Where information searches for you

The Visible Past ubiquitous knowledge environment for digital humanities

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Abstract— **Visible Past proposes a new class of interdisciplinary learning, documenting, knowledge production, and discovery experiences that are anchored in space and time indicators. The project is supported by a ubiquitous computing platform with wiki, implicit social networking, and location aware capabilities. The environment can be used as an integrated framework for enhancing learning and research in social sciences and humanities. Its main benefit would be involving the student, the researcher, and/or the museum visitor in mobile interactive experiences which rely on social networking around common topics or spaces.**

Keywords-location-aware; 3d; learning; wiki; ubiquitous computing (key words)

I. Introduction

The web is used widely for content, service delivery, and collaboration in humanities, but convenient access to content and applications that deal with spatial and temporal information is not very facile. Moreover, connecting and utilizing content that has spatial or temporal implications across websites and applications, while preserving connections with a specific geography or timeline is still a desideratum. A large part of the problem is derived from the fact that current methods to index information rely on associative hyperlinks and search engines that sort information by textual (keyword) methods, not by spatial location or time of occurrence. Such methods of information sorting, management, and retrieval strongly emphasize subject-matter taxonomies whose categories are not always intuitive. Moreover, such taxonomies leave out of reach a large part of content and services that is naturally associated with time and place.

Visible Past[1] aims to solve some of these shortcomings. It is an open source platform for humanities knowledge management and social networking that utilizes space and time metadata for organizing information [1]. The platform relies on maps and georeferencing of information for browsing the data. It is also location-aware, allowing it to deliver information at a specific location, including in the field, automatically. For example, a cell phone user can get a full archeological report on a Roman temple just by standing in front of it. In other words, learning and discovery in this environment is facilitated by the fact that records of events, research products, narratives, and artifacts are accessed by their geographic and temporal coordinates in addition to the usual hyperlinking [1, 2]. Moreover, the platform enables the emergence of virtual communities of learners capable of organizing content, tools, and services naturally and in a manner that is more immediately intuitive [3]. Such communities can be aggregated not only around declared interests or by initiating "friendship" relationships, but also, and most importantly, through the implicit interests they manifest in specific knowledge areas and/or spaces associated with them.

In its current format, the platform includes richly documented VR models of ancient Rome, 3D and fully immersive computer simulation of the events of the Allies' landing on Omaha Beach and several dozen Asian, Pre-Columbian, African, Middle Eastern, and European models of UNESCO cultural heritage sites. Several model virtual communities will be associated with one of these projects, which will also be used for training the first generation of platform users.

Currently, Visible Past is restricted to maps of the earth, but in the longer term other maps could be considered. For instance, the information can be organized by astronomical and planetary maps; abstract linguistic, cultural or conceptual maps can be used; anatomical maps; and so on. These possibilities can be enabled for by generalizing the association mapping and coordinate systems used.

II. Platform Architecture

The current Visible Past prototype has three carefully delineated components: the content data base, the spatio-temporal index associating content and maps, and the skins, which are clients that present the associated information and allow a variety of navigation strategies. Figure 1 shows the current setup for the Visible Past platform.

We have used the popular MediaWiki software package [4] to create a spatial data association via a space-time index (x, y, z, t-latitude, longitude, altitude and time) with a mapping service [5]. At the heart of the prototype there is a gWiki, a database that stores information spatially and temporally. Navigating to a specific location on the map using the cartographic interface found at the Visble Past site (which can also be accessed on an Iphone cell phone through a dedicated

[1] http://www.visiblepast.net

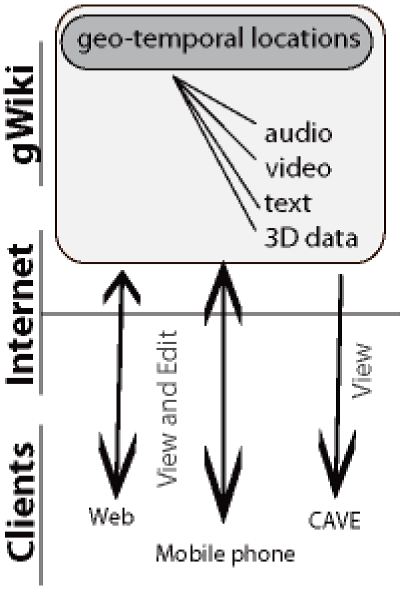

Figure 1

application) gives access to the spatially associated information for that location. Additionally, when using the mobile versions of Visible Past, the system will automatically pull up all the information that is linked to a user's current location. The information first shown to the users are summaries of linked information that allow the user to drill down to more detailed information that is provided in a multi-media format (Figure 2 shows an example of a detail page, along with a cartographic summary panel). These pages are the same on both the web and on the mobile device.

