Digital Athens: An Application of ArchiTOUR, a Multimedia Authoring System

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This paper presents an educational software package for teaching and learning architectural history and theory. The package called Digital Athens is intended to teach architecture in Ancient Athens. It has been developed with the ArchiTOUR multimedia authoring system. ArchiTOUR is a special-purpose authoring system for architectural education, especially architectural history and theory. It proposes an efficient way to handle and present the diverse multimedia data that architectural education requires. The first section of this paper describes the ArchiTOUR multimedia authoring system. ArchiTOUR's main features include 1) three different working modes; 2) ArchiTOUR objects; 3) linking ArchiTOUR objects; and 4) ArchiTOUR hotspots. The next part presents Digital Athens as an application of ArchiTOUR. This segment demonstrates the main ideas involved in the package and the authoring system by illustrating the contents of Digital Athens. Finally, the last part discusses future extensions of ArchiTOUR as well as the Digital Athens package itself.

Keywords: multimedia, hypermedia, authoring, 3D visualization, and history and theory.

1   Introduction

This paper presents an educational software package for teaching and learning architectural history and theory. The package called Digital Athens is intended to teach architecture in ancient Athens. It has been developed with the ArchiTOUR multimedia authoring system.

The main research question in this paper is how the computer can help in teaching and learning architectural history and theory. Some researchers have explored this issue from various perspectives and ways. One research attempts to use 3D visualization tools to study historic sites and buildings [Pelt & Seebohm, 1990; Seebohm, 1992], while another uses 2D drafting tools to analyze facades of historic buildings [Seebohm, 1990]. Some research focuses on building databases for history and theory classes using hypermedia technology [Millet et al., 1991] and others stress on searching and collecting architectural information via worldwide networks such as Internet [Choi, 1994]. However, no research has yet attempted to develop a framework that would allow teachers and students to easily create and manage applications for subjects in these classes. Due to the characteristics of these classes the framework also needs to support capabilities to handle multimedia data-2D and 3D vector graphics-- in flexible ways. Currently not many systems provide these requirements. This paper focuses on exploring this specific problem area.

ArchiTOUR is a prototype system developed to investigate these research issues. During its development such current computer technologies as hypermedia, multimedia, and 3D visualization were tested to probe the pedagogical as well as technological

implications for architectural education. Digital Athens was developed to test and evaluate the prototype authoring system.

ArchiTOUR is a special-purpose authoring system for architectural education, especially architectural history and theory. It proposes an efficient way to handle and present the diverse multimedia data that architectural education requires: text, raster images, 2D draftings, 3D models, sound, and animation. As computer technology advances, it is now possible to search, collect, manipulate, and handle architectural information within a single-interface environment. ArchiTOUR includes current computer technologies such as multimedia, hypermedia, and 3D visualization.

The next chapter describes the overview of the ArchiTOUR multimedia authoring system. Four main features include:

(1) three different working modes;
(2) ArchiTOUR objects;
(3) linking ArchiTOUR objects; and
(4) ArchiTOUR hotspots.

The third chapter presents the main concern of the paper, Digital Athens as an application of ArchiTOUR. By illustrating the contents of Digital Athens main ideas involved in the package and the authoring system are demonstrated. The ideas include how to present and navigate through multimedia information, the notion of dynamic presentation, and how the package can be used for teaching and learning the subject matters. Finally, the last chapter discusses possibilities for future extensions of ArchiTOUR as well as the Digital Athens package itself.

2   ArchiTOUR: A Multimedia Authoring System

2.1   Design goals of ArchiTOUR

ArchiTOUR was designed specifically to meet the needs of architectural history and theory courses. These courses have four characteristics that need to be considered when designing ArchiTOUR:

(a) requirement of access to and manipulation of a great amount of information;
(b) utilization of a variety of types of information, often multimedia;
(c) the need for teachers and students cross-referencing this information; and
(d) encouraging students to transfer knowledge acquired from history and theory classes to their design studios, and vice versa.

