Mobile Usability Lab (MU-Lab): A Tool For Studying Medical Device Accessibility

Jack M. Winters[1], Molly Follette Story[2], Sean Campbell[1], Melissa Lemke[1],
Sarma Danturthi[1], Alan Barr[2] and David M. Rempel[2]
Rehabilitation Engineering Research Center on Accessible Medical Instrumentation
[1] Department of Biomedical Engineering, Marquette University, Milwaukee, WI 53233
[2] University of California at San Francisco, Ergonomics Laboratory, Richmond, CA 94804

ABSTRACT

The Mobile Usability Lab (MU-Lab) is a tool being developed by the Rehabilitation Engineering Research Center on Accessible Medical Instrumentation (RERC-AMI) to study the usability of targeted medical devices by individuals with diverse abilities. The system integrates data collection hardware and software, and provides a Protocol Manager that helps facilitate problem identification, planning, data collection and data analysis across the continuum of the medical instrumentation analysis process. Two full systems are being implemented and evaluated, one based at Marquette University and one at the University of California Ergonomics Laboratory.

KEYWORDS

Usability, accessible design, medical instrumentation

BACKGROUND

This paper describes a state-of-the-art usability analysis tool that is designed to be mobile and to meet the needs of the Rehabilitation Engineering Research Center on Accessible Medical Instrumentation (RERC-AMI), MU-Lab. This technology will be used for a variety of RERC-AMI projects, including:

- Research Program R2, that conducts usability analyses of medical instrumentation;
- Research Program R3, that investigates the feasibility of next-generation accessibility measurement approaches;
- Development Program D2, that develops new medical instrumentation in response to problem areas identified and documented in Program R2;
- Development Program D3, that develops and demonstrates approaches for designing medical equipment that is accessible, interoperable, and integrates with interactive telehealth tools.

It is specifically designed for detailed multi-site product accessibility and usability analysis that can be made at a diversity of locations in the greater Milwaukee area (based at Marquette University) and San Francisco Bay Area (based at the University of California Ergonomics Lab). It is being co-designed by the authors, some from each campus.

METHOD

The first aim for the team, which communicates through email and one-three videoconferencing meetings each month, was to refine the design specifications. This process took advantage of team expertise in universal design principles (1), ergonomics, usability analysis methods and accessible design. Specification requirements included:

- Portability (fit into one-two standard carry-on suitcases), reliable, simple and intuitive, light weight)
- Software: A web-based Protocol Manager guides a multi-site research team and on-site experimenters through all stages of the experimental procedure, which includes:
  - Medical device problem statement
  - Pre-screening and tracking of subjects (medical patients and practitioners)
  - Activity performance observations during data collection
  - Post-activity interview of participants
  - Post-activity data analysis
  - Comprehensive research documentation and data tracking.
- Hardware: Synchronized data collection system composed of:
  - Multiple wireless video cameras
  - Audio collection via multi-channel wireless microphone system
  - Wireless sensors: contact ,accelerometer, and force sensors
- Data Collection:
  - Synchronized video, audio and sensor data
  - Capability of acquiring video with a range of compression algorithms, including strong and weak compression
  - Use of Protocol Manager to help administer participant post-activity interview forms
  - Exceptional integrated, interactive data analysis capabilities

These specifications have been met through an iterative process.

RESULTS AND DISCUSSION

MU-Lab uses two carrying cases, a primary case with customized interior foam for housing cameras, tripods and all related equipment other than the laptop and its components, and a second for the laptop computer and its components. Up to four video channels can be integrated into data collection, with several types supported since some environments are expected to involve placement challenges, such as a wide-angle camera for tight settings or a camera with strong zoom capability that must be located at a distance.

The entire data analysis process is coordinated through the Protocol Manager, which was designed through a systematic iterative process that involved over 20 versions by the team. The final specifications are implemented in ASP.Net, C# and XML software in the Microsoft's Video Studio .Net environment, and is available through a login-protected web site. The Protocol Manager guides the user through all aspects of the overall task evaluation process for a given target category of medical instrumentation. This includes cases where the human subjects may involve a practitioner as well as the patient/client. The software can be implemented on a single computer to procure data, or directly to the project web site when an Internet connection is available. The software also has a save and lock mechanism to protect data from accidental overwriting.

Real-time data analysis makes use of Synchronized Video Data Acquisition (SVDA™) software that is developed, along with Multimedia Video Task Analysis (MVTA™) for subsequent task analysis, by Drs. Robert Radwin and Thomas Yen at the University of Wisconsin – Madison (distributed by NexGen Ergonomics). A data acquisition card (NI-DAQ, PCMCIA port) is available for sensor data collection. MVTA provides an iterative environment for ergonomic task analysis. Also available for data analysis are several video editing packages that make use of Adobe Premiere but add speed and a rich

collection of features: Canopus DVStorm2 and Matrox RT.X100. The Protocol Manager is used to help integrate the multi-site data analysis process.

In summary, the MU-Lab provides a tool for sophisticated usability analysis that explicitly integrates in principles of universal design and considerations of accessibility. While focused on the needs and projects of the RERC-AMI, none of the specifications, components and capabilities are proprietary, and the team is open to collaborative relationships.

REFERENCES

1. Story MF, Mueller J. Universal Design Performance Measures for Products. A Tool for Assessing Universal Usability. In *Emerging and Accessible Telecommunications, Information and Healthcare Technologies*, Winters JM, Robinson CJ, Simpson RC and Vanderheiden GC, eds., Arlington: RESNA Press, 2002.

ACKNOWLEDGMENTS

This work is supported by the Rehabilitation Engineering Research Center on Accessible Medical Instrumentation, funded by the National Institute on Disability and Rehabilitation Research, U.S. Department of Education Grant #H133E020729. All opinions are those of the authors.

Author Contact Information:

Jack Winters, Ph.D., Professor and John P. Raynor Distinguished Chair, Department of Biomedical Engineering, Marquette University, PO Box 1881, Milwaukee, WI 53201, jack.winters@marquette.edu