

# Virtual Environment for On-Campus Orientation

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## ABSTRACT

*This paper presents details of the specification, design and functionality of the Virtual UNR Campus software (in short, VCampus), an interactive virtual environment that allows users to explore the 3D representation of the University of Nevada, Reno. VCampus provides a realistic rendering of the university and allows users to obtain useful information such as building names and directories, university historical and statistical data, events scheduled to take place on campus, and area maps centered on specified locations. The users can navigate through the 3D representation of the campus by adopting either a first or a third person view and by selecting either a walking or a flying exploration mode. Various graphical objects can be accessed in the environment to obtain orientation data and general information, a guided tour is available, and communication and collaboration with peers is supported by a multi-user, multi-character real-time interaction facility. The paper also includes a comparison of VCampus with similar projects, a discussion of the environment's advantages and limitations, and a set of pointers to future research and development work.*

**KEYWORDS:** virtual reality, virtual campus, collaborative environment, real-time interaction, 3D modeling, software specification.

## 1. INTRODUCTION

The Virtual University of Nevada Reno Campus (in short, VCampus) is a 3D environment that can be explored by the user by adopting either a first or a third person perspective and by selecting either a walking or flying exploration mode. The focus of this project has been on creating a 3D simulation environment in which useful campus information can be obtained through interaction with various graphical objects and devices. Due to their

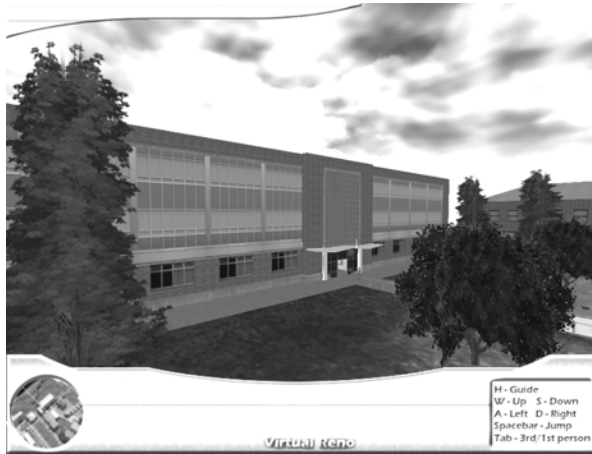
nature, graphics-intensive virtual environments offer endless capabilities for exploration [1, 2, 3] and, in this respect, VCampus is no exception [4, 5]. The functionality of the VCampus software includes displaying information on campus buildings (such as names, directories, and history data), providing maps with details on specified locations, retrieving class information, and advertising events scheduled to take place on campus. A virtual agent (named Matt, after one of the paper's authors) is available to take the user in a guided tour of the university. The software also allows users to communicate with peers by providing support for multi-user, multi-avatar, real-time interaction. In essence, VCampus proposes an attractive 3D graphics-intensive, virtual-reality based approach for providing to prospective and current students, faculty, other employees, and visitors detailed information on a particular real-world location, the University of Nevada, Reno campus (Figure 1).

This paper describes VCampus' functionality and presents details on the environment's software specification and design. Since various software specification aspects of an earlier version of the environment have been presented in a previous publication [5], the focus of this paper is on VCampus' software design and user interface aspects and only several more important software requirements are highlighted. Nevertheless, these requirements provide the "anchor" for the paper, as they are illustrated in the paper at a fair level of detail, with associated snapshots taken from the environment "in action".

A comparison of VCampus with similar recent projects is also included in the paper. This comparison is followed by a discussion of the advantages and limitations of our proposed solution. Several directions of further research and development work are also pointed out.

The paper, in its remaining sections, is structured as follows: Section 2 presents a brief overview of the VCampus environment, Section 3 details some of the

more important software requirements for the environment, Section 4 describes several design aspects of VCampus, Section 5 illustrates the environment's functionality through representative screenshots, Section 6 compares our proposed solution with similar approaches, and Section 7 points to several planned directions of future work and presents the conclusion of the paper.



