

Enhancing a Graduate Biomedical Engineering course with the Web

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Abstract

The Internet has been used to increase the understanding of various technical topics. In the graduate biomedical engineering program at New Jersey Institute of Technology, there is a course that deals with medical instrumentation, including both the theory and applications for a wide range of instrumentation. While the textbook, which is one of the standard texts used by many biomedical programs, covered most of the material adequately, the author merged the use of numerous websites into many of the lectures, providing students with more details about the application of the instrumentation, in a multimedia format. This material enhanced the ability of the students to comprehend the material.

Students were able to also view this material as part of a homework assignment. The paper will describe these various websites, and how they were incorporated into the various lectures, as well as the student evaluation of this process.

Introduction

One of the graduate biomedical engineering courses at New Jersey Institute of Technology (NJIT), called ECE 687, deals with various topics in medical instrumentation. While the textbook¹ effectively deals with many of the topics, there is a need to have students develop a deeper understanding in many of the areas.

A means to achieve this is the Internet, which has become an invaluable research tool for a wide variety of topics. While there are numerous sites for medical research, such as PubMed, the public Medline for biomedical articles, located at <http://www.ncbi.nlm.nih.gov/PubMed/> and Medscape, located at <http://www.medscape.com/>, there are additional sites that provide biomedical related topics that can be used to enhance both textbook and in-class material. There were two uses for this material – in the classroom setting and as a basis for self-study homework assignments.

At NJIT, there are specialized classrooms, which have carts containing a computer and a projector, along with Internet connectivity. These classrooms enable the instructor to combine PowerPoint slide shows and various websites into a classroom discussion. This graduate biomedical course was taught in one of these classrooms.

Websites were found that could enhance the material for several of the topics in this class, including ECG, blood pressure measurements, auscultation, and clinical chemistry instrumentation. This paper will describe these links, as well as describe how they were incorporated with this type of course.

Electrocardiography

While the textbook covered the basics behind an ECG machine, there was insufficient material on the theory behind electrocardiography, and the clinical interpretation. An outstanding course on electrocardiography can be found at the Alan E. Lindsay ECG Learning Center, which is located at <http://medstat.med.utah.edu/kw/ecg/index.html>. This site, authored by Frank G. Yanowitz, M.D, who is an Associate Professor of Medicine at the University of Utah School of Medicine, covers 12 topics in electrocardiography, ranging from an overview of the standard 12 lead ECG to topics such as ECG conduction abnormalities, ST segment abnormalities and ventricular hypertrophy. One of the sub-topics included an explanation of how to calculate heart rate on ECG paper. There is even a discussion on U waves, entitled “Nice Seeing “U” Again”.

The website allows the students to go linearly through the course, or pick random chapters. In each chapter, there are numerous images that can be clicked and expanded, and used in a classroom discussion. An example of such an image is shown in Figure 1. With the smartcart and projector, one can use this graph to illustrate the basic components of an ECG. These types of images were used for further in-class discussions.

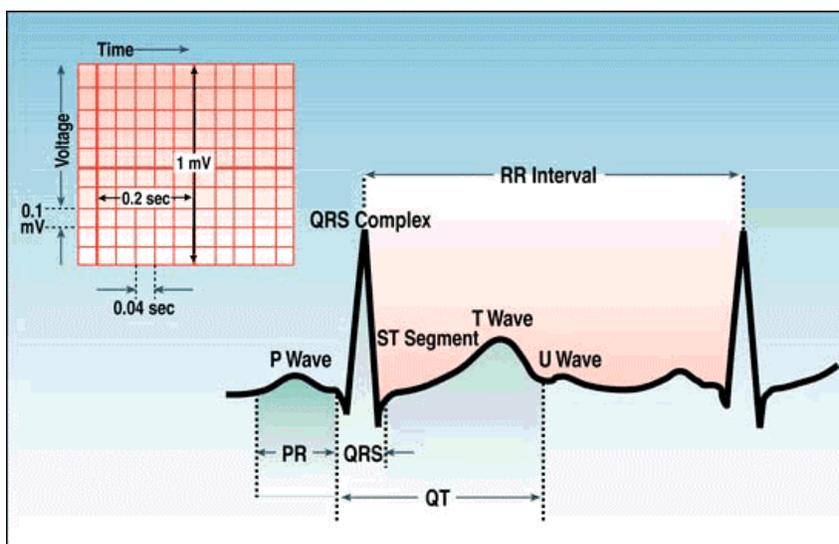


Figure 1 Example of images from Alan E. Lindsay ECG Learning Center

After each chapter, there are a series of questions that can test the student’s knowledge, and these questions can either be incorporated in class, or as follow-up to an assignment. For the medical instrumentation, both methods were used. For testing in-class, students were divided into groups, and the group came up with the answers. If the student gets the wrong answer, the

question could be answered again, or the student could see the correct answer with a detailed explanation.

While several classes could be spent on this website alone, only selected topics, were covered, totaling about 45 minutes of classroom discussion. Students were given assignments for the following two weeks covering material from this website, from section V (ECG rhythm abnormalities) and section VI (ECG conduction abnormalities).

A different method of delivery of this material can be found at a site from New York University Medical School. This site provides shockwave animation, and can be found at

http://endeavor.med.nyu.edu/courses/physiology/courseware/ekg_pt1/EKGtheory1.html

The animation is very effective, especially in covering the various parts of an ECG. A user can click on any link, and the segment of the ECG will blink and provide a brief description of that peak or interval. The discussion of the QRS mean electrical axis is extremely easy to follow, and very detailed. An example of the ECG

To provide a more rigorous examination of the 12 lead ECG, a site that is located at <http://homepages.enterprise.net/djenkins/ecghome.html#contents> was used. This is a 12 lead ECG library homepage, and is a great source of ECG samples for most cardiac abnormalities, as well as providing a good history of the ECG, as well as other ECG links.

