Computers in Human Behavior 49 (2015) 623–634

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

A 3D visualization framework to social network monitoring and analysis

Amadeu S. Campos Filho [a,*], Magdala A. Novaes [a,b], Alex S. Gomes [c]

[a] Telehealth Center, Clinical Hospital, Federal University of Pernambuco, Recife, PE, Brazil
[b] Department of Internal Medicine, Federal University of Pernambuco, Recife, PE, Brazil
[c] Informatics Center, Federal University of Pernambuco, Recife, PE, Brazil

ARTICLE INFO

Article history:
Available online 17 April 2015

Keywords:
Usability
Visualization
3D

ABSTRACT

Since the rise of the Internet, the volume of metrics (indicators) used to measure current conditions of the service has been increasing exponentially. One of the challenges is to transform this amount data into legible information through visualization techniques. Visualization and monitoring indicators design is an actual and relevant challenge to provide intuitive, clear and direct understanding of large datasets. The solutions to the problem points to complex Graphical User Interface (GUI) that demands high cognitive efforts to handle it. This paper aims to present and evaluate the design process of a 3D visualization framework conceived to be easy to understand. We adopted user-centered design process to develop the concept model and usability concept to evaluate it. The usability evaluation was conducted using a Telehealth indicators dataset. Data were collected through observation technique and with the help of usability questionnaires. Data analysis was based on quantitative and qualitative approaches. The results describe the major advantages and limitations of the 3D visualization framework. We observed an overall good usability level. Meanwhile, users reported a total of 18 usability problems and proposed 35 suggestions to improve the user experience. They demonstrated strong motivation and interest in using the prototype. The usability problems of the visualization interface guided new improvements.

1. Introduction

Currently, the volume of data increases very fast and it becomes more difficult to extract and visualize informations among it. It is necessary to use tools to transform these data in meaningful information. As a consequence to these phenomena, Schwartzman and Borning (2007) observed an increasing demand for methods and tools to support knowledge construction and variables (indicators) evaluation. These methods are used to present informations to managers in several areas, such as: health, education, economics, mathematics, engineering, and industry. One powerful method to deal with this kind of task is data visualization. Card, Mackinlay, and Shneiderman (1999) define visualization as a process to retrieve raw data and transform it into easy visual forms. Kantardzic (2011) defines visualization as a display of behavior of complex states in such understandable by human.

Over time, many hundreds of social network indicators are evaluated in an attempt to get an intuitive sense of this data but it was becoming more difficult. The reason is that traditional visualization techniques do not show clearly all details of complex database. They are not designed to support immediately trends discover from a fast inspection on two dimensions (2D) visualizations on a piece of paper, without loss of vision (Cvek, Trutschl, Kilgore, Stone, & Clifford, 2011). Adequate representations can often communicate information through indicators more rapidly and effectively. They can help decision makers prioritize theirs actions and regulations required to optimize the outcomes (Malczewski, 2006).

In the International Conference on "Visualizing and Presenting Indicator Systems", March 2005, at Federal Statistical Office, Neuchatel, some participants presented new ideas about visualization and indicators monitoring in service quality (Swiss Federal Statistical Office, 2005). According to Alfons, Templ, and Filzmoser (2009) there are many research projects on two dimensions graphical user interface providing quickly insights about indicators and reducing search time and cognitive load of awareness. The presentation of these indicators can efficiently communicate if the information is correct or mislead to users. Visualization of indicators is an issue that requires special attention due to the overwhelming information that users receive and the lack of overview solutions that avoid users to get lost inside of the visualization.

In some cases 2D visualization techniques cannot give to the user insights about the data because there is so much data to be represented in a 2D interface. Some authors (Sharafi, 2011; Tufte,

* Corresponding author. Tel.: +55 (81) 21263903; fax: +55 (81) 21263904.
E-mail address: amadeu.campos@nutes.ufpe.br (A.S. Campos Filho).

http://dx.doi.org/10.1016/j.chb.2015.03.053
0747-5632/

2001; Ware, 2012) argue that the use of two dimensions (2D) is sufficient to show only the information. The use of a new dimension (3D) should be applied to visualize the relations between the data in a semantically structured data set; or when more than two variables of the same data set are analyzed. Others, however, think that 3D visualizations techniques facilitate understanding by the human visual system (Irani & Ware, 2003), because they believe that the inclusion of aesthetically appealing elements such as 3D graphics and animations can improve the capabilities of interpretation, intuition and the ability to memorize (Hullman, Adar, & Shah, 2011; Komlodi, Hercegfi, Jozsa, & Koles, 2012).