**Figure 1.** UNR building (SEM)

Picture above shows virtual representation, picture below shows actual building

## 2. VIRTUALCAMPUS: BRIEF OVERVIEW

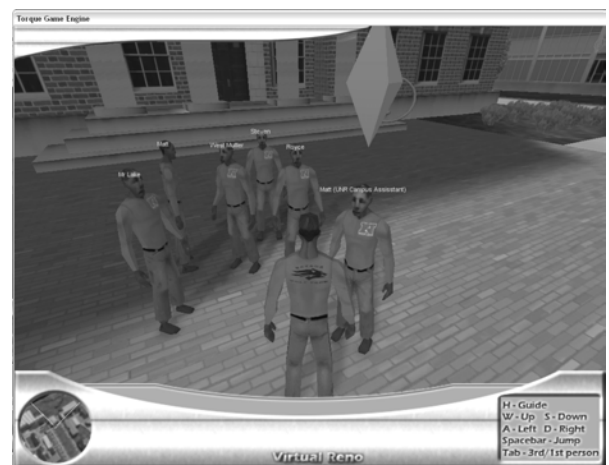
VCampus is a project that started in January 2004 in the Department of Computer Science and Engineering at UNR and resulted in an initial working prototype demonstrated in mid-2004 in several public forums [4, 5, 6]. A Computer Science senior project deemed best in class by peers was completed in May 2005 by the students involved in co-authoring the paper indicated in reference [5]. The facilities available in the original prototype included first and third person views, walking and flying exploration modes (Figure 2 gives an idea of the latter), access to information via interaction with various

graphical objects, and realistic rendering of circa 25 out of the about 80 buildings located in the main UNR campus. VCampus also has had incorporated from its initial version a guided tour where the user could obtain information about each building in video, audio, and text formats.

Currently, the primary objectives of this on-going project are to extend the functionality of the software, model new university buildings and add them to VCampus, improve the rendering of the environment, optimize the software for better performance, and enhance various aspects of the user-interface (for example, the layout of interface and the controls available in the main browser). Among new functionality recently included in VCampus the most notable is the support for multi-user participation and real-time interaction and collaboration. Specifically, several users could log-on in the same running application via a local network or via the Internet and interact in real-time with each other using avatars.



**Figure 2.** View from above the campus (flying mode)



**Figure 3.** Users preparing to go on a guided tour  
Matt, the guide (UNR campus assistant), is on the right-hand side of the image.

Thus, the users can exchange information on various subjects, collaborate on topics of their choice, help each other with data and news related to campus locations and activities, and participate in group explorations of the campus (Figure 3 shows a group of students interested in exploring the university getting ready to go on a guided tour of the campus).

In terms of collaboration and multi-user participation, Vcampus currently supports up to 32 users in one system. Although the above is quite sufficient for the environment's purposes, this will nevertheless be increased in the near future.

Regarding the chat facility, messages are exchanged through a chat window that opens in the top right-hand side of the screen. Through this window, a user can participate to a general chat session or exchange messages with individual users.

More details of the current VCampus software are provided in the next three sections of the paper, while a discussion of planned directions of future work is included in Section 7.

### 3. SPECIFICATION DETAILS

Excerpts from the software requirements specification and use case modeling of Virtual Campus are presented next. The requirements shown have been selected to describe salient features of the environment, but due to space limitations they are far from being complete. For more details on the initial software specification of VCampus the reader is referred to [4]. Note that elements of design and details of VCampus functionality provided in this paper have not been the subject of previous publications. Following the method and notations proposed in [7], the requirements are structured in functional and non-functional requirements as follows..

