Accessible Map Visualization Prototype

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ABSTRACT
In the use of the Web, one of the main problems for people with visual disability is the use of geographic maps which are visual by nature. This paper presents an accessible map visualization prototype that is designed with WCAG 2.0. For the development of the prototype, we have designed an architecture that helps to mitigate the visual barriers of the online geographical maps. As case study, the prototype displays some maps of the Ecuador. In addition, the prototype has been tested in different browsers and has been evaluated by accessibility tools, thereby, the degree of accessibility of the prototype has been determined in a real environment.

CCS Concepts
• **Human-centered computing**➝ Accessibility➝ Accessibility design and evaluation methods • **Interaction design**➝ Interaction design process and methods ➝User interface design • **Visualization**➝ Visualization application domains ➝Geographic visualization.

Keywords
Web Accessibility; Geographic Map; SVG; Accessibility Guidelines; WCAG 2.0.

1. INTRODUCTION
Nowadays, the geographic maps are present in several media such as television, magazines, Internet, and newspapers. So that, the use of geographic maps has become common in everyday life. However, most of the information of maps is presented visually without textual or sonorous support, which implies that people with visual disability cannot fully interact with them. To reduce these problems, the W3C defined the Web Content Accessibility Guidelines (WCAG 2.0) that lessen and help to remove accessibility barriers [1]. WCAG 2.0 are guidelines that help developers to design accessible websites. Therefore, it is necessary to integrate in geographic maps this recommendations that improve accessibility in geographic content and information. For this reason, in this study we propose an accessible map visualization prototype which is developed with WCAG 2.0. The prototype presents a case study with geographical maps of the Ecuador, these maps display provinces, railways lines, and main cities of the country.

2. ACCESSIBILITY BARRIERS
There are several accessibility barriers in geographic content for people with visual disability:

- Maps as image: it means that map is in image format on the website.
- Maps not operable with a keyboard: it means that the functionality of the geographic content of a website is not operable with keyboard.
- Maps with small text: it means that users with low vision cannot see the text on the map, if this is small.
- Full color maps: it means that users with color blindness cannot distinguish the colors on the map.
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Maps displayed in the web that have the features mentioned above, are not fully accessible. While it is true, the WCAG 2.0 help to reduce the problems with web accessibility, but there are some web accessibility problems of maps that are still not solved, such as the change of the color for people with low vision and color blindness.

3. DESIGN OF THE PROTOYPE
To solve the above mentioned problems, we have designed an architecture that consists in a framework Model View Controller (MVC) with the aim of the separate the functionality of the representation of the information. Figure 1 shows this architecture, wherein the database is connected with an Object Relational Model (ORM) which is joined to services and controllers. These are intermediate layers to manage its resources and they respond to requests of the methods of the prototype that are displayed in the interface.
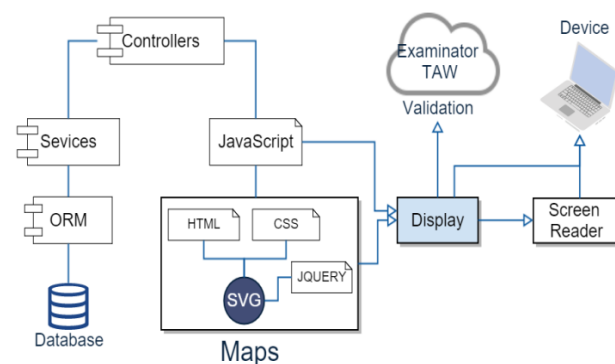

Figure 1. Architecture

The JavaScript files manage the behavior of the website and geographic maps. The maps are designed in Scalable Vector Graphics (SVG) format which is a type of format compatible with HTML. SVG does not lose its visual quality when resizing, so any can be displayed in different screen resolutions without they lose the visual quality of information transmitted [2]. SVG code allows

us to include information and metadata, which subsequently, can be extracted in the browser to make accessible the map.

To improve the accessibility of the attributes of the user interface, we apply Accessible Rich Internet Applications (WAI-ARIA) on geographic content. WAI-AIRA is a standard created by the W3C which increases the accessibility to web content and integrates technology that facilitates the use to people with visual disability. WAI-ARIA allows assigning roles, properties and information to fragments of code to improve controls of the user interface [3]. Once implemented, people with visual disability can use screen reader and a keyboard as means of navigation.

