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TECHNICAL NOTE

USABILITY RESEARCH LABORATORY FOR GEOSPATIAL AND ALLIED APPLICATIONS

[*]J. A. Quaye-Ballard[1], S. A. Akorful-Andam[2], M. N. Sackey[3], N. L. Quaye-Ballard[4] and A. Awotwi[5]

[1,2]*Department of Geomatic Engineering, KNUST, Kumasi*
[3]*Department of Mechanical Engineering, KNUST, Kumasi,*
[4]*Department of Geoinformatics, Building and Road Research Institute , Fumesua, Kumasi,*
[5]*Department of Geoinformatics and Spatial Development, University for Development Studies, Navrongo*
E-mails: [1]quayeballard@itc.nl; [2]aakorful@gmail.com; [3]mnsackey@yahoo.com; [4]naalamkai@yahoo.com; [5]aawotwi@uds.edu.gh*
[*]Corresponding author

ABSTRACT

The use of computers has penetrated every sector of the Ghanaian economy. Researchers in Ghana and the KNUST environs are continually developing computer applications for users for addressing societal problems, as well as, automating the manual process of doing things. Researchers and developers are moving away from the use of commercial software to customized and user-friendly applications to suit the Ghanaian economy, thereby maximizing profit. End user applications are developed daily and these applications are most often not subjected to usability testing and evaluation with real users. Usability engages individuals as testing participants of the target audience to assess the degree to which a computer application meets specific usability standards. This research, funded by Building Stronger Universities II (BSU II) Project, uses the 'Think Aloud' technique in developing a usability laboratory for testing end user applications before being released to the final user. End user applications such as problem-based learning applications for distance learning, computer supported collaborative learning applications, drought and flood early warning applications, land use land cover related applications, climate change related applications, etc. will benefit from this usability testing laboratory. The findings from this project contributes to the understanding and exploration of alternatives of end user applications.

Keywords: '*Think Aloud' method, VPA Archival Management System (VAMS), Human Computer Interaction (HCI), Usability Engineering (UE), Geo-information*

INTRODUCTION

The use of computers plays critical role in Geo-informatics and Geo-related equipment (Shekhar *et al*., 2015). For example, in all the aspects of Geographic Information System (GIS), Global Position System (GPS) and Remote Sensing (RS) Technologies, known as 3S Technology, the use of computers is important for data capture, input, management (data storage and retrieval), manipulation, analysis, output and providing end user-friendly applications (Quaye-Ballard *et al*., 2013b). Use of computers has penetrated every sector of the Ghanaian economy. Researchers in Ghana and

the KNUST environs are continually developing computer applications for users in addressing societal problems, as well as, automating and customizing the manual process of doing things. Researchers and developers are moving away from the use of commercial software to customized and user-friendly applications (Mulfari *et al*., 2015; Sugianto and Tojib, 2015) to suit the Ghanaian economy, thereby maximizing profit.

End user applications are developed daily and these applications are most often not subjected to usability testing and evaluation with real users (Paz and Pow-Sang, 2016). Usability refers to the procedure by engaging individuals as testing participants of the target audience to assess the degree to which a geospatial and allied computer application meets specific usability standards (Dix *et al*., 2004; Sharp et al., 2007; Rubin and Chisnell, 2008; Haklay and Skarlatidou, 2010). Thus, Usability Engineering (UE) needs to be applied for testing end-user applications (Quaye-Ballard *et al*., 2013b). The concept is more of Human Computer Interaction (HCI). Crystal and Ellington (2004) recognized the methods and levels of analysis in HCI.

The research therefore seeks to develop usability laboratory for testing end user applications before being released to the final user. The testing procedure is the Verbal Protocol Analysis (VPA) where explicit structured questionnaire, video recording, 'think aloud' procedure, on-screen capturing, and formative evaluation are used to determine the spatial cognition taking place in the minds of users. Many researchers such as Quaye-Ballard (2007), Todhunter (2015), Quaye-Ballard *et al.* (2013a), Anwar *et al.* (2015), Ariel *et al.* (2016), (Tenbrink, 2015), etc. employed VPA in acquiring cognitive process taking place in the minds of users. Thus, VPA Archival Management System (VAMS) as used by Quaye-Ballard *et al.* (2013a) is adopted for the testing procedure in this research. According to Quaye-Ballard *et al.* (2013a), VAMS is within the discipline of HCI in Engineering. End user applications such as problem-based learning applications for distance learning, Computer Supported Collaborative Learning (CSCL) applications, drought and flood early warning applications, land use land cover related applications, climate change related applications, etc. will benefit from this usability testing laboratory. The aim of usability is to attain users' requirements such that they can carry out tasks enjoyably, effectively, efficiently and satisfactorily (Preece *et al.*, 1994; Sharp, Rogers and Preece, 2007). Quaye-Ballard *et al.* (2013a) explored and documented true usability and the comfortability of geo-spatial user interfaces.

