DESIGN RESOURCES

DR-02 Automated Tool for Evaluating Product Usability

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Jennifer Boger, M.A. Sc.Eng., Alex Mihailidis, PhD
Toronto Rehabilitation Institute, University of Toronto

Issue and Its Importance to Universal Design

The Principles of Universal Design are intended to result in products, buildings, or environments that are usable by everyone regardless of their age or ability (Connell et. al. 1997). While product designers make every effort to incorporate these principles in their design solutions, evaluating design usability remains a challenge as usability studies are generally time consuming and costly. Problems associated with the collection of evidence based research on product design include the difficult collection of representative data, the laborious nature of analysing this data and the potential subjectivity of that analysis. Additionally, studies such as these can be compromised when examining product use among user groups that cannot give reliable user feedback, such as older adults with dementia.

Intelligent computer-based systems have the potential to automate (or semi-automate) the process of design evaluation, thereby reducing the cost, time and variability in assessing various designs. In turn, designers could assess their products more reliably and more quickly at a lower cost and could more reliably compare usability between similar products.

Existing Research/Evidence

Measuring product design relative to manufacturing costs, reliability and maintenance has is both quantifiable and repeatable. Product usability, on the other hand, has proven to be more difficult to capture with any rigor. As usability evaluations provide feedback from user groups, it is important that the designer can reliably interpret this data to understand how people interact with a product and the differences between potential user groups. This helps designers to improve the functionality of products and estimate how a new product compares to those that already exist. An automated evaluation tool could enable designers to process the analysis of user evaluations much more quickly with greater cost effectiveness and more reproducible results.

(Current) Design Guidelines

There are many resources available to guide designing with usability in mind. The Usability Professionals' Association provides a list of available guidelines and methods (Usability Professionals' Association, 2009). The International Organization for Standardization (ISO) also has issued reports and standards, such as those on Human-Computer Interface (HCI) and Usability (Bevan, 2001). The US government (Guide for developing usable and useful websites, 2009) and several large organizations (e.g., NASA (NASA, 2009)) also maintain websites that provide information and guidelines on usability and user-centered design.

Summary of Related New Research Accomplished by RERC-UD

RERC-UD is in the process of developing an automated tool based on proof-of-concept research. This tool will be able to evaluate product use by applying computer vision and artificial intelligence methods to data collected in order to build a system to autonomously evaluate how usable a product will be for older adults with a cognitive disability. The current prototype of the tool is semi-automated and uses a GUI (graphical user interface) to greatly facilitate the manual annotation of pre-recorded videos of people using a product, particularly using different water faucet types.

Faucets were selected as a representative product to design and test the software as they come in many quite different designs and are a product that is integral to many crucial daily activities (e.g., bathing and cooking). To test the prototype tool, videos were made of older adults, both with and without dementia, washing their hands with the aid of caregivers using five different types of faucets (please see R2.3 for more information regarding the faucet trials). Possible product tasks were identified (e.g., turning the water on and off, adjusting the temperature, and adjusting the flow of the water) as well as the number, type, and frequency of errors committed in completion of each task, the required number of times, level, and frequency of assistance provided by the caregiver in completion of each task, and the total time required for completion of the hand washing activity. A report file is automatically generated for each video that summarises the annotated information. Results from these preliminary, semi-automated tests will be used to improve the measures collected and to "train" the tool. The goal of this study is to design a completely automated tool.

Examples of this Application

Annotation reports can easily be grouped to provide comparisons in usability between different designs and different user populations. Data can also be sorted based on various usability metrics, such as a combination of completion time, number, type, and frequency of errors and required caregiver assistance. This type of analysis could be helpful in determining a product's comparative overall accessibility or identifying problem areas. Furthermore, annotated videos can be queried in a variety of ways. For instance, a designer might be interested in viewing **all** the errors made during the task of turning the water on, or viewing specific errors, such as grasping the object and not just those predictable errors.

Research Needs (What still needs to be done)

Automating the annotation and evaluation process is underway. Currently, a manual version of the annotation tool is being augmented with artificial intelligence techniques to detect specific events, such as the water being turned on, to create a semi-automated tool. The semi-automated tool will be used by human raters to annotate a large amount of training data (videos), which will be examined for consistency. Through the use of machine learning algorithms, this data will be used to develop a mostly, if not entirely, automated annotation tool.

Upon completion, the annotation tool is expected to enable a fast, cost-effective, and comparable method of evaluating of products, while simultaneously considerably reducing

subjective judgments. While the tool is currently customized to evaluate faucet use during the activity of hand washing, it can be redesigned for any product with minimal effort. The successful deployment of an automated, computer-based tool in this context could enable faster and better product design.

Acknowledgements

References

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Guide for developing usable and useful websites, URL: www.Usability.gov, accessed on Dec 18, 2009.

NASA's resource for designing effective and efficient websites, URL: http://www.hq.nasa.gov/pao/portal/usability/index.htm, accessed on Dec 17, 2009.

Usability Professionals' Association – Resources: Guidelines and Methods, URL: http://www.usabilityprofessionals.org/usability_resources/guidelines_and_methods/, accessed on Dec 18, 2009.

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