4. RESULTS

The interface of the prototype shows four panels: the overhead panel is the accessible toolbar, the left panel represents the navigation in the maps, the center panel shows the map and the right panel displays information about the selected area as shows Figure 2. With respect to the left panel, users can navigate through this panel with the tab key. Each button represents a map, and display its characteristics; which are interpreted by screen reader. The center panel contains a map that shows different geographic items of Ecuador with their descriptions, for this, we use the properties of the CSS and JavaScript to change color of a selected element, this element improves the perception for people who have low vision and color blindness. When the user presses the tab key, the right panel shows a description of the selected area.
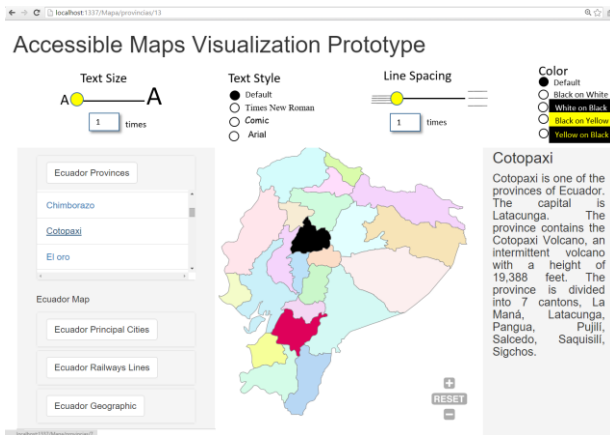

Figure 2. Accessible Map Visualization Map

Figure 3 shows the accessible toolbar, users can selected the following properties: change of text size, text style, line spacing, and color and contrast of all the webpage including geographic content. The "text size" control changes the text until two times its size normal. The "text style" control has a menu that allows to select different kind of text. The "line spacing" control changes the spacing until two times its size normal. The "color" control presents a menu that changes the color and contrast.

Figure 3. Accessible Toolbar

For change the color in all the content of the web page including the map, we applied an algorithm [4]. For example: if the user presses the color and contrast button. The "color" control displays a menu that change the color that can be black on white, white on black, black on yellow or yellow on black. Figure 4 illustrates the change of color to white on black for people with color blindness.
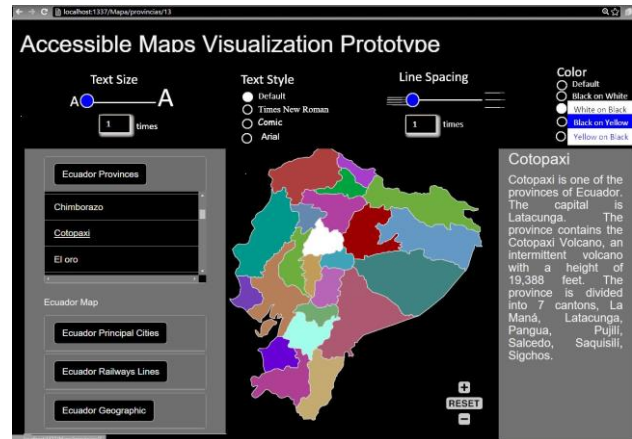

Figure 4. White on Black Combination

The validations were tested for obtain the level of accessibility of the prototype to according to the guidelines WCAG 2.0, we evaluated with TAW and eXaminator. These tools measure the compliance of the accessibility guidelines. With this, we ensured the display of the information without affect usability and navigation. The results obtained in eXaminator were of 10 points and for the TAW showed a total of 1 problem and 292 warnings.

5. CONCLUSIONS AND FUTURE WORKS

The accessibility barriers that have people with visual disability to use geographical maps could be mitigated by use of web tools and accessibility guidelines WCAG 2.0 as shown in this study through of case study. The code of this prototype uses of WAI-ARIA to enhance control elements in the user interface and applies the accessibility guidelines.

The prototype was tested in three browsers: Google Chrome, Mozilla Firefox and Microsoft Edge. Google Chrome supports SVG and is compatible with web styles and colors, however Google Chrome does not have compatibility with other features like SVG titles, while, Mozilla Firefox and Microsoft Edge support HTML and SVG, but these browsers are not compatible with the tabindex property. As future work, we will validate the prototype with people with visual impairment and present the results. These results will show in the visualization prototype.

6. ACKNOWLEDGMENTS

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