Based on these characteristics the design of ArchiTOUR focuses on seven issues:

(1) the use of "Tour metaphors,
(2) multimedia presentation,
(3) hypermedia presentation,
(4) authoring environment,
(5) user-friendly interface,
(6) portability, and
(7) utilizing other software packages.

2.2   ArchiTOUR data model: separating structure and content

This type of data model, where links and nodes are separated, has several merits over other models in which links are embedded in documents. First, maintenance is accommodated by separating structure and content. For example, if a node is removed from the hypermedia database, then all links to the node that is being removed can also be removed, thus allowing users to avoid dangling references. Second, nodes and links can be created, modified and deleted independently since hyperlinks are stored in a separate document. Lastly, this model provides an easy way to support a back-link capability that identifies links with a node.

2.3   Three working modes

There are three working modes available in ArchiTOUR: a Creation Mode, an Editing Mode and a Navigation Mode. The mode is important because it determines the effects of certain functions. For example, clicking on a text box while in the Creation Mode would allow the user to move that text box. If you click on a text box while in the Editing Mode, a dialog box will appear.
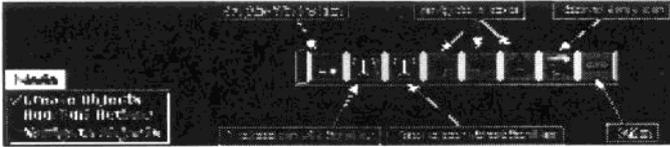
Figure 1: Three Working Modes and the Object Palette in ArchiTOUR

In the Creation Mode, users can create an ArchiTOUR object (a visual entity having its own attributes and actions (Figure 2)) by clicking an icon in the object palette. These ArchiTOUR objects belong to a separate window called "Trip that serves as a working area for other objects. Once the users create an object, they can resize and/or move the object in this mode to design the screen layout they want.

Figure 2: ArchiTOUR Objects

Once the users have more than one object for a presentation, they can define actions and/or attributes for each object. Each object has a different set of attributes and actions. In general, actions and attributes for each object are defined automatically by default. However, some object actions are not automatically defined. For example, the users always need to define an initial file to load for Graphics and Text objects. Otherwise, the object would not contain any information.

In the Navigation Mode the users can navigate through the ArchiTOUR objects with a mouse. This navigational scheme is based on the idea of developing a user-friendly interface.

2.4   ArchiTOUR objects

An ArchiTOUR Presentation (an application package of ArchiTOUR) contains many objects. There are several types of ArchiTOUR objects.

(a) Trip: A Trip serves as a playground for other ArchiTOUR objects. A Trip does not have any action, but can have a pattern and/or a background picture;

(b) Text Box: A Text Box allows the user to navigate through various texts. Six tools for each text box are available on the top of the text box (Figure 3). The first three tools are navigational tools such as "Go Home Page", "Next", and 'Previous'. The next one is a tool for searching text in the current text file and/or a set of text files in the databases. The last two tools modulate the font size for various purposes. For example, during a classroom presentation the instructor may want to increase the font size so that students can read the text easily.

(c) Graphics Window: A Graphics Window allows the user to visualize one of many multimedia files such as 2D draftings, 3D models, plain images, animation, sound, etc.

(d) Navigation Icon: A Navigation Icon allows the user to move through different Trips;

(e) Jump Icon: A Jump Icon allows the user to move from one ArchiTOUR presentation to another or activate other application programs; and

(f) Button: A Button acts like a hotspot and shows a descriptive name. Several different shapes for a button, such as a circle, arrows, and rectangles, can be created.
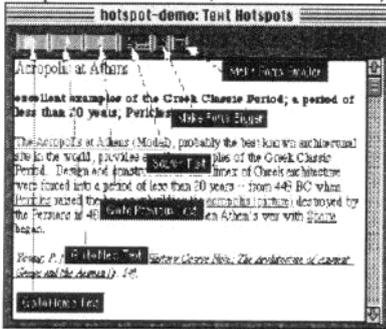