The students were assigned, as a group, a mini-paper on various topics with electrocardiography. Besides the websites listed below, another website that the students used can be found at <http://homepages.enterprise.net/djenkins/ecgurls.html>. This site consists of over 30 different links to various web pages that have information on electrocardiography, ranging from information that patients could use to physician test sites.

To also help in this research area, students were given a website for biomedical research, called Medical Matrix, located at <http://www.medscape.com>. The author has found that this site is one of the most comprehensive sites for links to medical research, and provides links to health search engines, journals, and over 2000 specialty related websites in the medical area. Students were expected to identify at least three other sources on the Internet, other than the sites listed in the previous paragraphs that dealt with electrocardiography. Medical Matrix was the starting point for this search.

Phonocardiography and Auscultation

One of the topics that could not be taught effectively by utilizing just the text and PowerPoint slides is auscultation, which was covered when we talked about phonocardiography. Students needed to get a “real-world” experience with auscultation, so they could relate the frequency analysis of the systems to the actual sounds, especially when topics such as murmurs are covered. A site that enabled students to better understand this topic is hosted by the UCLA

Medical School, and was developed by Christopher Cable, MD for second year medical students. The site, <http://www.med.ucla.edu/wilkes/intro.html>, was developed to help these students appreciate the different audio characteristics of heart murmurs and breath sounds. With the use of the smartcart and a loudspeaker, students were able to appreciate the variety of sounds.

Part of the discussion in this area also dealt with stethoscopes, and the author believed that students could benefit from understanding about the history of stethoscopes. By understanding the history of a medical device, students could appreciate how changes in technology can be applied to even the simplest of devices, such as a stethoscope. A website called Medical Antiques Online, located at <http://www.antiquemed.com/tableofcon.html>, provided an in-depth pictorial history of this area. The advantage of the Internet, for a topic area as simple as the stethoscope, is that it can effectively supplement the text. A medical device textbook would not offer the depth of information for this topic that websites such as Medical Antiques Online can provide.

While the intention of going to this website was not to immerse the students in medical history, for those students who were interested in additional topics, Duke University Medical Center offers a site called the History of the Health Sciences World Wide Web Links, located at <http://www2.mc.duke.edu/misc/mla/hhss/HISTLINK.htm#links>. This site has almost 100 different links; many to websites that are contain additional links, all related to medical history. Instructors who want to offer a historical perspective on almost any medical instrumentation area can use this site.

Clinical Chemistry

To help students understand the background of blood analyzers, a website developed by Ed Uthman, MD was used, http://www.neosoft.com/~uthman/blood_cells.html. This website provided a background in Hematopathology. Students were given this website as a homework assignment the week prior to classroom discussions on blood analyzers.

Perhaps the most comprehensive website for clinical chemistry can be found at a website entitled Clinical Laboratory Science Internet Resources©, which was developed by Louis B. Caruana, Ph.D. - <http://members.tripod.com/~LouCaru/index-5.html#Education>. There are over 200 links relating to organizations and information on areas such as hematology, immunology, lab management and microbiology. While there were no assignments from this website, it provided one student with a starting point for a term presentation assignment (this was required of all students).

Pacing and Defibrillation

One of the classroom discussions dealt with pacing and defibrillation, both internal and external. A good site that provided a starting point for multimedia discussion is called Implantable.com, located at <http://www.implantable.com/index.htm>. The best link from that website is the general articles link, which provided a web page that contained links to general articles on pacing.

One of the general article websites that was used in classroom discussions was an article on basic pacemaker timing, by Delos Johnson. This website, which is located at <http://www.studio-delos.com/brady/brady1.htm>, visual showed the basics for pacemakers, a pictorial discussion on indications, and detailed information on the different types of pacemakers. By clicking on the various links, the instructor was able to quickly offer the students an in-depth understanding of pacemakers. Students were required to review the material at home, and write a brief paper on a pacemaker related topic. Another website that students used for this assignment was part of a school project at North Carolina State University, and had concise background information on pacing and defibrillation. This site is located at http://www.bae.ncsu.edu/bae/courses/bae465/1995_projects/scho/index.html

Student Assessment

Students were very enthusiastic about these websites, and wrote in evaluations that these websites made the classroom discussions more interesting, and provided an alternative to the text that in many cases was more informative. Students felt that many of these websites were more concise than the text, and enabled them to understand the information in less time. They also felt that they would look at these websites after the course was completed, fulfilling one of the goals of the university in terms of life-long learning.

Conclusion

The Internet is an invaluable tool, and can be effectively combined in a classroom setting to offer alternative methods of learning information. Various websites were listed which enhanced the learning process for a graduate level medical instrumentation course. These websites were used in classroom discussions, as a pre-review to classroom discussions, and as a post-review involving homework or presentation assignments. Student evaluations were very supportive for this type of Internet-aided learning.

Bibliography

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Ronald H. Rockland received the B.S.E.E. and M.S.E.E. degree from New York University in 1963 and 1967, respectively, and his Ph.D. in bioengineering and electrical engineering from New York University in 1972. He also received an M.B.A. in marketing from the University of St. Thomas, St. Paul, MN in 1977. He is currently an Assistant Professor of Electrical and Computer Engineering Technology at New Jersey Institute of Technology, Newark, NJ, and holds a secondary appointment in the Biomedical Engineering Department. Prior to joining NJIT, Dr. Rockland spent almost 25 years in industry, working in research, engineering, marketing and sales management positions with several high technology corporations. His current research areas are application of computers to the technical learning process and biomedical signal analysis.