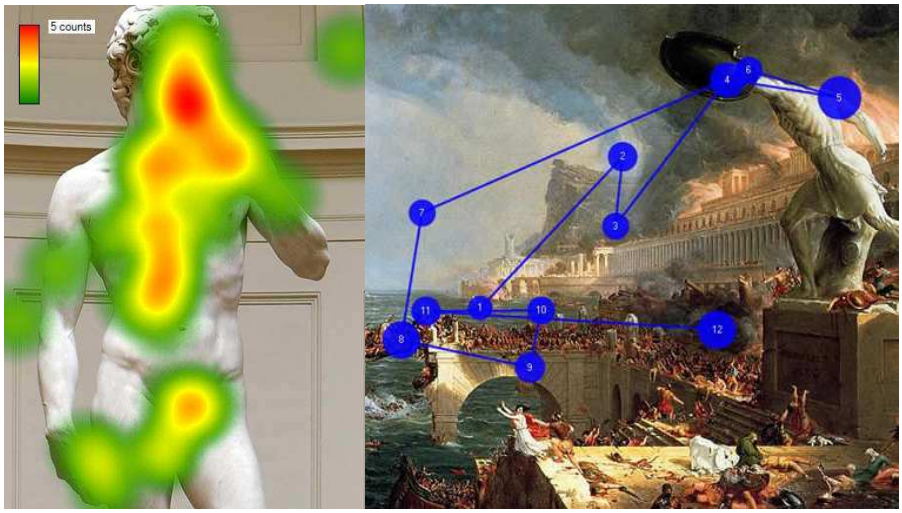

Figure 2 and 3: Usage of eye-tracking on historical works: heat-maps and temporal-line of visitor´s attention; source [5] and [7].

One of the first large scale studies involving the use of eye tracking equipment in a museum was undertaken by the National Gallery in London, during the exhibit "Telling Time" (Figure 4). However, besides demonstrating that it is possible to use eye tracking technology in large scale exhibits, the study did not substantially enhance museum's visitor experience [6].

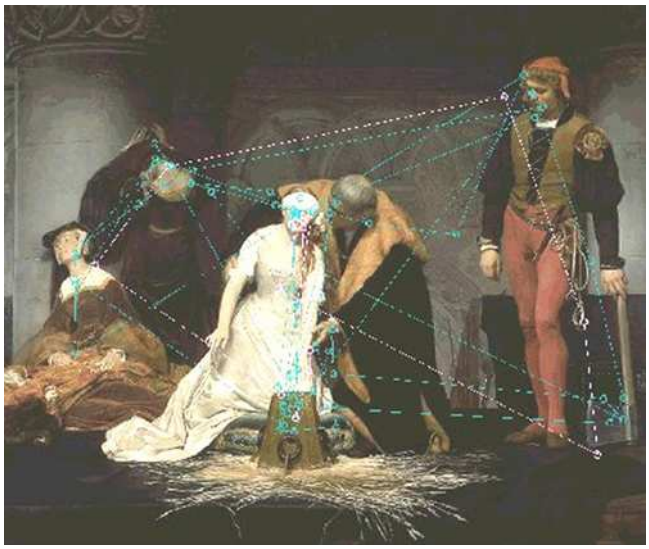

Figure 4: First eye tracking study focused on cultural heritage, National Gallery, London; source [6].

Milkevic [6] divide museum applications based on eye/gaze tracking into two groups: gaze-aware and gaze-controlled. Gaze-aware applications are those where a user´s gaze direction and fixation location are tracked, and based on this information, the application can trigger an event. The observed articles can be physical paintings, large scale projections, screens and even sculptures. The triggered events would most likely have the function to provide additional. In practice, visitors should see at original painting in the museum, but when they focus gaze on some details or part of painting (for example on the face) would start for example the sound on the background (Figure 5). Gaze-controlled applications are the ones where a user can actively interact with content (displayed on a screen, or projected) by using eye-movements. On the very large painting it can work as "zoom" and "pan" tools. Using eye-gestures it is possible to zoom-in (gaze to the left), zoom-out (gaze to the right), grab (gaze up) and drop the object (gaze down) [6].