Maps and associated content can be accessed by a variety of devices, including a web application, a client for high-end environments such as a CAVE or a VR theater,[2] and a portable application for low-end environments such as PDAs and cell phones (Iphone). GPS-enabled clients automatically query for the current location, with navigation accomplished by physically moving the client around. As the client moves to new areas, the information linked to that location is automatically pulled up in a summary page for the user to reference if it is needed. Navigation in a CAVE environment can be done in a similar manner. For CAVE visualization and interaction with the web-based data we chose to leverage the X3D standard [6] to implement the three-dimensional simulation components. Our selection of X3D was based on several key factors: (1) it is a mature and open standard with available import/export paths into and out of many common modeling and visualization tools; (2) it is supported by a variety of freely available or open-source browsers, plug-ins, and libraries, including players for the Web, immersive virtual reality displays, and mobile devices; and (3) it defines a set of geospatial extensions for working directly with geo-referenced

Figure 2

models, map levels of detail, and geocentric coordinates that vary over many levels of magnitude (and which would otherwise generate significant rounding artifacts at human scales with naïve single-precision coordinate representations.) Models of 3D environments can be developed in any suitable polygonal modeler. Care should be taken to adhere to the unit and orientation standards established by X3D: units in meters and a right-handed Cartesian coordinate system with y-axis up. The resulting scene is then imported into a program such as Google SketchUp so that it can be geo-referenced and allow surrounding terrain models and maps to be extracted from a terrain database, such as is provided by Google Earth. The resulting model and accompanying terrain is then exported in VRML97 (VRML 2.0) format which can be subsequently converted to X3D format using a conversion utility. (VRML97 is effectively a subset of X3D, so this conversion is straight-forward. Direct export in the X3D format is only now becoming widely available in software packages.)

For the second step, we implement the geographic placemarks by first defining a placemark X3D PROTOtype – essentially a new object class defined from a collection of standard components – with the appropriate visual representations and behaviors associating them to gWiki addresses. The locations, associated gWiki URLs, and other data for the environment's placemarks are extracted from the gWiki database and converted into instances of the X3D prototype with a simple formatting script. The converted model along with the prototype and instances are merged into a master X3D file using references to these component files (known as 'Inline' nodes in X3D parlance[3]). The Octaga player is recommended for visualizing the VRML Model[4].

For the final step, we add supplementary visual and presentation effects, including lighting, viewpoints, fog, backgrounds, audio, simple environmental animations, and stereoscopic viewing parameters. These effects are added to the X3D file via a text editing environment customized for X3D development. These components are selected or modified based on the capabilities of the display platform, the supporting browser, and the desired level of immersion and realism. For

[2] These are room-size, multiscreen 3d environments in which life-size, realistic reconstructions of the past or of imaginary space are reproduced with a high degree of accuracy. The projects takes advantage of Purdue and Indiana Universities CAVE environments (see http://www.envision.purdue.edu and http://www.avl.iu.edu/)

[3] http://www.avl.iu.edu/projects/VisiblePast/

[4] http://www.octaga.com/

example, to display the data correctly in a multi-screen, stereoscopic virtual reality theater, we specify the stereoscopic and full-screen rendering options available in the Instant Reality player [ref IR]. For online Web versions, we specify models and sounds with reduced resolutions to reduce load times, and embed the viewer in a Web page with an accompanying frame to display gWiki content. In an ideal implementation, every environment model should be able to be specified in the same geocentric coordinate system. The geospatial extensions for X3D make this theoretically possible.