Figure 3: A Text Box

2.5   Linking ArchiTOUR Objects

ArchiTOUR objects can be linked to each other in many ways, depending on the objects to be linked. ArchiTOUR objects contain anchors shown in Figure 4. A special type of object, an anchor, denotes the point where objects connect.
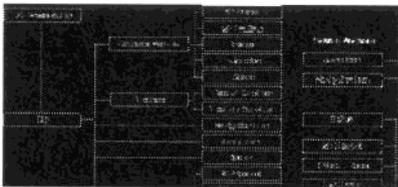

Figure 4: ArchiTOUR Objects and Anchors

There are two types of anchors: source anchors and destination anchors. A source anchor is an anchor where a hyperlink is connected from. In other words, the user is expected to invoke a source anchor to make the link work. On the other hand, a destination anchor is an anchor where a hyperlink is pointing to. When the user invokes a source anchor, the result is shown in the corresponding destination anchor.

The source anchors are divided into three types: Jump Icons, Navigation Icons, and Buttons and Hotspots. They can be distinguished by the destination anchors they are connected to. While a Jump Icon can point only to an ArchiTOUR Presentation (or a Program) and a Navigation Icon can point only to a Trip, Buttons and Hotspots can be inked to any type of destination anchor except an ArchiTOUR Presentation as shown in Figure 4. A source anchor A can also be linked to another source anchor B. From the view of the object-oriented paradigm, the second anchor B inherits actions from the first anchor A. This feature is especially useful when the user has multiple source anchors pointing to a single destination anchor. Instead of creating multiple links from each source anchor to the destination anchor the user can create a chain of source anchors (or a source anchor group) by pointing only the last source anchor to its destination.

The user can also specify a number of seconds for time delay before the action. With this feature the user can create an ArchiTOUR Presentation which runs automatically with a pre-defined scenario. The author can also set a mouse button option instead of using delay time to make the presentation interactive at any point.

2.6   ArchiTOUR Hotspots

Hotspots are an important tool for providing a deeper level of integration in the ArchiTOUR authoring environment. They enable cross-referencing among multimedia objects such as images, 2D draftings, 3D models, and text which are treated as entities, where each entity may be considered as the lowest-level data unit without these hotspots. They enable cross-referencing among objects. There are four types of hotspots: polygon hotspots, object hotspots, ATML hotspots, and text hots pots.

(a) Polygon Hots pots: This type works with the 2D space of a raster image or a vector graphics such as a 20 drafting or a 3D model. It uses special buttons designed to let the user interact directly with raster/vector graphics. It can be distinguished from general buttons in the following aspects:

(1) it needs not be rectangular; rather, it can take the shape of any arbitrary polygon;

(2) it typically has minimal or even no visual representation; and

(3) it automatically relates to part of the image to which it is linked, even if the image is scaled, moved, or sized.

(b) Object Hotspots: An object hotspot has the same three characteristics of polygon hotspots. Yet, whereas polygon hotspots denote an area on the screen, object hotspots are defined by the actual entities in the 2D draftings or 3D models. To create an object hotspot the user selects an object in a 2D drafting or a 3D model. Once the user selects an object, the object becomes a marked object, an object hotspot that can be linked to other ArchiTOUR objects. Object hotspots as well as polygon hotspots can be either visible or invisible.

In ArchiTOUR a user can use two types of spatial queries along with a 2D drafting: 2D object hotspots and polygon hotspots. A 2D object hotspot is useful for providing a spatial query directly related to an object in a 2D drafting, whereas a polygon hotspot is good for providing a region-related information (See Figure 5).
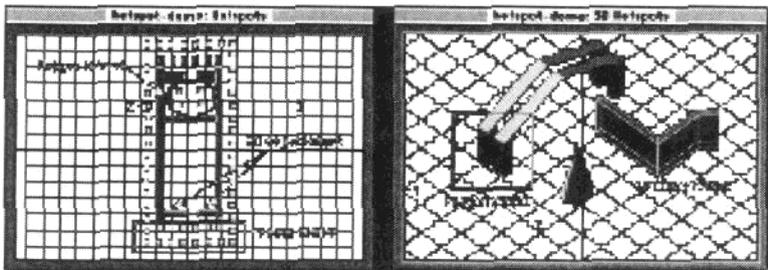

