INTERACTIVE 3D VE-CAAD SYSTEM FOR COLLABORATIVE DESIGN AUTOMATION USING RUBY ON RAILS FRAMEWORK

PINYO JINUNTUYA AND PRITTIPORN LOPKERD
Faculty of Architecture and Planning
Thammasat University, Thailand
pinyoji@gmail.com, popoku@hotmail.com

Abstract. This paper presents our 2 commercial CAAD solutions, to evaluate the suitability of tools and programming techniques for enhancing collaboration in design automation process.

Firstly, the paper describes a unique coupling of simulation-based web application with customizable parameters to maximize the possibility of our innovative website design. Architects can use the functionality of software in both preliminary design process and 3D rendering aspects. Customers can change or modify some parameters to satisfy their requirements via internet browser. Our parametric simulation use numerical values input with JavaScript and PHP interface widgets linked to C++ application embedded web server. The result is simulation-based website that allows users to create and customize their own house with fascinating 3D images generated by OpenGL rendering. However, 1024 by 768 pixel-based data transaction from server-client model can not reach all user’s satisfaction, shifted our focus to the creation of an interactive model.

Subsequently, we purpose a personal computer-based CAD solution with real-time cost estimation. Our system also provides design automation features to create the installation of architectural materials simultaneously. Moreover, the interactive 3D virtual environment-based parametric design extends the usage of software to be a part of decision support system. This interactive approach can be used in both 2D plan and 3D perspective view. Comparison to other commercial CAD system, our solution will yield a variety of alternative results and offer the possibility of dedicated software specification. The main work of our on-going research is to integrate both features of web-based accessibility and PC-based interactive CAD system. We are trying to develop web-based CAAD system for enhancing collaborative design automation using Ruby on Rails Web Application Framework, OpenGL as a 3D Graphics Library, and mySQL as database. Ruby on Rails will be used next for alternative approach in our web application development. And we are focusing on the interaction with Ruby API for Google SketchUp Software which should be the appropriated efficient solution for the next integration of collaborative features with customizable requirements.

1. Introduction

The functionality and resources provided by CAD systems have been increasing rapidly, but productivity growth expected from their use has been difficult to achieve. The study (Bhavnani, 1996) revealed that users had levelled-off in their learning and experimentation and were using the CAD system in suboptimal ways. Firms that have used their system for one year report productivity increases of only 5% and typically do not achieve the maximum productivity growth until they have worked with CAD for 5 years.

These include blaming the users for not reading manuals, not using help, not getting adequate training, and not modifying their work process appropriately. Others blame the CAD system for having poorly designed and unnatural interfaces, non-adaptive interfaces, inadequate and unstable functionality, and poorly designed help, training, and documentation.
There is a continuous and urgent need for innovative CAD system development from impact of user’s productivity. Based on this issue, it is essential to develop dedicated system from user-oriented aspect.

2. Background

If we look back at the nature of the research (Lee, 1999) undertaken in architectural computing over the past four decades it is possible to identify two obviously different approaches: (1) viewing computers as a thinking machine and (2) viewing computers as design tools. While the first direction has tried to solve design problems by representing design knowledge, rules or principles in computers, the second direction has aimed to help designer to draw faster, or produce photo-realistic renderings and animation in real time.

Because of the complexities of working process in architectural design, there are many kinds of CAD solution developed to help architects can work in much more efficient approaches.

2.1. COMPUTER SUPPORT COOPERATIVE WORK

CAAD researchers have attempted to gain new ideas from the state-the-art computational technologies or the advanced commercial software. One of the most significant issues is the interest of the appropriate design media for supporting the cooperative working.

The development of telecommunication has already led the designer to use the computer as a medium for communication and collaboration, such as electronic mail, voice mail, white boarding or video-conferencing.

This new information architecture creates new communication activities and new information flows among participants in the design process. At the same time, CAAD researchers have investigated the potentials of web-based design interaction, multi-user workspaces, or shared virtual reality on a web site. These techniques (Buattour, 2007) can be useful to facilitate various information by storing, retrieving, adding, modifying, and managing by sharing and exchanging data with model notions of construction description.

2.2. WEB-BASED VIRTUAL ENVIRONMENT

Virtual Environments (VE) provide a way for people to visualize, manipulate, and interact with computer-generated environments and exceptionally complex data where other human senses can be engaged. Emerging and affordable real-time interactive technologies for Web-based VE (Rafi, 2005) are expected to enhance the design process through better decision-making, improved communication and collaboration, error reduction, increased spatial awareness, interactive design, and real-time visualization.

3. Requirements for Collaborative Design

In cooperative design, participants get such parts to solve and later integrate in partial solutions that are again integrated in a whole design. Such activities of decomposition, task assignment, and solution integration occur throughout the whole design process (Piegl, 2005).

In collaborative design, the participants are not strictly bound to solve assigned partial problems, but are encouraged to engage in solving design problems from other participants as well or to contribute to their design work. One of main objective of Internet-based collaboration tools is their easy and wide accessibility (Blaszczyszyn, 2002). Collaborative design was supposed to emerge when all participants would have equally access to all sources of information on the design task. Implementations of this approach looked at the organizational nature of the design process and tried to incorporate various participants in the information exchange.
Collaborative design environment requires additional functionality to become useful. Good collaborative design process consists with 3 aspects (Achten, 2002). Communication behavior aims at consensus, understanding of mutual goals, and ongoing communication. Subsequently, identification between parties aims at the understanding intention of others. Moreover, communication environment is the key to support these processes.