The current prototype includes several sample 3D models, some of them in kmz, some in VRML format. There is an immersive mock-up of the Roman Forum painstakingly reconstructed according to archeological methodologies to its state around 400 AD, models of several Roman, Greek, Hindu, Japanese and Central American religious and civilian locations and the military configurations of armaments on Omaha Beach at the time of the Allies' landing on the morning of June 6, 1944[5]. However, this selected and limited collection of models is just an example of possible usage. Any model from any historical period and geographical context could also be employed.

All models and localities are linked through the gWiki with information about the place and timespan of their existence. In addition, we are working on linking Omaha Beach to a game environment that allows students to learn the details of that battle and test what-if scenarios and to network with each other based on interests in specific locations and topics.

Presently, the system resides on a central server. As community contributes more and the content accumulates, a distributed system needs to be deployed. Here, the core gWiki and some of the clients can be individually installed on several servers and then interconnected using a number of procedures including, but not limited to, geoRSS feeds.

The prototype so far associates data indexed by discrete points in time. This is appropriate for small scale events, such as archaeological sites, battle fields, landmarks, etc. When developing material associated with vast geographic or life sciences measurements, on the other hand, extended data sets must be associated wit spatial modeling techniques that allow the models to evolve with time. Such data can be associated by interpolating a scalar 3d field.

To ensure the success of the project we are actively seeking and building community support. We are organizing a number of teaching scenarios at Purdue University, where a number of classes (The Roman Republic, World War II, and the Great Battles of Modern Era) have been or will be taught using Visible Past. The virtual communities and the classes that will support them will be structured around clear organizational and normative templates or role repertories derived from social scientific research on virtual communities [7, 8]. The templates will be supported by user-centric software with community/collaboration capabilities. This will be enhanced by the fact that the platform will foster social networking and social sharing of knowledge through recommendation systems derived from user behavior and through direct social networking features such as friend lists and listings of users who are investigating the same area. A mock up of the proposed site is currently online[6]).

Visible Past is a logical next step in our quest for creating digital humanities environments and integrating them in the cyberinfrastructure. It goes beyond initiative such as MIT's OCW initiative [9], which uses the traditional curriculum delivery: syllabus, presentation materials (PowerPoint slides), readings, textbook references, exams. Our proposed platform helps us making the transition from a static learning material and one-way teacher-student communication concept to a collaborative and engaging learning environment that maximizes learner participation. The technology to do this is available today.

The software and the community template proposed by the project would be especially appropriate for research and education in history, archeology, anthropology, geography but also earth and atmospheric sciences, civil engineering, paleo-environment studies, forensic investigations, economic and social simulation – the fields in which it makes sense to organize data by spatial principles and in which location-aware delivery of content is helpful. It is also highly suitable for educational museum exhibits. Thus, the project aims to create future bridges between humanities and other types of learning and discovery [10].

III. Future Work

The gWiki mobile application is currently in a pre-alpha phase. For the future, we plan to integrate the system further into classroom environments by requiring its use for the majority of class assignments. During classroom use, user studies will be conducted to assess how the students prefer to use it and identify potential areas for further improvement. The next phase of development for the mobile application is adding in a layer of augmented reality that will allow the user to see on the mobile device's camera where various data points have been placed by others, in a method similar to Layar[7]. Additionally, as the application progresses, the ability to see who is actively studying a user's current data point and the surrounding locations is planned to be included, plus some other social networking features such as friend lists and chat features. Figure 3 shows how users could potentially see and network with others interested in the same area. Finally, it is hoped to find a way to link models and data into the real environment to create augmented reality mobile applications. The hope for these additions is to enable game-like environments that would allow users to collaborate to complete tasks in real time that are relevant to their classes and interests.

