Online Interactive Simulation for Communication of Visual Information
– An Application

by

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Abstract

The strength of the Internet as a means of communication has allowed visual information to be utilized as an effective data sharing paradigm. Traditionally, the sharing of visual data over the Web has involved the use of static images or non-interactive video. The effectiveness of such displays has often been limited by computer capability or bandwidth limitations, and the lack of user interactive control has hampered the power of such displays as a means of dispersing information. A recent application of Adobe Acrobat 3D to view 3D CAD solid model data over the Internet has shown potential as a means of effectively communicating complex visual information to a general audience in an interactive format. This paper addresses the background and development of the application of this technology for the communication of medical information.

I. Introduction

As part of the Computer Graphics Technology (CGT) 411 course (Contemporary Problems in Computer Graphics Technology) at Purdue University, students are expected to seek out, research, and propose/develop a solution to a relevant issue in society that involves graphics. During the fall semester of 2008, four senior level students attempted to address the issue of the lack of relevant and appropriately targeted information for
members of society that are facing joint replacement surgery. This problem is particularly relevant in light of the rapid growth of the elderly segment of the population, and the increasing need for rehabilitative surgery of this nature among this demographic. Experts estimate that the number of knee replacement surgeries will increase by 673% (3.48 million) by the year 2030 in the United States, with hip replacement surgery increasing by more than 170% (572,000) during the same period (Chang, 2006). As individuals face the somewhat daunting prospect of joint replacement surgery, there is often a hesitation to proceed with the needed procedure due to a lack of understanding about the operation and its potential impact of the individual’s quality of life post-replacement. The four students attempted to address this lack of information problem by designing an interactive website that would include information and graphics to assist potential joint replacement candidates. A website was selected as the tool of dissemination based on research indicating that many individuals place credence and trust on medical information retrieved from the Internet (Parekh, Lim, Booth, & Nazarian; 2002). One of the items considered for inclusion on the website was a graphical image or images of the replacement procedure that would alleviate some of the concern of the potential patients. The challenge for the students was to develop a means and method for pictorially communicating the procedure effectively without providing information that was overly disturbing or too surgically realistic for non-medically oriented individuals.

II. Model, Simulation, and Website Creation

The students decided to utilize Adobe Acrobat 3D to display a dynamic simulation on the website. Adobe Acrobat 3D provides for the use of three dimensional objects in PDF format and is generally accessible by most computer users. The students created a 3D solid model of the bone structure anatomy of the human knee and relevant replacement hardware, using a functional knee joint model and actual knee replacement implant parts as references. The model was created using both solid and surface construction techniques in the CATIA software package (See Fig. 1). The CATIA model was imported into Adobe Acrobat 9 Pro Extended software, where lighting and viewing orientations were defined in order to generate the 3D PDF file. This file allows for a significant amount of user interaction as part of the simulation, including real-time control of rotation, translation, zooming, viewing angles, and visualization options such as walk- and fly-through capability. Additional camera views can also be defined to examine the model from multiple angles and parameters. The user also has interactive control of lighting and rendering display options to vary the appearance of the model in the simulation. An additional function that significantly contributes to the ability of the user to interact with the model is the capability to define and orient user-manipulated cutting planes to view cross-sections of the model.

The website that the students designed was reviewed by joint replacement industry professionals and web designers, and the final product reflects their recommendations (www.orthosolution.com). PHP and CSS technologies were used to create the preliminary version of the site, which included information for potential users on joint replacements, testimonials from several individuals that have received replacement.
surgery, and the interactive simulation (See Fig. 2).
III. Survey Information and Results

Qualitative Survey information was gathered on the perceived effectiveness of the website as a means of communication. One of the areas probed by the survey involved the effectiveness of the Adobe Acrobat 3D simulation. 100 responses were collected from individuals of various ages (See Table 1). 42% of the respondents were 20-29 years of age, 15% were between 30-39 years old, 13% of the participants were 40-49, 17% were 50-59, 10% were from the 60-69 age range, and 3% were 70 or older. 97% of the respondents claimed to use computers on a daily basis, and 54% said they use the internet as their primary/first source for medical information.