Collaboration activities can happen synchronously, or asynchronously, at the same location or between remote places. And the characters of Advocacy, Buoyancy, Efficacy, Fluency and Transparency are important principles for designing collaborative tools (Gross, 2007).

4. Programming Techniques for Collaborative Design

4.1. INTERACTIVE CAAD USING C++, OPENGL, AND QT

Our first CAAD Solution is for Roof-tile Company. We developed alternative software for 3D CAAD Simulation with real-time cost estimation. Different from algorithm in other software [Paranandi, 1995], we concerned about user friendly concept. We developed an automatic system in 3D roof design which can generate an interactive simulation with essential parameters in few clicks. We used OpenGL for 3D rendering using C++ language, and Qt library for Graphical User Interface Design.

![Figure 1. 3D CAAD Solution with real-time cost estimation for roof-tile company](image)

4.2. WEB-BASED CAAD USING PHP, C++, OPENGL AND JAVA

While early websites might have had a handful of server-side actions, today’s sites routinely include JavaScript for client-side interactivity and checking dynamically generated web pages, and a complex “back-end” that often includes extensive processing logic written in Java or a scripting language like PHP, distributed processing functionality in a J2EE container, a database management system, and specialized components for security, e-commerce, and management of web services.

For our web-based CAAD Solution, we decided to develop our source code with these technologies. We created another innovative web-based 3D solution for website of Roof-tile Company from scratch. It took 2 years for 3 main developers of each computer language in C++, PHP, and Java.
4.3. VIRTUAL CAAD ENVIRONMENT USING JAVA AND JAVA3D

Java and Java3D technology is one of the appropriated solutions for web-based application development. We are trying to use web application framework to develop our dedicated solution in much more efficient way.

JCAD-VR framework (Conti, 2001) aims to provide the designer with a tool for creating 3D-shapes in a shared VR environment, thus allowing the design to be shared as it evolves. The idea upon which JCAD-VR is being built is that all the users present in the virtual world have to be able to share the same virtual environment in 3D user interface, instead of the traditional menu/windows based layout. Java3D was used to code the GUI and everything concerning the VE (Conti, 2002). Its network-centric nature, its multimedia integration together with the use of native hardware acceleration (OpenGL) and multi-processor support make it the obvious choice for the development of a real-time multimedia collaborative system.

5. Ruby on Rails Web Application Framework for Collaborative Design

The use of web application in CAAD solutions has tremendous benefits for users of web-based systems. Web application is a software application that delivers its functionality to a user from a web server, through a network such as the World Wide Web or an intranet (Wasserman, 2005). The user views and manipulates the application through a Web browser. The development of a successful web application involves many different kinds of design, including functional design, software architecture, business process or workflow design, user interface design, and database design.

At first, web application development was facilitated by the creation of a Common Gateway Interface standard (CGI), which standardized how web servers interact and invoke scripts that could carry out such tasks. However, the CGI approach had limitations. There were performance issues. It was fairly easy to create simple applications but it became difficult and costly to maintain and update more complex sites. This causes developers of enterprise-level systems have to build their code on two key technologies, Java -based J2EE and Microsoft .Net with difficulty on its learning curve and required pragmatic experiences in web programming. In this present, a number of web application frameworks have been introduced to work with these technologies. A framework is a reusable, semi-complete application that can be specialized
to produce custom applications. The introduction of web framework will solve this problem by providing coding skeletons. That means web framework will not only build skeleton applications, but will also stock those applications with defaults so that programmers don’t have to configure everything from scratch.

Ruby on Rails is a powerful framework for rapid web application development using the dynamic and flexible Ruby language, sets out to reduce project cost, make it easier to develop, deploy, and maintain web applications (Oren, 2007).

Using Ruby on Rails can reduce learning curve by providing a set of folders and files which immediately present with a working environment, and a set of best practices which follow the most effective database design.

6. Conclusion and Future Works

We tried to develop CAD solution which should be useful on both collaborative design and decision support system aspects. Our research focuses on design automation process about how cost estimation and decision support system can be improved in such a way that collaboration will help architects, suppliers, and customers can create various usages and alternative design in architectural material selections. Our past experiences in 2 commercial solutions on Interactive 3D Simulation CAAD Software and Web-based 3D Simulation Website, has shown how we use various technologies like C++, PHP, Java, Qt, and OpenGL to develop our user-oriented dedicated CAAD solutions from scratch.

We found the new approach to develop system in efficiency using Ruby on Rails Framework. For next project, we will make a new proposal not to create an innovative CAAD solution. But to develop web-based application which linked to existing CAAD systems like Google SketchUp CAD Software with Ruby API Connection. We are trying to make a demonstration package to show our customers about how to take full possibility from using Ruby API with Ruby on Rail Framework.

Ruby on Rails Framework will be a very considerable way for architects to specify and develop demonstration of their own web applications in a simple manner before experienced programmers coming in complex coding phases. This process will provide high usability in web application development via getting essential requirements from and by users dire.

References