A Reproducible Experiment Towards the Accessibility of a Geographical Map

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Abstract. The "Mappa Mundi d'Albi" is an eighth-century map, registered in the Unesco's World heritage list in 2015. Difficult to understand even visually, it requires explanation and contextualization. In accordance with the legislation regarding the accessibility of cultural works, and to allow its understanding, we have implemented various devices, via digital technology, to make it accessible to as many people as possible. Different criteria of accessibility and perception of sensory modalities have been studied. After an analysis of the already existing accessibility design we have designed and evaluated different prototypes of enhanced digital and tangible maps. These prototypes have been put in place through different partnerships and based on a goal of reproducibility at low cost. The other objective was, taking into account the "diy" culture of fablabs, the work in collaboration for teachers specialized in accessibility or not and non-computer scientists.

Keywords: Accessibility · Sensitive map · Blind people

1 Introduction

The objective of our study is to propose different criteria of design and evaluation of several digital devices that can contribute to the principle of accessibility in the face of a geographical map visually difficult to understand. The chosen map is of the 8th century: the "Mappa Mundi d'Albi" (see Table 1), one of the first representations of the known world, is kept in a public place, the library Pierre Amalric in the city of Albi. Since 2015, it has been inscribed on the UNESCO's world heritage list. It must therefore comply with the law of accessibility of the 11 February 2005 "for equal rights and opportunities, participation and citizenship of people with disabilities" [1]. The interest of the "Mappa Mundi" rests on the fact that it is visually inaccessible to the non-specialist of the ancient world maps, so we looked for ways to adapt it to make it understandable for everyone. In a first section, we will present works and principles which served us to build our adaptation of the map. In a second section, we will detail the different prototype of the map that we propose. Before concluding, we will detail the experiments carried out to test the accessibility of these prototypes.

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Table 1. Mappa Mundi

Map	Description
	D : computer screen, swell paper
	A: click or touch on a touchscreen
	R: sighted, visual impaired, deaf
	K: audio and visual feedback on the names of different countries, cities or rivers.
	NeS: touch, hearing, seeing
	S: Inskape, audacity, html and javascript

2 State of the Art

Our accessibility thinking was influenced by the results of research on image adaptation for the visually impaired and by the reproducible principles.

In his thesis [2] shows the importance of the simplification of the tactile image which must represent the essence of the real image, in order to overcome the tactile perception which is of lower resolution compared to the visual perception. The work of [3] showed that blind children had better recognition of images is they are textured. We were also inspired by the principle of audio description, a process born in the United States and which was established in France and Europe by the association Valentin Haüy [4], allowing to describe the images or the video. The audio feedback of tactile images is today privileged thanks to digital. The first interactive map with audio output was introduced by Parkes in 1988. The interactive tactile maps [5] are based on the representation of a relief map with legendary sound output. The work of [6] adds that users better remember information with interactive maps. Our work is therefore based on these observations: inclusion and equal opportunities for all, achievable through adaptations and compensations related to collaboration but also through the plurality of access modes to knowledge. Knowledge of the map can be achieved through different sensory modes and interactive audio return, in order to provide advantages of access and memorization.

The process of building different virtual or real objects to present the information contained in such map has to be reproducible at low cost. The prototype has been made in the Fablab of the University of Toulouse. It uses block programming that does not require syntactic knowledge of a programming language.

3 Prototype Description

We will present various adaptations of the map “Mappa Mundi” and we describe them with the following information: Device, possible Action, useR, feedbacK, seNSe used, Software for realization. (DARKNeSS)

This first prototype principal aims to sighted people to explore and understand this map, the adaptation for visual impaired or deaf people is possible with adaptation (relief drawing, text in black, etc.).

Two representations are designed to visual impaired people based on a sensitive wooden card coupled with an application on a smartphone which provides an audio description (Fig. 1), or with an autonomous system which provides a tactile sound feedback to each element. An adaptation of this prototype has permit to deaf people to manipulate and understand the map (description written on the smartphone, name of country visible on the wood, etc.).

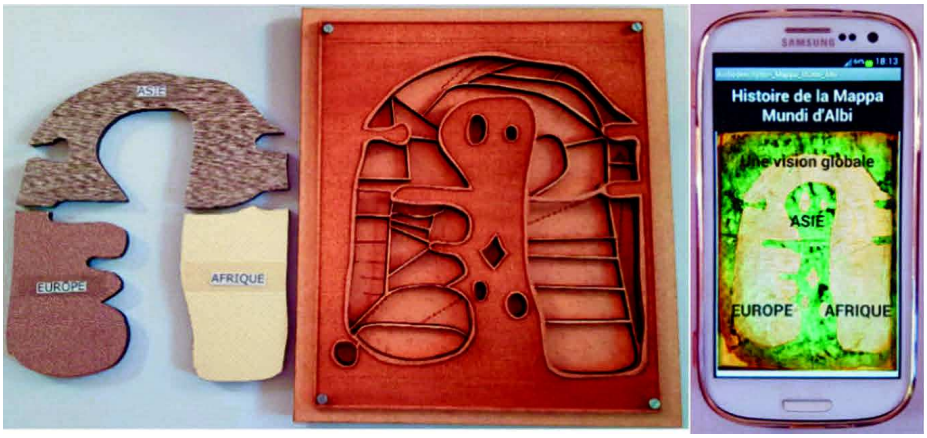

Fig. 1. Sensitive wooden map coupled to an audio description application

Description of this prototype with the previous information DARKNeSS:

- D: wooden card, smartphone, Arduino sound card
- A: Touch the wooden card, click on the mobile phone (4 buttons)
- R: sighted, blind, deaf (the description
- K: audio and visual feedback on the description of the map
- NeS: touch, hearing, seeing
- S: Inskape, audacity, laser cutting, Audacity, Photoscape, AppInventor.

4 End User Tests and Reproducible Process

4.1 First Prototype

Protocol: 19 end users (2 visual impaired) test the first prototype, they answer to 11 geographic location queries: cities, rivers, countries, islands and seas, and 2 queries of presentation and context: map material and orientation during 11 to 25 min.

Result: There is no significant difference between the results of sighted and one visually impaired user.

Overall geographic areas were identified: the number of correct answers ranging from 12 to 19 depending on the question asked.

The clickable area of the contextualization information has not been identified.

4.2 Second Prototype

Protocol: 4 blind users, map exploration with oral feedback during around 1 h.

Result: Continents (form + Braille + texture) were well identified.

The different levels of description, the discovery of the countries and the audio description adaptable to the listening rhythm of the user were positively appreciated.

4.3 Reproducible Process

The reproducibility of our prototype is mainly based on the use of easy to use and free software such as Inkscape for vectorization of images and Audacity for sound processing. The interactive sound card is reproducible as it uses HTML and JavaScript language. The wooden map was made thanks to a FabLab, shared place where digital manufacturing machines are available, such as laser cutting/engraving and 3D printer. The map reproduction is easy and inexpensive. Programming an application with the AppInventor programming uses logic blocks to generate a smartphone application.

5 Conclusion

In this exploratory study, we worked on the accessibility of a map which is very difficult to interpret visually without provided information: the "Mappa Mundi d'Albi". We are now able to reproduce the process for other maps such as the new French regions.

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