Figure 5: Types of Spatial Queries in a 2D Drafting and a 3D Model

The polygon hotspot is also available in a 3D model, but needs to be used carefully since the user can change the view angle. Therefore, the use of polygon hotspots in a 3D model is limited. On the other hand, a 3D object hotspot is equivalent to a 2D object hotspot in a drafting for a model. However, multiple objects cannot be grouped yet. This is a feature that needs to be implemented in the future extension of ArchiTOUR.

(c) ATML (ArchiTOUR Text Markup Language) Hotspot: It has been implemented to support the hypertext capability in the ArchiTOUR environment. ATML will include Hypertext Markup Language (HTML), though the current version of ATML does not contain many syntax from HTML. The following are some features that have been implemented:

(1) Font Styles: font styles can be specified for a string or text;

(2) Title and Subtitle: Providing titles and subtitles for textual information allows users to review a large amount of textual information rapidly (Kaltenbach and Preiss, 1994). ATML contains titles and subtitles in an ATML file. For a title, ATML uses <T> before the string and </T> after the string;

(3) Bibliographical Reference: ATML uses <SRC> and </SRC> for a bibliographical reference; and

(4) Multimedia Referencing: Lastly, ATML supports multimedia referencing to any ArchiTOUR object. It is especially useful to link to any multimedia file from local as well as global databases.

(d) Text Hotspots: Unlike the ATML hotspot, a text hotspot can be created directly within the ArchiTOUR environment. While this type of hotspot is sometimes useful to create a link that is not specified in an ATML file it often creates a dangling reference.

(e) Interface Issues Related to Hotspots: There are two important aspects:

First, how does a user know where to find or if there are any hotspots on an image? Three solutions to the first problem can be considered. The first is to highlight the hotspot in some way, either by drawing in the edge or by applying a mask to the whole region. The second solution is to change the cursor shape when the user moves the cursor to the inside of a hotspot. For polygon and object hotspots, ArchiTOUR uses a special cursor shape to indicate a hotspot. However, for the text hotspot, ArchiTOUR currently does not change the cursor shape. Instead, it highlights the text with a specified color and a underlined style. A third approach that has not yet been implemented is to add a text label or icon to the hotspot to indicate its presence.

Secondly, how does the user know what will happen when a hotspot is selected? For this problem a user can indicate a data type to be linked for a text hotspot. Attaching an icon like the one in the NCSA Mosaic, a WWW client, might be a future extension. However, currently there is no indication for polygon and object hotspots. A future solution might include having a text box to show a help message to indicate such information when the user selects a hotspot.

(f) The Use of Spatial Referencing: Spatial referencing is the reverse of a spatial query. Whereas a spatial query is an entity that leads to information related to it, spatial referencing means that the destination data contains spatial information.
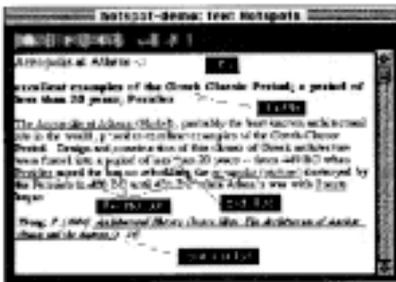
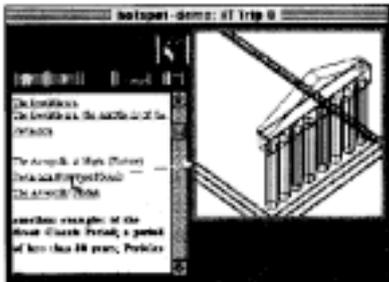

