Peer-reviewed version available at *Big Data Cogn. Comput.* **2018**, *2*, 38; doi:10.3390/bdcc2040038

Article

Prototype of Mobile Device to Contribute in Urban Mobility of the Visually Impaired People

Fabrício Amorim*, Fernando Santil [1]

* Federal University of Paraná; Postgraduate Program in Geodetic Sciences;
[1] Federal University of Uberlândia; Geography Institute; santilflp@gmail.com
* Correspondence: fabricio.amorim@ufpr.br; Tel.: +55-34-99123-8103

Abstract: The vision can be used to recognize images and to improve mental pictures of environments. Visually impaired people feel a lack of aid for their independent or facilitated urban mobility, which can be achieved with the use of mobile devices and cartographic tools using audiovisual outputs. This work raises issues about urban mobility for the accessibility of visually impaired people in areas still unexplored by them, it uses cartographic technologies in electronic devices. For a preview of the test area located in Monte Carmelo (MG), a tactile model was used to form the first image of the eight volunteers. Results were obtained through research with not blind and blind individuals, it validated the use of áreas's mobile registration prototype positioning in field or not, when the coordinates from the objects are known for registration. The results indicate that both the tactile model and the audiovisual prototype can be used by blind and non-blind people. Above all, the prototype proved to be a viable and adequate option for decision making in urban environments. New ways of presenting data to blind or otherwise blind people can still be studied.

Keywords: visually impaired people; mobile devices; assistive cartography.

---

1. Introduction

Humans have needs of connection with the environment in which they live, through everyday activities. Every day, people perform urban mobility in their cities, each one with its intrinsic characteristics. This process is called navigation [1]. One of the purposes of using geographic information is to facilitate the movement of people from one place to another. Since people rely on sensory organs to form their inner knowledge of environments (mental maps). Language is an essential factor for the apprehension of body space and, subsequently, space-environment. This is how communication occurs, enunciation and understanding, since the word is loaded with meaning [2].

For Iida [3], perception occurs because of sensory stimulus processing, giving it meaning. The perception of the outside world is driven by information captured from the environment from sensory systems reported by Gibson [4]: guidance system, auditory, haptic, smell, taste and visual system. This spatial knowledge formation can be correlated with what occurs in tactile maps and in audio and / or visual maps. Each type of map has its specifications and "should" produce information appropriate to each type of public, whether for social, economic or physical (human or material) purposes [5]. For the case where the reader or public of the map is visually impaired, these people can make use of the other senses of the body to interpret their surroundings. Therefore, maps can be used by these people and can become an object of inclusion, especially when access to them is possible [6].

Mapping and access to the maps have been modified and readers have been the producers of the geo-information, concomitantly [7; 8]. From the WEB 2.0 to nowadays, users' relations with information products became interactive [7]. In the case where the user can "populate" the cartographic database, without necessarily having an employment or scientific link with the map, are called the voluntary or collaborative geographical information [7].

Peer-reviewed version available at Big Data Cogn. Comput. 2018, 2, 38; doi:10.3390/bdcc2040038

Given the required ease in urban mobility of the visually impaired, a mobile prototype was developed. The prototype contains global positional information using a courtesy base map from Google Maps [8], some information is described onscreen as some audio features. In the prototype, the user can register points through their coordinates (raised in the field or already known from other sources). The record is the description of the point and insertion or confirmation of coordinates in a mobile device dialog, more precisely, in application or system software. The application was field-tested with selected users (04 visually impaired and 04 not visually impaired) for comparative purposes. A research involving application requirements and general questions for voluntary knowledge (mind map) has been developed. The volunteers were trained with the basics necessary to use the mobile device (AudioMaps) using a tactile model. An urban area belonging to the city of Monte Carmelo (MG) was chosen to support the design of the maps (tactile and audiovisual).

1.1. Cartographic Communication and Visualization in Online Maps

The use of maps can involve the processes of communication (information transfer) and visualization (thought and knowledge building) [9; 10]. Based on the concepts of cartographic communication and visualization, a path is observed between the cartographer's conceptions and the map users. In this context, different exploratory possibilities of virtual environments, sounds and images can be inserted through communication models. Cartwright et al. [11] relies on the idea that information acquisition is an active process. The communicability of the navigation model is tested believing that interactive environments can improve the common user's spatial perception. The greatest obstacle to reading seems to be the understanding of spatialized data on maps by the lack of specific knowledge to decode the cartographic generalization applied to represent the real world [11].