[5] http://visiblepast.net/gwiki/index.php?title=UNESCO_Heritage_Sites

[6] http://visiblepast.net/gwiki/index.php?title=Howto:Help

[7] http://layar.eu/

IV. SIGNIFICANCE AND IMPACT

The Visible Past platform is not just simple software, but a new class of interdisciplinary learning, documenting, knowledge production, and discovery experiences that are anchored in space and time indicators. The proposed environment could become an integrated framework for enhancing learning and research across disciplines [10-12]. Its main benefit would be that it involves the student, the researcher, and/or the museum visitor in interactive and engaging experiences that go beyond simple information transfer [13]. The environment can dramatically improve the quality and interactivity of learning and discovery experiences by transforming the manner in which data and information are turned into knowledge. Until recently, learning space- and time-related subjects has been focused on direct examination of specific artifacts which where only nominally and theoretically associated with maps, plans, book descriptions, paper and pencil exercises, or slideshows. In contrast, the environment that we have created keeps all artifacts, events or structures virtually in situ. Moreover, the environment is scalable across learning situations and technological platforms. It can be used both in dedicated, high tech facilities, such as a fully immersive, 3D, FLEX theatres, and in individual settings, using cheaper and portable devices, such as desktops, laptops, or cell phones. This interoperability is possible because the core of the environment is a geo-referenced database that can be edited on the fly by collaborating users located across the entire world.

Presenting geocoded information from within its accurate geospace engenders a vivacity that appears to not be possible in other media. A scenario wherein a student or researcher can locate information about a place while they are in that place holds great potential for those interested in empowering, enabling, and increasing the efficiency of research and learning. In the past, the organization and presentation (and therefore the discovery) of information has been largely prescriptive; librarians, catalogers, publishers, even authors encode material using complex (but nonetheless rigid) taxonomies and classifications and researchers are expected to locate and discover from within those structures, many of them unintuitive and foreign without consistent practice. The explosion of the web has inverted this model and spread content across millions of computers serving millions of documents containing many millions of potential keywords, but with very little structure. This dispersed, unstructured world of information enables great learning scenarios and techniques but also prohibits the measured, logical, ordered process of research where content as well as the vessels of content no longer share a handful of common traits. Information is no longer contained within an enumerated set of media (book, journal article, news article, CD-ROMs, etc.) but is fragmented and spans innumerable formats; information is no longer available from specific locations (libraries, publishers, etc.) but rather any device that can connect to the internet from most places around the globe; information is no longer discoverable by restrictive languages of retrieval (library classifications, Boolean query syntax, etc.) but is in many

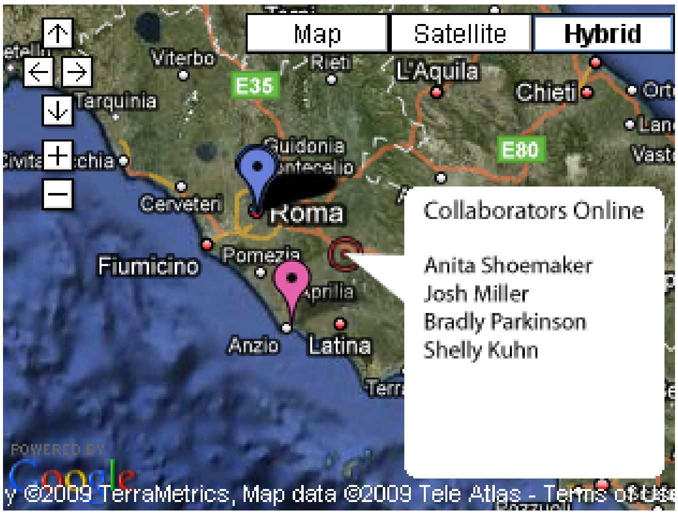

Figure 3

situations being organized, categorized, and cataloged by the authors themselves or by social consensus.

The Visible Past environment brings order to this universe of heterogeneous information by adding a space dimension to information search. More importantly, it is not always necessary to actively search for information for the system to make its utility felt. Its location and ubiquitous capabilities ensures that as long the user location is known to the system, information will be delivered to her. In effect, through Visible Past, information searches for its users.

AKNOWLEDGMENT

The authors thank Mike Boyles and Jeff Rogers at the Advanced Visualization Lab of Indiana University as well as Chris Miller, Nick Rauh and David Braun, at Purdue University, for their advice and support. The Visible Past software was written by a group of very talented undergraduate students at Purdue University: Chris Hartman, Galymzhan Uteulin, and Jeff Neufert. The Visible Past content was collected and organized by Ed Park. The Iphone application was created by Fuhe Xu, Matt Sbai, Matthew Swanson, and Ryan F. Scott, while enrolled in the Vertically Integrated Projects course project at Purdue University. The VIP project is directed by Aron Ault and Jim Krogmeier

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