Figure 6: Text Hotspots and ATML Font Types

Figure 7: A Text Hotspot Linked to a 3D Model

In ArchiTOUR the idea of spatial referencing is used in several ways. First, it can show levels of details related to a vector graphics. A second use is to show information from a different viewpoint. The last use of spatial referencing is to relate a piece of information to regions or objects in a vector graphics.
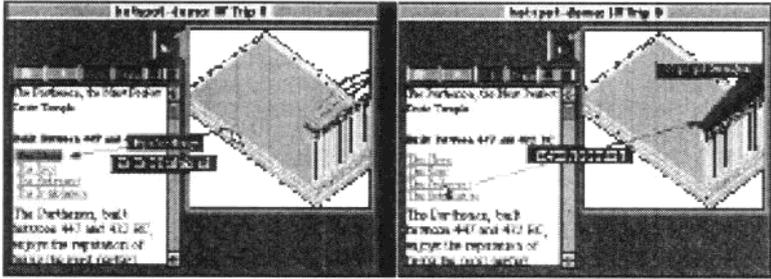
Figure 8: Spatial Query and Spatial Referencing

3 A case study: digital Athens

Digital Athens is an experimental application developed mainly for testing and demonstrating ArchiTOUR's authoring capabilities. Buildings in Ancient Athens have been selected as a case study because they comprise one of the most influential heritages in architectural history with well-known historic sites and buildings such as the Agora and the Acropolis. To construct this application, Digital Athens, data was collected from many different sources. The data based on multimedia forms, such as text, photographs, 2D draftings, 3D models, sound, and animation, has been digitized and stored in the local databases.

The initial screen (Figure 9(a)) of Digital Athens contains six nodes which lead to different subjects about Athens. The six main nodes include: Greek maps(b), an overview of Ancient Greece(c), Greek orders(d), the Acropolis(e), the Agora(f), and other buildings(g). Through the construction of this application, hypermedia concepts presenting architectural multimedia data in a non-linear fashion are tested and further explored. Non-linear presentation helps the users construct structured knowledge since the users can choose their own paths of learning by accessing information randomly.
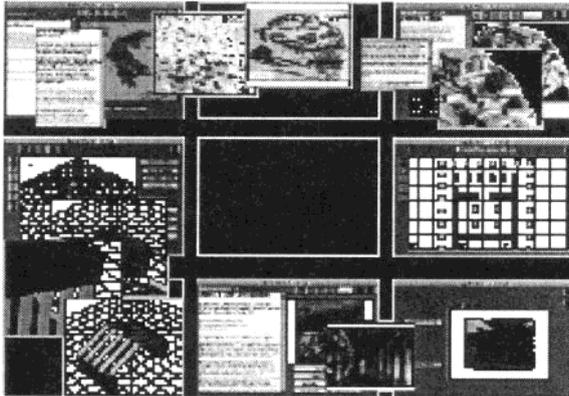

Figure 9: The Initial Screen and Six Different Paths

3.1 Greek Maps

The button "Greek Maps" in the initial screen leads to the Trip "Greek Maps" (Figure 9(b)). Three types of objects are shown in the Trip: a text box, a graphics window, a19 two buttons. The left text box shows an example of hypertext navigation. Some text hotspots in the text box is linked to the "sound" files. The graphics window shows a map of Greece with a visible hotspot on a portion of the map indicating the city of Athens. Invoking the "Athens" hotspot links to the city map of Athens along with several polygon

hotspots for the Acropolis and other buildings. In turn, in the map of the Acropolis the user can select a polygon hotspot to explore a specific building in the Acropolis. Two buttons at the bottom of the Trip window give access to show other maps such as a world map.

In this particular example the notion of "maps" has been explored. Maps are an important media in architectural education and practice for several reasons:

(1) they clearly represent visual information about places;

(2) they show spatial relationships between geographic locations; and

(3) they contain macroscopic information useful for architectural design and education.