The representation of geospatial data can be carried out through cartographic products transmitted in new media such as the Internet [12; 13]. The use of the Internet is growing, companies are targeting their products to the Web because of the global visibility, in addition to cost reduction, increased process automation and wide possibility of tools. The use of the Internet may also be possible in mobile handsets. Brazil is the fifth largest mobile phone market in the world, by 2012, about 130 handsets were available for every 100 habitants, with smartphones being the largest segment [12]. The main characteristics of electronic devices are: portability, usability, functionality and connectivity, each of these characteristics is important, but none of them can be considered genuinely definitive [14].

Interoperability in data sharing has meant greater possibilities and capabilities of data perception by users [15]. Geographic Information Systems (GIS) plays an important role in the collection, treatment and dissemination of spatial information [7; 8]. Virtual navigation, unlike maps printed in predetermined and static format, it allows for interactivity. With the support of information technology, the Internet and the multimedia interactivity of several cartographic communication products have increased, allowing the production of representation in the best form (pretended) of space understood and abstracted by users. The user is presented as a central agent in this case, the freedom to select what you want to represent and to produce representations of the space according to your interest, since it has tools that [8 ; 10; 11; 16] .

1.2 Visual Disabilities in Urban Mobility Tasks

Accessibility for the sensory handicapped or reduced mobility is established by Law in Brazil [17]. The law and the decree describe the elimination of barriers and obstacles in public roads. By the way, it is necessary that cities are planned and adapted to meet the different needs of this population. Therefore, accessibility to spaces can be made possible. Accessibility can be defined as "the possibility and extent of the condition, perception and understanding for safe use and autonomy of buildings, space, furniture, equipment and urban elements" [18].

In 1972, the World Health Organization (WHO) established two groups of visual impairment, low vision and blindness. In 2013, 39 million cases of blindness were reported worldwide, while another 246 million cases of moderate or severe vision loss. In Brazil, about 528,000 people are unable to see. Still, about 6 million people have low vision [19]. People with visual impairment have

Peer-reviewed version available at Big Data Cogn. Comput. 2018, 2, 38; doi:10.3390/bdcc2040038

difficulty identifying objects, identifying obstacles and gaps, determining directions, following itineraries and identifying signs [20]. The difficulties faced by these people during their locomotion cause them to seek products offered by the assistive technology industry.

The concept of assistive technology is quite broad when considering care products. However, methodologies, strategies, practices and services that promote the functionality related to the activity and participation of people with reduced mobility can be included [21]. The problems for the visually impaired in urban mobility can be highlighted: access to and exit from establishments, obstructions of sidewalks, surface without accessibility features, events and crowds [22]. Finally, aiming at an ideology or regulation, the Universal Design of Cities presents a proposal to meet the individual desires of these people [22].

Guidance and facilitated urban mobility can enable blind people to have independent movements in various settings, with practice broadened over the years and maturity. To expand the possibilities of orientation and spatial understanding of people with visual impairment. Dischinger [23] emphasizes the need to combine individual special education to improve orientation and mobility skills. Furthermore, they point to the development of appropriate tools or equipment to increase accessibility to existing spatial references.

1.3 Visual deficient and maps

In recent years, there has been the development of technologies and guidance systems for visually impaired people. These technological advances, however, have not been accompanied by an adequate investigation of human-computer interaction (e.g. designing navigational aids for people who form different cognitive maps for navigation) [23]. Still, there is no consensus on how to consider the data produced by citizens in their daily activities, such as those derived from the use of smartphones or collaborative mapping activities. Thus, the use of information produced by citizens in a "Spontaneous" through digital technologies is still a matter of debate.

According to Morita [24], the dynamics of a system with digital resources and information in "real" time transform information from a map into visual or oral representation styles. For sensory substitution systems, many efforts have been developed to help blind people access visual information such as text, graphics, images, and sounds [25]. Inclusive or assertive cartography is represented not only by 'tactile maps'. These maps are displayed in high relief using materials appropriate for the visually impaired. Other types of accessible representations to the visually impaired may be tools that include audiovisual resources. These resources can be electronic objects, such as computers or models with audiovisual responses [26]. Some products with maps are used by blind people, such as accessible desktop-based maps [printable tactile map, virtual acoustic map, virtual tactile map, enhanced paper-based tactile map, braille tactile map] and on-visual mobile maps (GPS-based maps, portable tactile screen maps, non-visual mobile maps) [27].

