Distributed Instrumentation and Computation: A Look at What's Out on the End of the Internet

Jerry C. Hamann, Suresh Muknahallipatna
University of Wyoming

Abstract

This paper provides an overview of some emerging uses of the internet in engineering education and research. Included are descriptions of unique instrumentation and laboratory facilities made available to the world community by way of the ubiquitous web.

1. Introduction

The internet is truly becoming commonplace in education, industry and commerce. It provides a channel for entertainment, advertisement, education and even some good old-fashioned work. The fluid nature of the beast we refer to as "the net" or "the web" is becoming ever more apparent in the form of just precisely what is sitting out there at the end of the connection. The *Uniform Resource Locator* (URL) is taking on nearly universal proportions with potential targets being everything from the University Computer Center Server (we used to say "mainframe") to the COKE machine on the first floor of the Residence Hall. For educators and researchers, the internet is providing a vast communication channel for distributed efforts through collaboration with colleagues at remote locations as well as sharing unique resources such as instrumentation, data archives and laboratories.

In this paper, we examine some of these emerging uses of the internet. The authors have recent experience with placing instrumentation, data logging, and data base retrieval resources on the web to distribute and integrate research findings associated with various projects undertaken at the University of Wyoming. We also discuss changes being introduced in undergraduate curricula to support student and faculty utilization and development of networked resources.

2. The Menagerie Hiding Behind the URLs

While many resources available via the *hypertext transfer protocol* (http, the web) of the internet consist of static, slowly changing text and image files, the growth of dynamic web sites is reaching a fevered pitch. Rather than retrieving fixed information (which can be valuable in its own right), many web surfers are caching in on the availability of dynamic resources: e.g.,

Up-to-the-minute stock quotations from net-savvy investment houses [1]

Regularly, if not immediately, updated weather and climatological data for their local setting or one or more locations around the world [2]

A real-time video perspective of current freeway conditions [3].

Institutes of higher education entered this game quite early, with perhaps the most infamous examples being the networked COKE machine projects which sprang up in the mid 1980's and

have been replicated around the globe in many and various forms [4]. Understandably, not everyone is intrigued with on-line data concerning the availability of caffeine in the nearby vending machine. However, the fact that a group of Caltech students have wired such a machine with electronic eyes, voice, and the ability to vend on demand from a remote web browser leads one to conclude that a whole host of truly valuable "dynamic" resources can be made available on the web.

Indeed, if robots are your game, telerobotic access, where you control a robot at the University of Western Australia from the comfort of your own hometown and favorite web browser, is here [5] and has been for some time [6]. Should you need access to unique microscopy facilities, you can enter the queue at the TelePresence Electronic Laboratory at Argonne National Lab and conduct your exploration through real-time control and imaging on your own desktop [7]. Several telescopes are available to the world community in similar fashion [8,9,10].

3. The Measure of a Dynamic Web Site

Constructing a dynamic presence on the web need not be a "sizable" undertaking. Thanks to advanced yet readily available electronics designs, examples of less than daunting proportions (roughly 4"x4"x2") are now answering the call of many a web browser [11]. For this particular example, real-time weather data can be provided across the web via a readily duplicated, small foot-print web server. Will common household appliances soon be delivered with internet interfaces pre-installed? Size is certainly not a limiting factor. Perhaps one of the most popular devices finding itself attached to the web is the video camera [12].

The measure of "remoteness" is also rapidly changing. If your unique instrument or facility is located in reach of satellite communication services (e.g., in North America, all you need is space for a small satellite dish), "plugging into the web" is absolutely feasible [13] and growing in availability, capacity, and affordability [14].

4. The Dynamic Web and Engineering Education

The web has made a splash in higher education. Interactive web pages provide a means for asynchronous learning [15], where the web provides customized tutorial instruction. The multimedia, hypertext nature of the web is a natural avenue for encouraging or supporting exploration of diverse topics [16,17].

Access to laboratory facilities for undergraduate engineering education is maturing as well [18]. For example, a suite of Engineering Control Systems experiment set-ups [19] have been instrumented and made available to conventional web browsers [20]. This on-line laboratory greatly increases the utilization of unique resources by enhancing access not only in a temporal sense but also via "shrinking geographic distances." The latter feature may prove to be fundamental in the success of several distance learning initiatives, including the Western Governor's Virtual University [21]. Industrial support for the technology underlying such lab facilities is also growing [22,23].

5. Supporting Education for Web Utilization

"Surfing the web" is perhaps one of the various computing skills that engineering educators need not expend effort developing within their students. Thanks to the commonality of the web interface, on-line resources are typically user friendly and quite forgiving. Some exceptions do exist, and the problems are typically encountered when measurement data is shipped from the web resource to the end-user. The authors have dealt with precisely these issues to provide web access to data from instrumentation which monitors several photovoltaic research installations [24]. Skills involving conventional data structures and underlying data formats for computing machinery are necessary ingredients in the future recipe for intelligent web instrument users.

From the development side, undergraduate and graduate engineers are faced with another layer of complexity in the measurement system task in order to provide webbed services. Concepts of client/server task organization underly much of the philosophical design. Web-centric programming languages including Perl, Tkl and Java will be finding their way into support courses due to several features: object orientation, network service capabilities, efficiency in data and text conversion, graphical user interface design.