3.2 *The Acropolis*

This Trip demonstrates the most significant features in ArchiTOUR such as 3D visualization Vector graphics. Four main objects are available in the window: a text box with a scroll bar, a graphics window for 3D models, a graphics window for images, and a text box without a scroll bar. The text box on the left shows general textual information about the Acropolis. The graphics window on the right side shows a perspective view of the Acropolis. Each building in the Acropolis is clickable and defined with a polygon hotspot. As the user selects a hotspot the name of the building shows up in the text box at the bottom. The building name is a hotspot leading to another Trip for the specific building. The graphics window on the bottom left presents a small 3D model for the Acropolis. Selecting the button, "Navigate Model" allows the user to move through the Acropolis in a bigger window. The model can be rendered and each object representing a building is a hotspot which leads to a more detailed model of the building. Buttons available on the right side allows the user to explore other models as well as draftings.

3.3 *Other features in digital Athens*

The Trip titled "Ancient Greece" contains a text box with many hotspots. These hotspots in the form of topics related to Ancient Greece in turn lead to other hypertext information. Each hypertext file contains hotspots linked to multimedia data including other hypertext files. The multimedia data is stored either in the local database (in this case Digital Athens Database) or in the global databases which store general information.

The Trip "Greek Orders" contains three types of objects: a text box, a graphics window, and buttons. Similar to the Trip "Greek Maps" its text box includes many hotspots which connect to other textual information. The text has several parts: a main title, subtitles or keywords, topics as hotspots, the actual content, and the source of the textual information.

An animation file, a Quick-Time Movie, is available by selecting a button in the Trip titled "Other Buildings in Ancient Athens". Each movie can be controlled by three buttons: "Play", "Stop", and 'Rewind".

Finally, other features include personal notebooks; preferences and parameter lists; printing Trips and objects; and history lists and bookmarks.

4   Future development and conclusions

This paper presented an experimental application, Digital Athens, developed with the ArchiTOUR authoring system. Both the application and the authoring system need to be further extended and explored. ArchiTOUR presentations for buildings in other cities in Ancient Greece should be developed to teach and learn buildings in Ancient Greece more thoroughly. Some mechanisms to cross-reference the multiple applications should be explored.

Among many issues for future extensions several important issues include:

(1) a networked educational multimedia authoring system;

(2) better interaction with 3D models, video, and raster images;

(3) analytical database management editors;

(4) searching for local databases;

(5) information search and retrieval via Internet; and

(6) a multimedia information delivery system for architectural design education.

4.1   A networked educational multimedia authoring system

Future ArchiTOUR will be based on the client/server structure shown in Figure 10. In this structure the remote servers will play an important role. These servers will provide many functions as well as multimedia data. The main issue here is what kind communications mechanism these servers use because it will determine the structure of the multimedia databases. The communications mechanism will provide a set of component such as a server, client programs, and a communications protocol.

The future ArchiTOUR interface will allow users to create, search, collect, store or edit multimedia information. Each application will be an application document" that runs by the host authoring system. Thus, any applications interface can be customized h authorized users at any time. Supporting tools will also be documents particularly designed for each application document. Such tools, called "editors', can be categorized into six main groups: media editors, analytical editors, management and storage editors, search and access editors, communication editors, and intelligent tutoring editors. These features described in the following sections, were designed to strengthen and enhance the authoring capabilities.
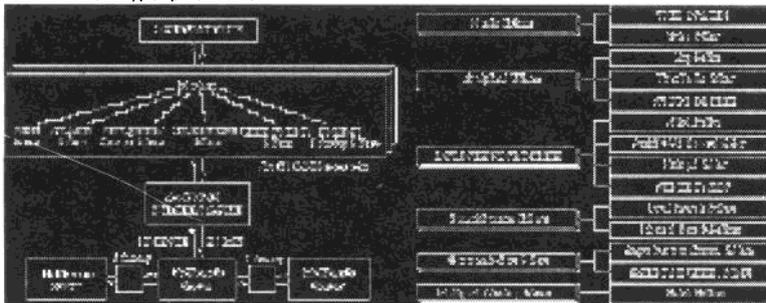

Figure 10: Future ArchiTOUR and the Editors

4.2   Better interaction with 3D models, video, and raster images

Current 3D modeling environments lack the type of interaction that we have when we work with a physical model. The intangibility of computer models often makes the users feel a distance between their models and themselves A remedy for this situation is to provide a virtual environment where design objects are more tangible and the user can feel more immersed. Current VR technology would allow for better interaction between the users and the virtual space as well as the objects in it.