#### 3.1. Functional Requirements

Some of the main functional requirements of the VCampus are as follows:

1. VCampus shall simulate the UNR campus in 3D, including models of buildings, trees, cars, and people;
2. VCampus shall provide bump mapping for all the buildings to make the environment realistic;
3. VCampus shall allow the user to create and assign a name to an avatar (character) that represents himself or herself in the environment;
4. VCampus shall allow the user to explore the campus using a perspective he or she selects: either first person or third person perspective;
5. VCampus shall allow the user to walk through and fly over the campus;
6. VCampus shall provide the user with the ability to interact with other users' characters in the environment;

7. VCampus shall provide support for user interactivity with static objects. By interacting with these objects, the user should be able to get information on various campus items, for example building names, building directories, and contents of bulletin boards.

#### 3.2. Non-Functional Requirements

Some of the most important non-functional requirements for VCampus are the following:

1. VCampus shall have the ability to run on a Windows machine;
2. VCampus shall support interaction with the mouse and keyboard;
3. VCampus shall be written in C++ and C#;
4. VCampus shall be usable on most new computer systems;
5. VCampus shall include a facility for communication over LAN;
6. VCampus shall include a facility for communication over the Internet;

#### 3.3. Use Case Diagram

The use case diagram shown in Figure 4 depicts some of the main interactions between the user and the VCampus software. The diagram is drawn using the UML notation [8, 9] and, as it is intended for illustration purposes only, presents only a portion of the complete (and rather large) VCampus use case diagram.

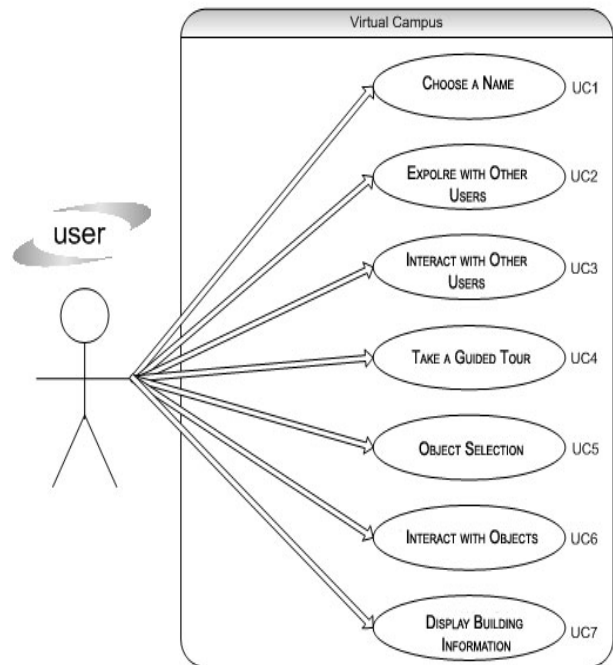


Figure 4. Excerpt from VCampus use case diagram

As it can be seen from the above use case diagram, the VCampus user can choose a name he or she would like to be associated with. Then, the user has the option to explore the campus either by himself or herself or to join other users and go along with them in the trip. In the latter case, the user is able to interact with other users using a real-time chat facility that includes selection of pre-defined expressions. An alternative for the user is to take a tour guided by Matt, the knowledgeable and amiable virtual agent present in the environment. Once the user is familiar with the virtual world he or she can select certain objects in the environment, interact with these objects, and display and record useful information such as building history, location, and directory.

## 4 DESIGN ASPECTS

### 4.1. General Aspects

VCampus' conceptual model borrows elements from several model classes, but fits best in the category of direct manipulation/virtual environment conceptual model [10]. The users can explore a world that is made of objects that represent different pieces of information about that world. The users can interact with these objects, directly manipulate them, and through interaction and direct manipulation can obtain various types of information about the campus.

Also, VCampus incorporates several interface metaphors. For example, VCampus has specialized graphical symbols (3D objects) included in the environment, such as a *handicap access* symbol for buildings that have a handicap access ramp or entrance, or an exclamation mark symbol (*information symbol*) that points out to the user that information is available there about a particular building or other on-campus item (Figure 5). Another metaphor used in VCampus is that of a human tour guide, who can help the user explore the campus.