In the studies of Bradley and Dunlop [28], data provided by the visually impaired and used by people with and without visual impairment were studied. The results revealed that the instructions made by the visually impaired resulted in a lower score of the weighted workload, smaller minor deviations and faster times for visually impaired participants. In contrast, it has been found that these instructions cause higher scores of the weighted workload for participants with vision. The results are discussed in relation to the issue of the customization of context-compatible mobile systems for people with visual impairment [28].

Rice et al. [29] used collaborative data from visually impaired people to provide local infrastructure updates, powered by voice, text message and e-mail to inform changes in local environments. However, in the study of Rice et al. [29], the data provided by the users were not evaluated later. A network of collaborative routes for people with disabilities provided by OpenStreetMap (OSM) was developed by Neis and Zielstra [30]. The map included information on sidewalks in areas in Europe and can be used in numerous applications and maps dedicated to people with disabilities. The results showed the success of the final implementation of the attribute-dependent algorithm of the OSM data set [30]. Ungar et al. [31] carried out interpretive studies of comparisons of tactile maps with groups of blind and visually impaired people. The author

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 25 September 2018 doi:10.20944/preprints201809.0483.v1

Peer-reviewed version available at Big Data Cogn. Comput. 2018, 2, 38; doi:10.3390/bdcc2040038

concluded that these types of maps have great potential in the construction of cognitive maps for the blind. The visually impaired can create mental image areas from the same tactile practices even in unfamiliar environments.

2. Materials and Methods

This research was developed from the construction of a cartographic representation in a two-dimensional prototype (multimedia) and in a three-dimensional model (tactile model). Spatial data modeling encompassed several stages due to numerous spatial features that needed to be understood and addressed with a view to the user. At this stage, it was important to limit the extent to which reality would be abstracted, thus avoiding the lack or the excess of geographic data. A real scenario was selected to guide the tactile model composition.

2.1. Scenario

A study area in the city of Monte Carmelo (Brazil, MG) was selected to support the map project (Figure 1). The selected area corresponds to the central part of the city, with flat relief. This area was selected in reasons to be a representative area of the city, according to the characteristics of the existing resources.

Figure 1. Study Area Image, [32].

2.2. Tactile Model

The tactile model (Figure 2) for the tested area was elaborated with the intention of expressing physical details and expressions, so easily to recurrent information to those who seek positional and descriptive information. The following information was represented in the tactile model from the survey of the needs of the blind users in their urban mobilities: poles, landmarks (church, hospital and funeral home), pedestrian tracks (their ends), coordinates of the locations of the corners belonging to the test area. A similar idea of presenting graphical information respecting its symmetrical and zonal values by scale were considered adequate to the scale model, which had paper size A3 (420 x 297mm). It was sought that the size of the tactile model was suitable for the fast reading of the area represented there. The minimum size of the represented objects corresponded to 0.5 cm (in pins for posts).

The tactile map for the test area in Monte Carmelo (MG) has contrasting colors, each color on the map represents a feature, the streets are represented by light gray color. The pedestrian strip is represented in yellow color, with the texture of "sandpaper" facilitating the tactile perception. The poles are represented in the white color by means of balls also easily identifiable. The symbols for localization (church, hospital and funeral parlor) are represented by texture in suede and similar design to that represented in signs of road. The blocks in the tactile maps have an elevation in relation

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 25 September 2018 doi:10.20944/preprints201809.0483.v1

Peer-reviewed version available at *Big Data Cogn. Comput.* **2018**, *2*, 38; doi:10.3390/bdcc2040038

to the road that is signaled by means of Braille writing, there is still the demarcation of a central bed separating a road, it is represented in green with a velvety texture. The direction of the track is represented by an arrow with sandpaper texture indicating its direction, this indication is too important for decision making when moving on the tracks.

