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Architectural impact of the SVG-based graphical components in web applications

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ABSTRACT

The present work is intended for showing the architectural impact in the use of the WIMP components present in the graphic user interface (GUI) using the SVG technology. We have made several experiments in a client server environment and we measured the CPU utilization, memory usage and response time when SVG-based graphical component are used in WEB applications. We use three navigators (Internet Explorer, Firefox and Opera), and we analyzed as those metrics changes when single and complex images are used, and we note a good behavior of the SVG format since our test obtained a confidence level superior to 95%.

1. Introduction

The current patterns of the GUI (Graphic User Interface) in *Web* have two major systems for representing graphics information on computer: raster and vector graphics. The dynamic interaction based in raster-type images consumes a significant part of the computational power (server/client and network) [5,12].

Added to the computational cost of the graphic interface, three essential elements present in the Web architecture may affect the performance of Web applications: less powerful servers, deficient means of transmission, and low-power computational client-machines [11,20].

The development of applications is strongly influenced by features of operating systems, which in turn are guided by advances made in the architecture and capabilities of the hardware. The impact of this development has many dimensions that vary the design of the application until its performance. It is known that small mobile devices have little memory and a low speed CPU, the visualization display is limited and the latency to the network has limitation by the width band. The adoption of the technology of SVG leaves some issues that were studied in this work. Among several are:

- What are the gains of the effective use of SVG in relation to other standard graphics?
- What is the impact of this technology in architecture with low computational power: tiny client, mobile phone, PDAs and Palms?
- What the impact of SVG in the architecture of the network?

Furthermore, we have done a comparative study with other raster images formats. In this case, we also have emphasizing on different architectural aspects such as CPU utilization, memory usage and the network latency for client/server situations. We use three different navigators (Internet Explorer, Firefox and Opera) in our experiments.

2. Tangible User Interface in SVG

The purpose of TUI (Tangible User Interface) is to provide abstractions of mechanisms and tools that permit to develop interactive applications which can adapt to a method of use of countless controls [21]. The TUI is characterized by the physical junction of the real world to the controls from digital information. They offer physical form to digital information, while employ physical artifacts, both as representation and controls to computational media. The physical representations joined by the TUIs are physical object space manipulation with digital representations, for instance.

Pierre Dragicevic [4] has evaluated the TUI as a different manner of physically controlling modern computers. He also affirmed that the power to execute calculations and the graphic ability of home computers is increasingly bigger, but this evolution seems to have reached a satisfaction level to users that only have interaction with a keyboard and a mouse, opening menus or dragging icons by using the mouse.

The SVG has motivated the use of this technology in different user's interaction. Many events are possible by using the mouse (e.g. rollover

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effects, mouseover, mouseout interactivity) and keyboard which allowing a linking of a web page, with visual components (button, menu, windows, icon and text) [19,17]. The SVG pattern was being leaning for several organizations - including the academic ones – which are responsible to create the HTML and XML markup languages, among others. There are a myriad of such organizations involved in SVG definition and documentation, such as the MIT (Massachusetts Institute of Technology), Apple, Sun MicroSystems, the INRIA (Institut National de Recherche en Informatique et en Automatique), Adobe, IBM, Kodak, and Keio University [22,5].

SVG is a language which describes 2D graphics (straight lines or curves) expressed in mathematic relations in XML. The first specification was the (SVG 1.0) in 2001 [5]. The SVG pattern specification is divided into:

- *Full* — complete, which comprises Mobile and Print specifications;
- *Mobile* — mobile equipment (cell phones, PDAs and palms);
- *Print* — impression-dedicated.

This format is flexible and its application can be used combined with other technologies such as JavaScript, server-side *scripting*, XML, and style resources such as CSS (Cascading Style Sheet), XSL (Xtensible Stylesheet Language), thus creating several possibilities of utilization in applications as Science, Engineering, business and graphic user interfaces.

The set of such concepts defines the SVG capacity, and justifies its creation as the graphic technology to the World Wide Web.

Unlikely other image formats used in the Web, the SVG file is not binary and it consists of a text format document structured according to marks defined by its DTD (Document Type Definition). This text file is used as Internet page file and processed by navigation programs.

Three graphic objects categories defined by the DTD of SVG are [5]: vector images, raster images, and text, that is, the three elements can be combined in a single application. These objects may be groups and transformed, and all SVG graphic can be interactive or animated by means of SVG elements or external scripts [5]. One of the advantages of this format is the fact that it is not affected by the aliasing effect when redrawn; therefore, don't have big distortions [22].