![Respondents by Age](chart.png)

**Table 1. Survey Respondents by Age**

ANOVA analysis of the survey responses showed that age was not a significant factor in the response for any question. Respondents reported an increase in comfort level and general knowledge regarding joint replacement surgery from viewing the website information and interacting with the simulation. 84% of users claimed an increase in knowledge as a result of the site. 55% of the respondents felt that the simulation was the most effective means of communicating the relevant information, as compared with 23% for the written informational content, and 22% for the testimonials from those who had experienced such surgeries. 95% noted that they would be comfortable recommending the site to others who might be considering joint replacement surgery.
IV. Conclusion and Recommendations

The authors feel that the results of this preliminary research and website application indicate that a website of this nature could be beneficial in providing information and guidance to those involved in medical situations. The results seem to indicate that this initial attempt at an interactive information portal also signify that interactive simulations can be an effective means of communicating valuable information. Although additional research is warranted before solid conclusions can be claimed, preliminary results are promising. Further development of this site and similar informational websites to include additional surgical and medical procedures is recommended. It is also recommended that informational websites of this nature be carefully reviewed in partnership with medical professionals and professional organizations to ensure accuracy and relevance of content.

References


Author Biographies

Dr. Patrick E. Connolly is an Associate Professor in the Department of Computer Graphics Technology with Purdue University at West Lafayette, Indiana. He received his B.S. degree in Design and Graphics Technology and M.S. degree in Computer Integrated Manufacturing from Brigham Young University in Provo, Utah. He completed his Ph.D. in Educational Technology at Purdue University. Dr. Connolly has been teaching at Purdue since 1996, and is active in several professional organizations. Prior to entering academia, he worked for twelve years in the aerospace and computer software industries and has extensive experience in CAD applications and design, CAE software support, and customer service management. His interests include solid modeling applications, visualization techniques, learning styles, virtual reality, and distance learning.
Kimberly Batta Davis is currently working on her Master of Science in Educational Technology at Purdue University in West Lafayette, Indiana. She is working with the College of Education on improving their website. She graduated from Purdue in 2008 with her Bachelor of Science degree in Computer Graphics Technology with a focus in Interactive Multimedia and a minor in Psychology.

Alex Morgan graduated from Purdue University with a Bachelor of Science degree in Computer Graphics Technology focusing in Virtual Product Integration. He is currently working as a Designer for DePuy Orthopaedics in Warsaw, IN. His job consists of making custom patient instruments designed from CT scans of each patient's bones. Based on the surgeon's technique and the design intent of the customized part, he also creates the surgical procedure for application of the parts in each patient's surgery.

Eric Wack is a contract designer for DePuy Orthopaedics in Warsaw, Indiana. He is a 2008 graduate of Purdue University with a bachelor’s degree in Computer Graphics Technology. After graduation he became employed by Miller Consulting, Inc. and hired as a contractor for DePuy Orthopaedics. He is currently working in the custom design department using 3D rendering, CAD skills and is also involved in training new designers. His interests involve medical design, custom product and part development, and utilizing new design techniques.
Ben Wheeler is a recent graduate from Purdue University in May of 2009 where he received his Degree in Computer Graphics Technology and Minor in Film. He continued to pursue his 1 year Internship with Ezra Manufacturing and Distributing this previous summer designing a multipurpose lift prototype, creating digital web content, and building databases via content management systems. He is on call with Ezra Distributing for special projects. He currently assists with General Utility Operations with Aramark Corporation at Eli Lilly Corporate, Indianapolis. His interests include product development, advertising, marketing, publications, web design, best practices and structure, media implementation, and art. After much deliberation and job searching, Ben has accepted the call to serve his country in The United States Air Force as an Officer. Ben is a member of Beta Sigma Psi National Lutheran Fraternity, Greek Intervarsity, and The Hoosier Mountain Bike Association.