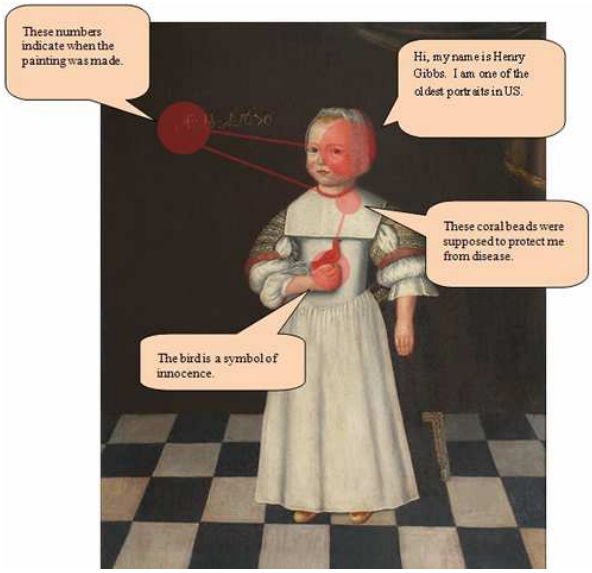

Figure 5: An example of gaze-aware museum application. Red circles indicate points of gaze fixation. Callout boxes indicate the sound played after triggering on a target; according to Milkevic [6].

5.2 Cathedrals, castles, bridges…

Not only art-works but interiors and exteriors of buildings can be analyzed by eye tracking - how people feel huge space and in what they are interested in inside the big cathedrals, what is attractive inside palace or castles, how new facade changes perception of the castle, which part of the bridge is the most photogenic etc.

5.3 Information systems in the museums

At Utrecht University was developed Medieval Memoria Online (MeMO) project (Figure 6). This project aims to facilitate research of the medieval culture of remembrance and it is nice example of RIA concept for cultural heritage in practice. The presentation has four levels. The user enters the application through a graphic layer, which is to be explored and consists of reproductions of paintings, maps and original historical documents. This activity takes the user to the second level, which is largely text-based, with illustrations and interactive. On the third level the reader can zoom into images, e.g. photos of charters or other textual sources. Relevant passages are highlighted and provided with a transcription and translation. The lowest level comprises research notes with detailed comments, like extensive footnotes in printed publications. This way of publishing is available just because of RIA approach an it was chosen, not only to excite a broader interest for the subject itself, but also to demonstrate how conclusions were achieved and how art objects may be interpreted in connection with other, textual sources, thus showing the importance of crossing the borders of academic disciplines such as history, art history and literary history [2].

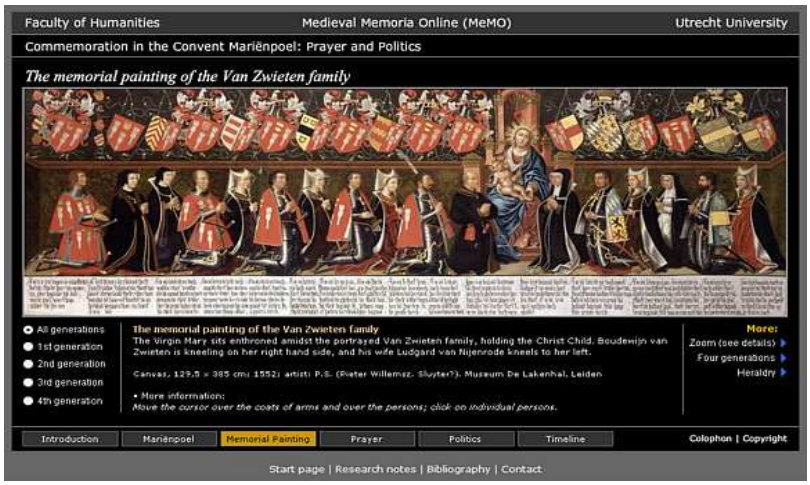

Figure 6: Medieval Memoria Online – Rich Internet Application focused on paintings; source [2].

A system that generates presentations of artworks in a museum is concentrate to the behavior of a person visiting the museum. On the one hand, the system must facilitate movements within the space by aiding the orientation of the user using appropriate linguistic support ("to your right you will see…"), then proposing suggestions about the best route for continuing the visit ("the next room contains an interesting…"). On the other hand, the system must be able to interpret the implicit intentions of the person's movements. For example, the prolonged observation of one object may be interpreted as a sign of interest [11].

The future of museum guides has some keywords: 3D, dynamics, interactivity and sound. Also it allows implement not only plain sound, but 3D audio effects, noises characteristic voices and sounds. Combination of these factors stimulate user's attention and bring some "added" value compared with recent other applications.

5.4 Archeology

There is a one big restriction in cultural heritage, especially in archeology. The works are often priceless and it is not possible to show and share it at public. Archaeology is other field where large research community shares lots of data, for which purpose online databases and Internet applications are used. There are numerous of spatial archeology databases like Online Cultural Heritage Research Environment (OCHRE) developed at the University of Chicago, and targeted at a varied group of historical disciplines, including archaeologists. It requires a Java client application, which communicates with a backend database, being a central, XML-based repository, in which data from multiple sources have been integrated following the data warehouse concept [2].