It is based on the above that the research developed usability laboratory for testing end user applications before released to the final user. The usability laboratory adopted VAMS, an acronym for VPA (Verbal Protocol Analysis) Archival Management System to unravel cognitive processes taking place in the mind of the users. The test participant provides running commentary of the thought process by thinking aloud while performing the tasks of the testing. Evaluation of user satisfaction, effectiveness and efficiency of the application is determined after the testing.

MATERIALS AND METHODS

Study area

The scope of the research is the academic setup of the Department of Geomatic Engineering (DGE), Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana. The department conducts research that provides end-user applications in the form of maps, computer programs, etc. with the use of the 3S Technology (Quaye-Ballard *et al*., 2013b). Sophisticated measurement, data collection techniques and modern computer-based data management and visualization tools play key role in Geomatic Engineering for designing, constructing, managing assets, monitoring of the changing environment, planning urban environments, monitoring man-made structures, etc. (Quaye-Ballard *et al*., 2013a). End-user applications from these studies need to be tested before being released to the final user. The DGE has four sections, namely: Land Surveying and Land Management; Geodesy and Engineering Surveying; Photogrammetry and Remote Sensing; and GIS, Cartography and Information Technology (IT). The Departmental staff are Licensed Surveyors and profes-

sional members and fellows of the Ghana Institution of Surveyors (GhIS) and Ghana Institution of Engineers (GhIE).

Organization and installations

The setup was funded by the Building Stronger Universities II (BSU II) Project covering one-year duration. Table 1 shows the materials used in setting up the laboratory.

For this research, the methodological mechanism in acquiring user feedback by using the VAMS is adopted from Quaye-Ballard *et al.* (2013b)

The setup

An office, room number 005, located in the Bamfo-Kwakye Building, College of Engineering was used to pilot the project. The room is well ventilated and averagely sound proofed for the 'Think' aloud procedure. The plan view of the proposed Usability Research Laboratory for Geospatial and Allied Applications setup is shown in Fig. 1. Four CCTV cameras with different focal lengths have been installed at the roof corners of the office to capture user actions during the "think aloud" process (Fig. 2). An eight pin Internet 1TB Protocol (IP) Digital Video Recorder (DVR) and FHD Samsung 32" TV installed to record videos from the CCTV cameras (Fig. 3).

Figs. 4a and 4b show the installed eight pin switch board for the CCTV and the Uninterrupted Power Supply (UPS) respectively. Figs. 5a and 5b respectively show the laptop with webcam and 2TB external hard disk. A multi-purpose software was used for capturing user actions and voice/image recordings during the "think aloud" process on the computer that has been installed. Fig. 6 shows the setup with a student testing an application.

DISCUSSION

Guidelines are needed for the execution for the testing procedure. That is, the test should be conducted where there are no disturbances from the outside of the testing laboratory. The test participants should initially be introduced to the objective of the test at the trial session. This should be proceeded by explanations on how to accomplish the tasks and how to respond to the

Table 1: Materials used for the laboratory

Quantity	Element	Purpose
1	Laptop with inbuilt webcam and Windows 64-bit Operating System	Capturing user interactions on the application
	Multi-purpose Software	Capturing onscreen activities into the computer
1	32" Full High Definition (FHD) Samsung TV	CCTV output interface and playback sessions of protocols
4	CCTV cameras	Capturing user interactions between 3m to 5m
1	Eight pin IP switch board for the CCTV	High definition IP CCTV network access
1	Besteker Wi-Fi Full HD 1080P Camcorder	Video capture at a 1m to the test participant
1	External Microphone	Audio capture at 1m to the test participant
1	5m HDMI cable	Connecting laptop and TV
1	8-channel Digital Video Recorder (DVR)	Recording video on a hard drive
1	2TB Hard disk drive	Storage media for the DVR
1	1TB External Hard disk drive	Backing up verbal protocols
1	Binatone 650VA UPS	Providing near-instantaneous protection from input power interruptions
1	SanDisk 64GB Memory Card	Storage media for the Camcorder
1	50" lightweight tripod with bag	Mounting Camcorder

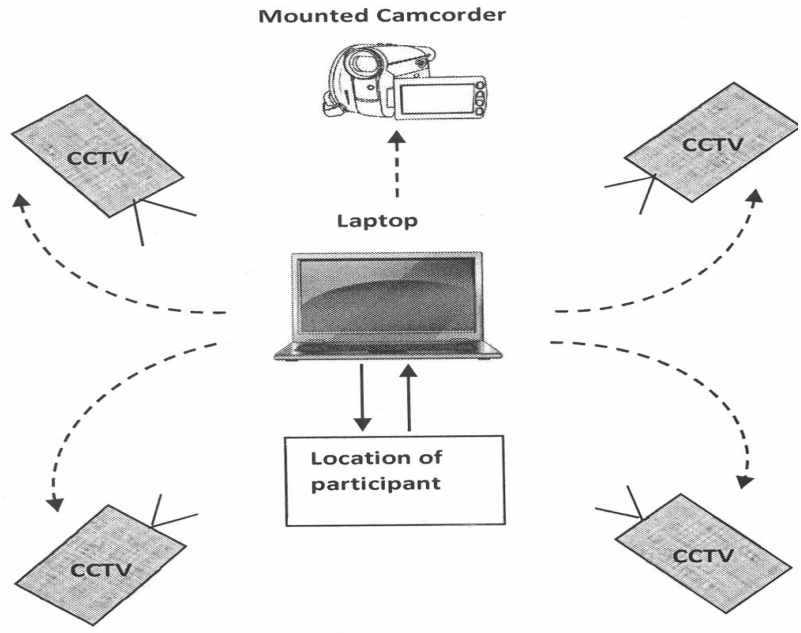

Fig. 1: Plan view of the VAMS procedure, where the arrows indicate flow of information