The adoption of SVG as pattern recommended by W3C, has been widely used in various areas. Some researchers have used it as visualization tool for different types of Human Computer Interaction, for example: Graphical User Interface, Zoomable User Interface. For example, Stephane Chatty et Al. [2,3] use it and join SVG and interaction models to build highly interactive user interfaces. He did the following comments in his article:

> […] the states that the distance between Web and user interface projects is increasingly shorter, as demonstrated by recent researches on the concept of the Internet application, and that the SVG (Scalable Vector Graphics) is the core of such evolution since it offers a high definition of 2D graphics. This format is familiar to graphic interface designers, and can adapt inside a Web navigator and standalone applications (self-sufficient system which does not need another system to its functioning.

Chatty et al. [2] present the building of a flight simulator with panel sensitive to every interaction resource similar to the WIMP components interaction. Fig. 1 illustrates part of the flight simulator built with SVG and the possible combinations of its interactions.

Another application using SVG for SCADA Applications was done by Rodrigo Garcia [6]. In his paper, he explains the applicability of the interaction graphic components in SVG and respective interaction with the SCADA (Supervisory Control and Data Acquisition) system, in which is made available a graphic interface that is necessary to monitor and control production process in industrial facilities. Fig. 2 illustrates an example for a single control using a motor with three states.

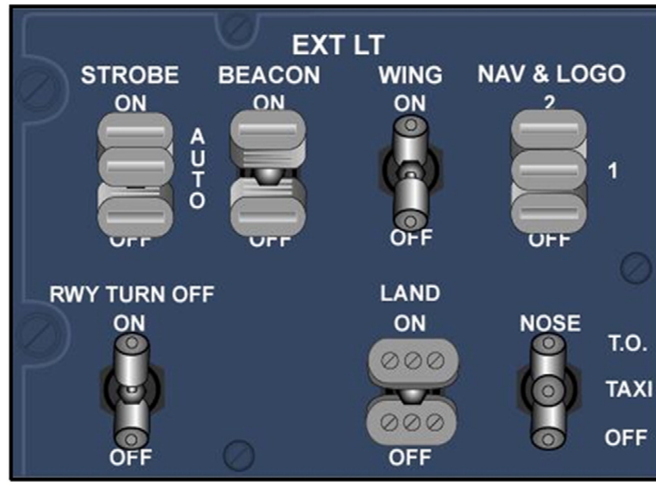

Fig. 1. SVG visualization of area navigation instrument [2].

The possible change in the state of a motor only affects those graphical elements which have to change their properties. These single changes can be combined to represent a wide variety of different states.

The primary approach in the modeling of vector images is performed by means of the compositions of elements that describe primitive geometric structures such as rectangles, circles, ellipsis, lines, and polygons. This technology promotes the reuse of graphic objects through of definition and instantiation structures, and besides contributing to the creation of graphic patterns, these structures propitiate the generation of smaller files; *characteristics interesting to a better server performance and web latency*.

The graphic objects generated by this technology can be animated through of three approaches (SVG, 2005): using animation elements of the vocabulary itself, using the SVG DOM (*Document Object Model*), or integrating the content to the SMIL, also developed by W3C. SMIL is a language for the integration of synchronized multimedia aimed at creating multimedia presentation in the web.

The SVG animation elements were developed by the Synchronized Multimedia Working Group in partnership with the W3C, creators of the specification to animations in SMIL. Thus, except for some SVG specific rules, the normative definition for its animation elements and attributes follows the animations specifications in SMIL.

A number of events can be added to the user interface. Thus, developers can give form to the images which interest them the most, such as color, format, size, indicating an action trigged by the interaction of mouse, keyboard, or other input device.

In this context, other events can be added to the user graphic interface according explained by Xiaohong Qiu [18], for instance: the application of a set of events of mouse and keyboard which allows the user to generate highly interactive action in real time. The semantic events generated by the SGV represent the functionality in the application domain, permitting this model to have maximum reusability of components in the effective collaboration to with media interactivity in the different web contents for several clients and different web environments. Besides these characteristics, the author [17,18] suggests a uniform interface, which is pattern to the next web client generation, with omnipresent access.

Three relevant works show the utilization of graphic interaction components in SVG. The first one is Rodrigo Garcia's [6] in the SCADA project, in which he showed the utilization of these components in the monitoring and control of installations in an industrial plant geographically distributed by means of an interface with components of vector interaction. The second is Felipe Marinho's work [12–14], which explains the SCADA, shows the use of mimic diagrams in the use of SVG in the reality of the system automation area.