Figure 2. Tactile Model: Study Area

2.3. Prototype of Mobile Device

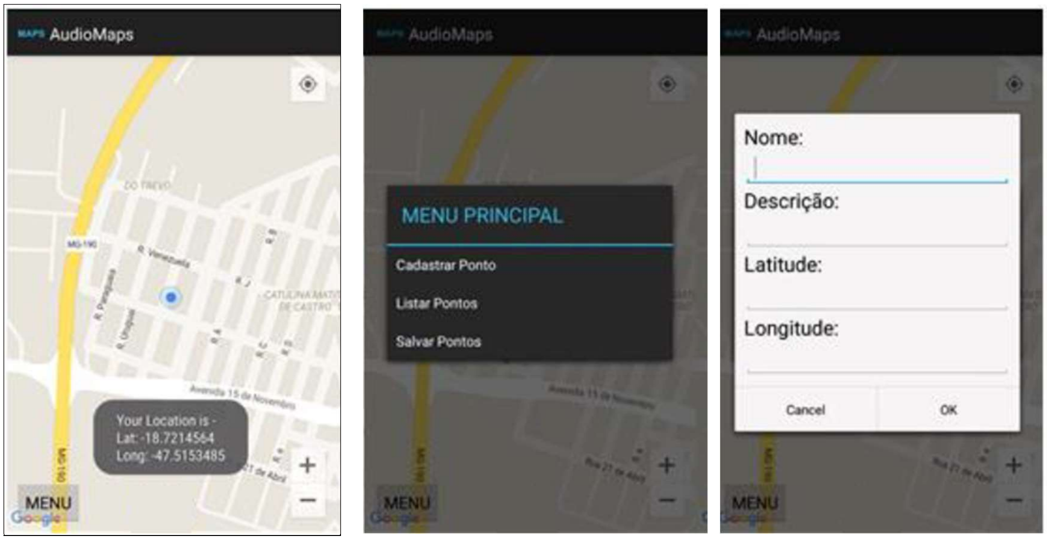
The design and production of the device (AudioMaps) took place from programming and implementation in software (Application Programming Interface - API). The cartographic base and the tools used in designing the project were provided by Google [9]. The AudioMaps application has the objective of obtaining coordinates and registration of points of interest. For each point registered in the prototype, whenever the location of the device is close to it (15 and 5 meters), the prototype provides in audio form the previously registered description of the point.

Starting the prototype, users can view the interface containing their current location by means of a message at the bottom of the screen (text only) (Figure 3a). The geographical coordinates of the registered points are presented in sexagesimal degrees in the device according to the location of the user on the point. Also, there is the possibility of inserting coordinates for cases of distance mapping, if the coordinates of the point are known.

This initial interface allows you to enlarge or reduce the displayed area, as well as the choice of any area already available in the Google Maps base map. At the top of the screen the device symbol or logo appears (in blue). The lower part of the display shows the menu where the points registration tools are displayed, the points already registered and the saving of these points in text files (.txt) (Figure 3b; Figure 5). For the registration of points (Figure 3c), the same must be specified from phrases or words for later audiovisual identification.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 25 September 2018 doi:10.20944/preprints201809.0483.v1

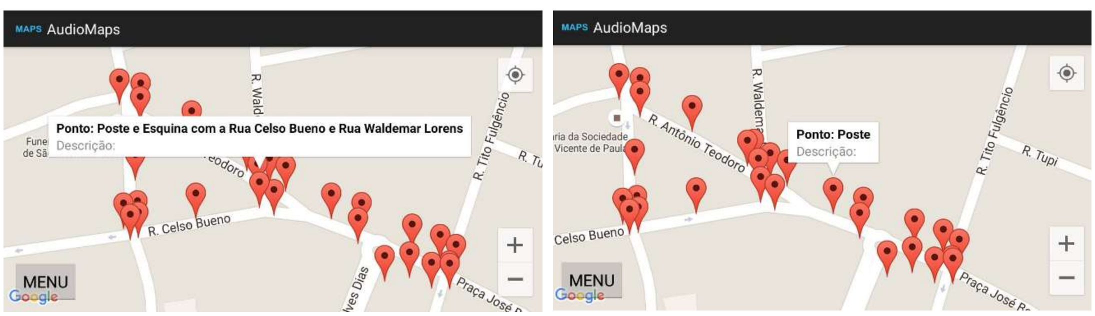
Peer-reviewed version available at Big Data Cogn. Comput. 2018, 2, 38; doi:10.3390/bdcc2040038



(a) **(b)** **(c)**

Figure 3. AudioMaps Interfaces: Real time location (a); tools (points register, visualization and storage) (b); points register description (c).