In the other side, social media platform are growing quickly and are becoming increasingly complex. In many cases, social data is unstructured and this makes difficult for users to summarize, understand and make sense of them in order to better decide and discover insights (Chakraborty, 2014; Keim, 2002). To overcome those problems, we designed a 3D visualization framework. The goal of this paper is to describe the design process and the usability evaluation of this 3D framework. For the users tests, our case study was performed using Telehealth and social media data. Telehealth is the use of Information and Communication Technology – ICT to offer health services (Education, research and healthcare) remotely.

1.1. Comparative analysis of competitors

Before we develop and evaluate the usability of the prototype, we realized a comparative analysis of existing solutions in order to identify in the literature software with 3D technique that is more suited to the previously identified requirements. The competitor analysis is a technique that involves the assessment of products already on the market in order to collect guidelines and principles of good design practice for the development of a new product (Borchers, 2000). Thus, by identifying these elements can be found useful features and characteristics that must be maintained in the new product design and those that should be avoided. In addition, Nielsen (1993) emphasize that the analysis of competitors can also help to identify potential usability issues because it is important to visualize and to identify the mistakes of competitors so that errors are not repeated.

The aim of competition analysis is to extract features of the selected 3D software, assess the strengths and weaknesses of competitors and identify the best 3D software that fits with the requirements defined in the literature review. Before the analysis of competitors, we define the minimum requirement was to have a 3D visualization technique scatterplot. We chose this requirement because the data to be analyzed were multivariate numerical indicators where the 3D scatterplot visualization technique would enable the six variables simultaneously. In addition to this requirement, the software would have to meet the following features that are related to the identified requirements: freeware, database integrated via XML or Excel file, data filter, Animation, Drag, Zoom, Subtitle, hierarchical cluster and rotation.

After research, we identified the following 10 competitors: Origin, Graphing Calculator 3D Grapher10, SimpleGraph3D, 3D Graphs Calculus, CoPlot, 3D Graph Explorer, Excel3Dscatterplot, 3D XY Scatter Chart. All these software were analyzed according to the requirements listed above and the test result can be seen in Table 1.

According to Table 1, most software analyzed did not meet 100% of the necessary requirements to be the object of study for analysis proposed in this study. For this reason, it was decided it would be better to develop a new prototype based on variables and previously defined requirements and in some features and functionalities of both 2D and 3D display technologies that solve the problems found in the literature review and were not found in tools analyzed competitors.

1.2. Framework for 3D information visualization

The 3D information visualization framework was designed using a user-centered design process. The process of user-centered design is a technique that involves the user in all phases of the design cycle as shown in Fig. 1 (Mao, Vredenburg, Smith, & Carey, 2005). We used the User-Centered Design because it involves in a multidisciplinary approach to design, based on the active involvement of users to a clear understanding of the role of the user, the requirements of tasks and design iterations (such as project and process) and assessments. It is considered as a key element for utility and usability.

Fig. 1 shows the user-centered design process briefly and aims to include the perspective and needs of the user in the design process of the artifact. The generation phase of the concept and idealization of the prototype was initialized with the analysis of competitors and finished with results of the data analysis of user profile and the identified requirements. After the conclusion of the first phase, the requirements document is revised to start new phase of design and development of the prototype. The techniques used in the design of the prototype and development of the system were the creation of characters and scenarios that helped in understanding the context to be developed. For preparation of scenarios and characters were used the results obtained during the first phase conducted in this study.

The first step was to define the types of interactions with the user. The interactions with users depend on the tasks that will be performed. The choice of interactions styles was based on the fundamental premises of human visual perception (Card et al., 1999; Chen, 2006; Ware, 2012). The interactions mapped by Amar, Eagan, and Stasko (2005) and Shneiderman (1998) also inspired our design. We had chosen those that best fit the purposes of 3D interface design. The criteria were such that interaction allow user to: click, move, retrieve the value, rotate, zoom (in/out), filter,

Table 1
Comparative analysis of competitors.

Software	Scatter plot	Freeware	Data base	Filter	Animation	Drag	Zoom	Rotation	Cluster
Origin	Yes	No	xls	Yes	Yes	Yes	Yes	Yes	Yes
Graphing Calculator 3D	Yes	No	xls/cvs	No	Yes	No	Yes	Yes	No
Grapher10	Yes	No	xls/cvs	No	No	No	No	No	No
SimpleGraph3D	No	Yes	web	No	Yes	No	Não	Yes	No
3D Calculus Graphs	No	Yes	No	No	Yes	No	Yes	Yes	No
CoPlot	No	Yes	xls	No	No	No	Yes	Yes	No
3DGraphExplorer	No	Yes	Function	No	No	No	Yes	Yes	No
Excel3Dscatterplot	Yes	Yes	xls	No	Yes	No	Yes	Yes	No
3D XY Scatter Chart	Yes	Yes	xls	No	Yes	No	Yes	Yes	No