### 4.2. Software Design

VCampus was developed using a streamlined, iterative and incremental software process [7, 10]. During the design phase of this process, the UML notation was used for the software's high level design (architecture and components) and detailed design (activity charts, pseudo-code). Due to space restrictions, the detailed presentation of design items is left outside the scope of this paper.



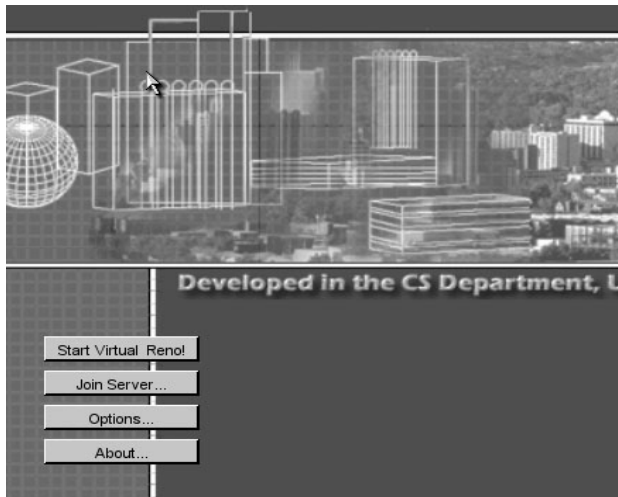
**Figure 5.** Rotating 3D symbols for *handicap access* and *information*

In terms of graphical modeling and rendering, pictures taken with a digital camera have been used as basis for creating the buildings and for obtaining a realistic representation of the campus. The resources available in [11] were used as guidelines for texturing and for creating 3D models of various buildings and other campus components. To obtain efficient program execution, each building or campus part was drawn multiple times with different levels of detail. VCampus employs the Torque game engine [12] for incorporating various 3D models into a standalone, integrated environment.

Details of the environment's user interface design are apparent from the snapshots presented in the next section.

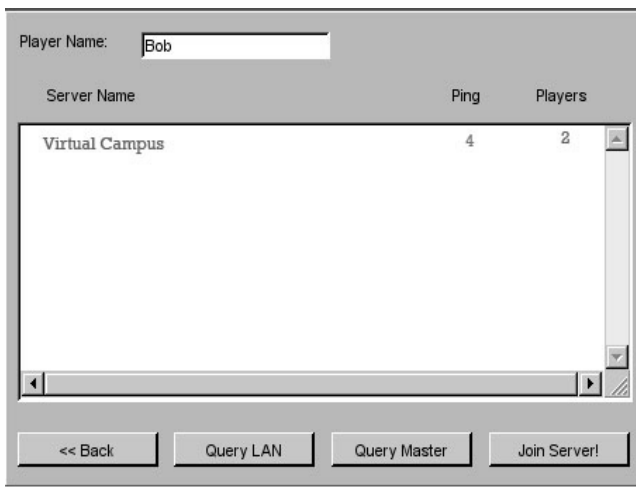
## 5. FUNCTIONALITY DETAILS

VCampus includes numerous functions, and covering all of them is impossible within the scope of this paper. Thus, we refer back to the use case diagram shown in Figure 4 and illustrate with commented screenshots only some of the more important functions of the environment included there. Before that, the initial menu screen of VCampus is shown in Figure 6. From this screen, the user can choose to join a multi-user session by connecting to a server or can customize various aspects of his or her experience with VCampus by setting a number of options (such as the level of the audio volume and the pace of the tour guide). Also from here, the user can select to start the VCampus application in single-user mode.



**Figure 6.** Main menu screen of VCampus

The first use case (“Choose a name”) of the use case diagram presented in Section 3 is illustrated in Figure 7 below. In this case, the user specifies his name and is ready to join a multi-user session via a server.



**Figure 7.** Specifying name and joining a multi-user session

The use case “Explore with other users” has been illustrated in Figure 3 and is further shown in Figure 8. In the latter figure details of interaction with Matt, the interface agent tour guide, are also visible (for example, the users can ask Matt to take them either to a complete tour or to a specific location).