Another example is TArcHNA project (Towards Archaeological Heritage New Accessibility). It intends to develop new models and tools for accessing archaeological heritage with focus on mobile devices. The mobile application is a modified version of desktop TArcHNA designed to work within the compact environment of the PDA/smart-phone. It offers the user the same basic functionality as the web-based application, and it is designed for use while in the field, visiting archaeological sites. In addition the users' exact position and overall route can be represented on the map using a GPS receiver [1].

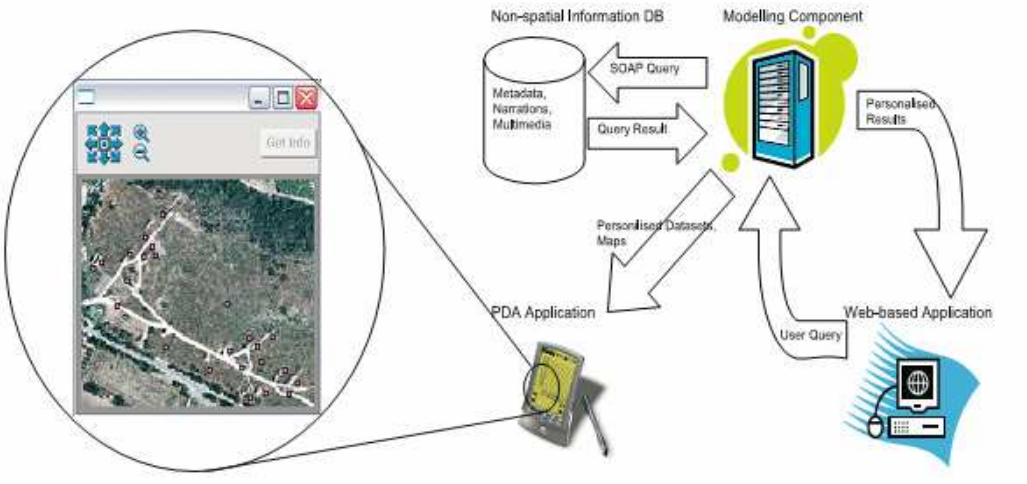

Figure 7: Structure of TArcHNA mobile application; source [1].

Eye tracking technology isn't so often used in archeology, but there is place for modeling and visualization. Today are used triangulation-based laser scanners for digital reconstructions. In the process of visualization are used "3D layers" with different colors for highlight some hidden or hard-visible shapes, letters etc. and for their better interpretation [10] (Figure 8). Just in this process can eye tracking bring new methods how to easily indicate hard-visible shapes.

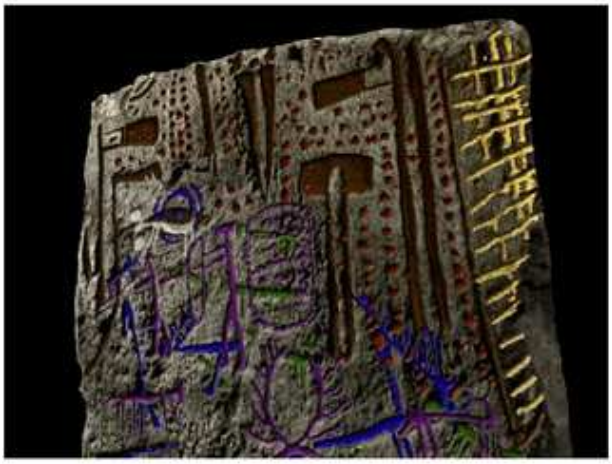

Figure 8: 3D modeling of a prehistoric stone by 3D layers, hard-visible layers are highlighted by different colours; source [10].

6. CONCLUSION

This paper assesses possibilities of implementation absolutely new geoinformation technologies for Cultural Heritage especially with the focus on RIA (Rich Internet Application) concept and eye tracking. Solution based on the concept of RIA application is just a new trend of processing and publishing outputs and brings the tools, practices and conventions from desktop platform into interactive web applications, providing greater user comfort. Thanks to eye tracking device is it possible to evaluate which part of art-works are the most attractive. Another advantage can be the study of historical monuments, which is enabling by combination of technologies RIA and Eye Tracking System.

Like in other revolutions that happened with the digital media (web applications, digitizing libraries and paintings), the only one question is the time, respectively the price. In some years, when eye tracking devices will be cheaper, we will use it in every museum every day. It is a great experience to compare accurate survey data with personal interpretation and knowledge about historical monuments when we compare real and virtual world of cultural heritage.

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