The points selected for the representation of the tactile model were inserted in the audiovisual mobile cartographic device. Navigation for data collection on points of interest in the field was facilitated with GIS / GPS integration by a mobile device (Samsung Galaxy Grand Prime, Android operating system, 5 inches). Conventional cadastral research consisted of conducting on-site visits to collect data to generate a descriptive memo related to the points recorded on the mobile device. The coordinates of the recorded points and their descriptions were obtained using the device itself (Figure 4).



(a) **(b)**

Figure 4. AudioMaps interface with the registered and described points.

After registering a new point, the list of points already registered and lastly the bottom to save on own mobile points already registered in text format (.txt), which are files described the names of points (primary information), description (latitude and longitude in decimal degrees) and the date of registration of this point (Figure 5). The system lacks reliability as to the origin of positional information (coordinates). Therefore, whenever the device's GPS is not sending information because it is disconnected (offline) and / or other interruptions, the system does not return information.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 25 September 2018 doi:10.20944/preprints201809.0483.v1
Peer-reviewed version available at Big Data Cogn. Comput. 2018, 2, 38; doi:10.3390/bdcc2040038

(a) **(b)**

Figure 5. Description of the registered points of: corners (a); objects (b).

2.4. Participants and grouping

After the production of the cartographic representations (tactile and audiovisual), experiments were performed with two different groups of users (blind and visual). Thus, the experiment was based on a road map for the use of maps in activities to be developed in the study area. and specific questions about each activity. The test was performed with eight volunteers, where they were divided into groups with visual impairment (4 people) and non-visually impaired (4). These two groups were organized based on their prior knowledge of the area. Soon, half of each group knew the area and the other half knew.

The characteristics of the volunteers (visually impaired or not), as well as their interactions with mobile devices and other electronic technologies were collected and recorded in a participant characterization questionnaire. The responses to the questionnaire were tabulated to allow the completion of the proposed evaluations. All volunteers signed the compromise agreement agreeing to provide results for this search while preserving their information.

2.5. Experiment

The test was divided into parts. The first part refers only to the user profile, characterized by a collection of information about schooling, experience with cartographic visualization and knowledge of the area. In the second part, users were trained with the tactile model to perform the preliminary recognition of the test area. The third step was the test in the test area with the volunteers using the prototype developed during a walk along a predefined path. All volunteers were assisted by the experimenter during this stage.

The volunteers were supported (holding in their arms) and oriented during the journey. During the experiment, the volunteers were instructed to recognize the mock produced productively. In cases of doubt, they could question the experimenter to solve them. Subsequently, some information about the orientation of some routes and location of some places represented in the model were argued.

For the tests with volunteers in the test area, all should be in the same conditions of visual perception of the environment. For those who visual volunteers, their eyes were blindfolded to manipulate tactile mockup and to perform mobility in the test area using the mobile device. Therefore, the methodological procedures that guided the project were based on the perspective on

Peer-reviewed version available at Big Data Cogn. Comput. 2018, 2, 38; doi:10.3390/bdcc2040038

the same level of blindness (total) for all users. However, the visually impaired were able to use a walking stick during practice.

3. Results

The research phase on the tactile model was characterized by a user perception test on the test area represented there. The test addressed the variables present in three-dimensional cartographic representations (texture, size and orientation). These variables were chosen because of their practicality, in order to know how users perceive them tactile. All the volunteers were able to identify the information represented in the tactile model, after being questioned about their locations. Overall, blind volunteers had greater difficulties in understanding and correlating the spaces in the tactile model. Therefore, these people were less efficient at reading this type of cartographic representation visually.

Along the way through the test area, all members were amazed at the responsiveness and functionality of the prototype. The distance between the volunteers and the registered objects was considered of extreme importance. Thus, the distance between the points was confirmed and associated with the real world. In the user's comments to the questionnaire sheet, they said the prototype is easy to navigate and very interesting, which can facilitate spatial orientation. Thus, the model enabled the user to create relationships between represented space (virtual) and real (physical) space. The virtual navigation also allowed to enrich the mental map of the users. Blind users were interested in learning how to register more points on the device. Therefore, they have shown themselves to be potential producers of geospatial information.