Places a user may explore, either alone or in group, and either guided by himself or guided by Matt, can be both outside (such as the one shown in Figure 9) and inside the buildings (such as the one shown in Figure 10).



**Figure 8.** Group of users talking to the tour guide

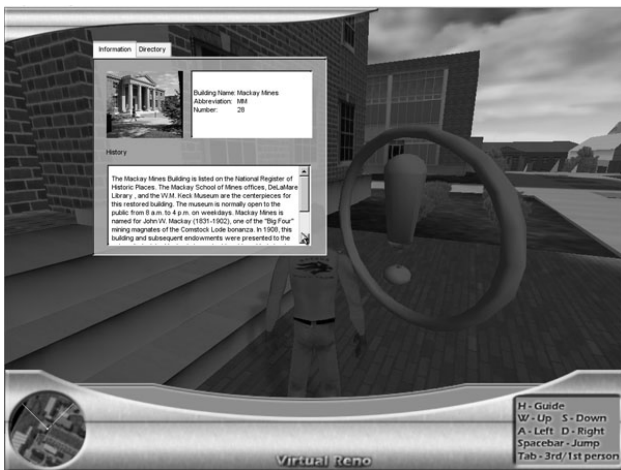


**Figure 9.** View of the Morrill Hall Building (the oldest in UNR campus, built in 1878)

The last three use cases shown at the bottom-right of Figure 4 relate to object selection and interaction (and, as part of this interaction, with obtaining information about buildings and other on-campus items). Examples of objects a user can interact with include bulletin boards, building directories, hallway posters, parking signs, and maps. An information symbol near a building or other campus item lets the user know that he or she can obtain details about that item. When the user navigates his or her character into an information symbol a GUI dialog appears on the screen with the accompanying data about the symbol’s associated item. The dialog is closed when the user navigates away from the information symbol. An example of obtaining information about a building is shown in Figure 11.



**Figure 10.** View of SEM's main lobby (the exterior of this building is shown in Figure 1)



**Figure 11.** Obtaining information about a building (Mackay building)

## 6. COMPARISON WITH SIMILAR PROJECTS AND DISCUSSION

### 6.1. Related Work

Virtual environments of various types have been built for a while now, and good examples with various subjects abound, for example walkthrough environment [13] virtual cities [14] and virtual museums [15, 16]. There are also similar VR products to VCampus, some commercially available such as the one offered by Geosimcities [17]. However, Virtual Campus generally differs from them in important ways.

For example, VCampus is different from the Geosimcities' product in that the users can explore a

campus (not a city) and find out information in video, audio, and text forms. In the Geosimcities program, the user can only receive information visually or as text. Furthermore, VCampus has a talking tour guide that takes the users around campus and shows them all the interesting features the campus has to offer to the students. The Geosimcities' product does not have a similar facility.

Other interesting projects, probably the closest to VCampus, have also been developed [18, 19]. While these solutions incorporate a great amount of functionality (e.g., in [18] it is possible to talk with a virtual admissions counselor or to click on "hot spots" that provide access to various websites), the particular details of graphical representation, the implementation approach, and the options available are nevertheless different in VCampus. For example, the VUCSC environment used at the University of California at Santa Cruz [18] has somewhat less attractive graphics, its interface is not self-explanatory (hence, its functionality and modes of operations take more time to learn), and its primary purpose is that of a teaching aid. The environment at Nanyang Technological University [19] is web-based and uses a VRML engine, and as such it is slower than VCampus and likely more limited in its possibilities of expansion. In addition, our solution is less expensive.

Other products that have some similarities with VCampus are the many virtual tours that schools and universities have on their websites to show how the campus looks like [20, 21]. Virtual Campus is quite different from those because it is not simply a collection of pictures taken from the same campus, but a real-time environment in which the users can get themselves immersed for exploring a realistic and exciting 3D world.