Video is a form of document that is unique compared to other multimedia forms. It reveals information that cannot be presented in text: utilizing spoken language and providing a way to present images of all kinds. Its weaknesses are time-dependency and difficulties in finding patterns (See Hodges et al, 1989; Hodges & Sasnett, 1993). Future ArchiTOUR should address these issues.

Animated objects called "dynamic graphics" can be utilized in raster images to demonstrate a different type of simulation [Hodges & Sasnett, 1993]. Dynamic graphics respond to changes in their environment, dramatically increasing the system's capability to interact with its users. Dynamic graphics will allow ArchiTOUR to provide better ways to integrate these graphics into the multimedia environment.

4.3   Analytical and database management editor

Future ArchiTOUR will provide three types of analytical aids. The first is use of geographic maps that allow the user to navigate through 2D geographic space. A chronological table is another type of analytical aid ArchiTOUR will provide. With the time table the user will be able to examine different historic periods. Finally, the last aid is an architect list available in the architect database. The list will allow the user to find and learn about particular architects, buildings they designed and their design philosophy.

Database management editors include editors for ATML, ArchiTOUR Record, hotspot, and annotation. Issues related to the design of the ATML editor are:

(1) making the contents of the text searchable;

(2) linking to multimedia data;

(3) automating the creation of links;
(4) avoiding dangling references; and
(5) using intentional links.

4.4   Searching for local databases

Searching multimedia databases obviously gives the user more navigational power. Irish and Trigg [1989] explored the searching capabilities in hypermedia systems and identified three types of navigational mechanisms: tracing links to nodes to examine their contents, searching the database for some string, keyword, or attribute value, and navigating around the network using a graphic display.

4.5   Information search and retrieval via Internet

Because of the increasing need for global communication, telecommunications is an active area of research and development in many fields. Several Internet systems are currently available and some popular protocols include World Wide Web (WWW), Wide Area Information Server (WAIS), and Gopher. Such Internet tools have great potential for architectural computing. For example, ArchiWAIS [Choi, 1994] explores the use of the WAIS model for searching and retrieving architectural databases.

World Wide Web is another Internet tool that is even more popular than the WAIS model. The advantages of using WWW include:
(1) an easy way to publish information;
(2) the presentation of images and text in many ways; and
(3) ability to use other protocols such as ftp, WAIS, gopher, etc.

The future extension of ArchiTOUR will explore the web model as a tool for searching architectural databases. To do this, four issues should be addressed:
(1) the structure of architectural databases;
(2) the design of the WWW page which contains several text boxes for a 'fielded search' and many other options for search and retrieval;
(3) implementation of gateway programs such as "SFgate" or "waisgate";
(4) compatibility with commercial systems to manage architectural databases.

4.6   A multimedia information delivery system for architectural design education

The current version of ArchiTOUR is less useful for design studios. One of the main reasons is that it lacks the capability to deliver design information; hindering collaborative design and limiting our ability to integrate the architectural curriculum since architectural design is one of main components in any model of architectural curricula.

Thus, the future version of ArchiTOUR should include features such as "design tutor" and "digital pinup-board" (See Wojtowicz and Davidson, 1992). The former feature is a case-based approach that parallels the cognitive apprenticeship model of learning, and would allow designers to look through design databases containing other works. Similarly, the latter would allow designers to also view projects in progress, thus encouraging collaboration and active participation. Finally, the "design pinup-board" would need to address the following issues:
(1) encapsulating design ideas to transfer these ideas to others;
(2) annotating design information based on multimedia;
(3) managing multiple annotations made by different designers; and
(4) managing different versions of a design.

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6   Acknowledgment