Fig. 2: Four installed CCTV cameras (a) Front left corner camera; (b) Front right corner camera; (c) Back left corner camera; and (d) Back right corner camera

Fig. 3: Internet 1TB Protocol (IP) Digital Video Recorder (DVR) and 32" TV

Fig. 4: (a) Installed eight pin switch board for the CCTV; and (b) Uninterrupted Power Supply (UPS)

questionnaire. Test participants must be given a quick demonstration on how the interface of the application works. test participants must then be left alone to accomplish the test whilst timed. ten to fifteen minutes can be allotted to the testing session. the test participants must perform the task and respond to questionnaire whilst they 'think aloud'. ten to fifteen minutes can be allotted to the response to the questionnaire whilst 'thinking aloud' in order to deter-

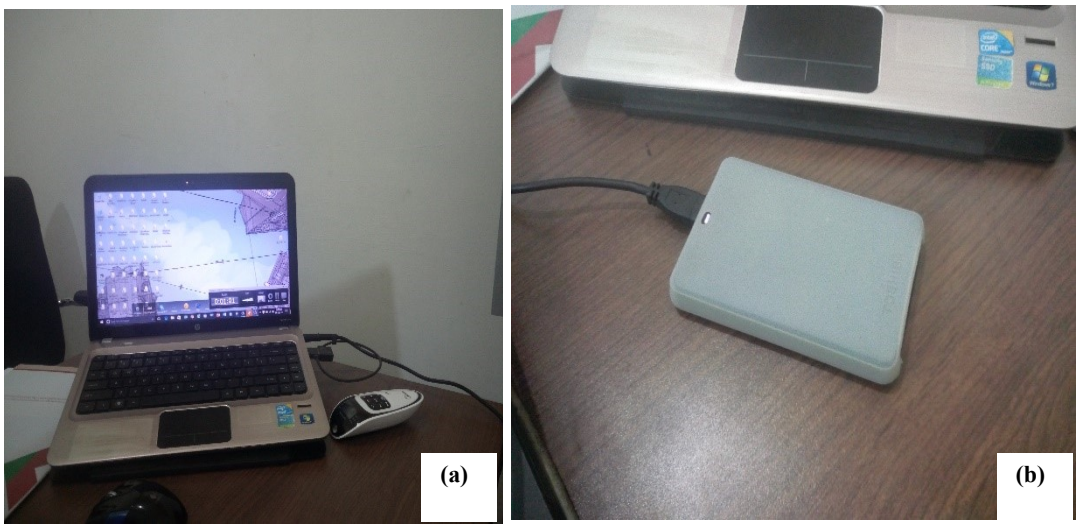

Fig. 5: (a) Laptop with webcam; and (b) 2TB external hard disk

Fig. 6: Setup with student testing an application

mine the satisfaction, efficiency and effectiveness of the geospatial and allied computer application.

Based on the above, the test should be conducted as a trial and testing sessions. The trial session should involve an introduction of the application required for testing. At this stage, test participant will familiarize themselves with the user interface before testing the actual application. The testing session should comprise of pre-defined tasks to perform whilst 'thinking aloud'. This should then be followed by the questionnaire. The questionnaire can be totally structured questions to be answered by ticking a choice on paper whilst 'think aloud' to explain the choice of answer. The questionnaire can be structured under the following headings: (1) ***Satisfaction*** - the total fulfilment of a need. Questions should determine the test participants' satisfaction after the task; (2) ***Effectiveness*** - the degree to which objectives are attained. Effectiveness is used to find easy-of-use of the geospatial and allied computer application; and (3) ***Efficiency*** - the mental effort in attaining the goals. Questions for determining efficiency must be found out (and especially) whether or not the application involves time.

SUMMARY

A novel usability testing laboratory is developed to retrieve the spatial cognition taking place in the minds of users in order to come out with an efficient, effective and satisfactory user-friendly application before its release to the final user. The laboratory provides the impetus for improvement in the way engineers and graduates conduct research. The findings from this project contributes to the understanding and exploration of alternatives of end user applications. The developed usability testing laboratory provides academicians with wide research scope by subjecting end user applications for testing. In other words, a research avenue is opened for a learning process in identifying the cognitive process taking place in the minds of users. The setup laboratory is envisaged to widen research findings on GUI designed applications on KNUST campus and Ghana as whole. In addition, potential application developers in Ghana will have an advantage of testing their applications before it is released to final user. This will enrich their product, enhance their confidence of surviving in the market as well as maximizing profit.

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