6. Conclusions

The World Wide Web continues to have a profound impact on engineering education, even beyond the fact that many students (and faculty) have found web browsing to be a suitable excuse for procrastination from the job at hand. One of the on-coming waves in the web momentum is the availability of dynamic resources, such as unique instrumentation or laboratory facilities, at the desktop of every web surfer. This capability should be a boon to both students and educators, however it also demands some re-focusing of supporting education. This commitment by educators is supported by various industries and felt directly by the society impacted by the engineers we educate.

References

[1] "SchwabNow: e.schwab on-line investing," URL http://www.eschwab.com/, 1997.

[2] "The Weather Channel On-Line," URL http://www.weather.com/twc/homepage.twc, 1997.

[3] "Arizona Department of Transportation Trailmaster," URL http://www.azfms.com/, 1997.

[4] "bsy's List of Internet Accessible COKE Machines," URL http://www-cse.ucsd.edu/users/bsy/coke.html, 1997.

[5] "Australia's Telerobot on the Web," URL http://telerobot.mech.uwa.edu.au, 1997.

[6] "Australia's Telerobot on the Web," 26th International Symposium on Industrial Robots, Singapore, October 4-6, 1995.

[7] "TelePresence Microscopy Project Visitor's Gallery," URL http://www.amc.anl.gov/docs/anl/TPM/TPMHomePage.html, 1997.

[8] "Bradford Robotic Telescope Observatory Site," URL http://www.telescope.org/, 1997.

[9] "The UC Santa Barbara Remote Access Astronomy Project Remotely Operated Telescope," URL http://www.deepspace.ucsb.edu/rot.htm, 1997.

[10] "Stardial: an autonomous astronomical camera on the World Wide Web," URL http://www.astro.uiuc.edu/stardial/, 1997.

[11] "The World's Smallest Web Server," URL http://smallest.pharlap.com, 1997.

[12] "Top:Computers and Internet:Internet:Entertainment:Interesting Devices Connected to the Net:Spy Cameras:Indoor Cameras", URL http://www.yahoo.com/Computers_and_Internet/Internet/Entertainment/Interesting_Devices_Connected_to_the_Net/Spy_Cameras/Indoor_Cameras/, 1997.

[13] "Introducing DirectDuo Highspeed Internet Access and Satellite TV," URL http://www.directduo.com/about/, 1997.

[14] "Hughes Communications SPACEWAY Program," URL http://www.hcisat.com/SPACEWAY/revolution.html, 1997.

[15] M. L. Swafford and D. J. Brown, "Mallard: Asynchronous Learning on the World-Wide Web," *1996 ASEE Annual Conference Proceedings*, Session 2632, CD-ROM, Washington, D.C., June 1996.

[16] L. J. Genalo, C. Collier, M. Roberts and J. Sandberg, "Creating Web Explorations in Science and Engineering," *1996 ASEE Annual Conference Proceedings*, Session 2392, CD-ROM, Washington, D.C., June 1996.

[17] M. Rais-Rohani and K. A. Young, "Development of a Multimedia Structural Mechanics Teaching Tool on the World Wide Web," *1996 ASEE Annual Conference Proceedings*, Session 1668, CD-ROM, Washington, D.C., June 1996.

[18] J. Henry, "Controls Laboratory Teaching Via the World Wide Web," *1996 ASEE Annual Conference Proceedings*, Session 3513, CD-ROM, Washington, D.C., June 1996.

[19] J. Henry, "LabView Applications in Engineering Labs: Controls, Chemical, Environmental," Presented at the *1995 ASEE Annual Conference*, Anaheim, CA, June 1995. Text available at URL http://chem.engr.utc.edu/Documents/ASEE-95.html .

[20] J. Henry, "Internet Laboratory Server in Engineering Systems Laboratory," URL http://chem.engr.utc.edu/defaultf.html, 1997.

[21] "Western Governors University," URL http://www.westgov.org/smart/vu/vu.html, 1997.

[22] "National Instruments Live Demos", URL http://www.natinst.com/livedemo/, 1997.

[23] "Hamilton Hallmark Creates a $500 Internet Appliance," URL http://www.qnx.com/realworld/hamilton.html, 1997.

[24] "The University of Wyoming Department of Electrical Engineering Photovoltaic System Data Center," URL http://eepv1.uwyo.edu, 1997.

JERRY C. HAMANN
Jerry Hamann received the BS degree in Electrical Engineering/Bioengineering from the University of Wyoming in 1984. After employment with Hewlett-Packard he returned to the University of Wyoming as a NSF Graduate Fellow, completing the MS degree in 1988. He completed the PhD at the University of Wisconsin in 1993, with emphasis in automatic control systems. He is currently an Assistant Professor of Electrical Engineering.

SURESH S. MUKNAHALLIPATNA
Suresh Muknahallipatna received the BS degree in Electrical Engineering from the University of Bangalore, India, in 1988. After employment he returned to the University of Bangalore to complete an MS degree in 1991. He

completed the PhD at the University of Wyoming in 1995, with an emphasis in Neural Networks. He is currently an Assistant Professor in Electrical Engineering.