### 6.2 Discussion

VCampus is a prototype software that incorporates many practical features and offers significant opportunities for future development. Perhaps the most useful aspect of this project is to provide the users with a 3D visual representation of a real-world university location. Extracting visual information from 3D media is much more effective than using a 2D map, especially when considering that human eyes view the world in 3D. Currently, the UNR website has a virtual campus tour that is comprised of 2D images taken on campus, but it is only useful in that it contains pictures of individual buildings [20]. However, it is difficult to obtain rich information about the campus as it is presented on this site. With VCampus we propose a more complex, more attractive, and more efficient solution for presenting information – a solution based on a medium that gives the user a first person perspective as if he or she were physically at the real location. The methods that VCampus use to display

information are modern and have the potential to appeal to different categories of audiences.

Also, VCampus has excellent marketing potential, particularly in terms of recruiting new students to the university and for paid advertisement. Universities have practiced sending to potential students material aimed to attract them to register at their institutions. VCampus could be an asset for any university as a recruitment tool. The virtual environment in VCampus could include different parameterized tours tailored for different audiences. For the prospective student, VCampus currently offers a tour of the campus but the environment could be expanded to include a downtown area, an area the student would explore to find out what are the attractions and facilities the city has to offer.

For first time students at a particular institution, VCampus can have an orientation tour to familiarize them with what they need to know about that particular institution's campus. Furthermore, a guide can show the students where the financial and registration offices are located on campus and provide the students the forms and other pertinent information needed for registration. VCampus could be extended to include information on local businesses such as restaurants and retail stores, and thus benefit from paid advertising. A restaurant's owners could pay a monthly fee to have their advertising information displayed in a virtual representation. Businesses could get a lot of exposure with VCampus distributed as a recruitment tool. Each semester, any university could distribute thousands of copies of VCampus to potential students. In short, any university could have a competitive advantage if VCampus is used for advertisement and recruitment.

Also, a commercial version of VCampus could have a significant environmental impact by reducing the amount of printed material that is dispersed by universities through the mail. Instead of printing thousands of informational packets, a university could eliminate the paperwork by incorporating all the required information in a digitized format on a single CD.

Due to the complexity of this project, the current version of VCampus can be improved in many ways. These ways can be grouped in the following categories: additions to functionality, enhancements of the environment's graphics and user interface, code optimization, and more effective modeling of the buildings. Some of these are detailed in the next section.

## 7 FUTURE WORK AND CONCLUSIONS

In terms of new functionality, our immediate plans for future development include displaying bilingual information to accommodate more diverse audiences. Also, another additional feature considered is that of an

interpreter that supports sign language for users who are disabled. Other features we have planned to include in VCampus are the modeling of vehicles (e.g., cars and bikes) that move or are parked within the campus and the availability of a new mode of exploration, which can be called exploration by driving (and, possibly, by cycling). Yet another planned enhancement is to include a facility that uses a step-based plan and directional arrows to provide guidance to the user for traveling from one location to another.

As part of the ongoing development of VCampus, work on other new features such as engine enhancements is currently underway. These enhancements are related to the new technology used today in video games and simulations to create vibrant and vivid worlds that interested users can explore. New technologies planned for VCampus include bump mapping, pixel shading, and objects properties such as reflections.

Representation of characters is also a topic for future enhancements, including graphical aspects, emotion presentation [22], and increased interactivity and believability [23]. Other features, such as a "scavenger hunt" educational game play to increase group participation and familiarization with on campus items, are also considered.

The possibilities for enhancing our simulation are countless and could be focused on many different directions. In fact, we can state that as VCampus has grown, so has the number of enhancement ideas and features that we would like to incorporate in the environment.

The people involved in this project believe that the VCampus environment presented in this paper in terms of specification, design and functionality offers an attractive and practical software solution for exploring a university campus while sitting in front of a remote (or, perhaps, not that remote) computer terminal. Furthermore, this solution has significant potential for future enhancements and constitutes a challenging and exciting topic for research and development.

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