After the practice, the visually impaired were able to inform the position of some registered points. This confirmation of mapped elements was less effective for the visually impaired. The visually impaired who already knew the area were able to describe in a more detailed and practical way all the location information during the test. Visuals made better use of the mobile device and seemed more into it. The volunteers returned to their mind maps and added landscape elements that they considered important.

Some visually impaired people reported having traumas for attempting to perform urban mobility without assistance, including some accidents / incidents that occurred due to lack of adequate road signs and inadequate structure of guides. Soon, short-term obstacles (holes, garbage bags in the street or debris) were pointed out as necessary on this type of map. Above all, with the registration of this type of information, navigation of the blind by urban environments seems to be facilitated. However, it has been noted that your registration may be impractical.

4. Conclusions

Although approaches to digital mapping offer an opportunity to collect and share information for the visually impaired. To date, it is not clear whether different groups of users (blind or not) behave similarly when navigating in urban spaces with the use of maps. Several solutions have been implemented and proposed to deal with navigation in environments for both the visually impaired and the visually impaired. Each solution may involve a different type of product.

The methodology used in the tests provided preliminary results, and future analyzes are required using preliminary field tests, after which they are tested with volunteers and end users. The aim of the device was to obtain coordinates of isolated points and to orient individuals spatially (audiovisual) in relation to defined distances (15 and 5 meters).

In the experiment described here, the degree of communicability of the prototype was significant, revealing itself as a potential tool to promote the development of the spatial perception of the visually impaired. The prototype allowed the environment to be characterized and exploited by the user in a simple and interactive way, responding to their actions and allowing them to perceive the environment as if they were moving around the city.

The prototype facilitator of urban mobility can directly affect the quality of life of people with visual impairment. It can eliminate or reduce the need to remember all street routes or nomenclatures. It was realized how valuable it is to work with new forms of cartographic representation to

Peer-reviewed version available at *Big Data Cogn. Comput.* **2018**, *2*, 38; doi:10.3390/bdcc2040038

democratize and transmit information to the visually impaired. Thus, the study attempted to show the importance of developing cartographic communication models to increase access and understanding of spatial information.

Social relations with space, mediated by new technologies, can increase the possibilities of local subjective reconfigurations, social life and the world of images we share, expanding the construction of new layers of territoriality.

Author Contributions: Both authors formulated the concept, methodology, and design of this study, and completed the data curation. Both authors edited and approved the final manuscript.

Funding: This research received no external funding

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Board, C. Map reading tasks appropriate in experimental studies in cartographic communication. *Cartographica: The International Journal for Geographic Information and Geovisualization*, **1978**, v. 15, p. 1-12.
2. VYGOTSKY, Lev Semenovitch. A formação social da mente. Trans. José Cipolla Neto, Luis Silveira Menna Barreto e Solange Castro Afeche. 1991. Iida, I. *Ergonomia*: projeto e produção. 2ª edição, São Paulo, 2005.
3. IIDA, I. Ergonomia: projeto e produção. **2005**, 2. ed. São Paulo: Edgard Blücher,.
4. Gibson, J. J. *The senses considered as perceptual systems*. 1966.
5. Keates, J. S. *Cartographic design and production. London*: Longman, 2ª edição,1989.
6. Nogueira, R. E.; Almeida, L. C. Iniciação cartográfica de adultos invisuais. In: Nogueira, R. E. (Org.) *Motivações hodiernas para ensinar geografia*. Florianópolis, Ed. Nova Letra, 2009. 252p.
7. Goodchild, M. F. Citizens as sensors: the world of volunteered geography. *GeoJournal*, **2007**, v. 69, n. 4, p. 211-221.
8. Google Maps. Available online: https://www.google.com.br/maps. Accessed in: 10 May. 2018.
9. Slocum, A. T.; McMaster, R. B.; Kessler, F. C.; Howard, H. H. *Thematic Cartography and Geovisualization*. **2009**, 3rd ed. Prentice Hall.
10. Maceachren, A. M.; Kraak, M. *Exploratory cartographic visualization*: advancing the agenda, **1997**.
11. Cartwright, W.; Peterson, M. P.; Gartner, G. (Org) *Multimedia Cartography*. **1999,** 2. ed. Berlin: Springer-Verlag.
12. Nmc, Firjan - *Federação das Indústrias do Estado do Rio de Janeiro*. Horizon Peport, **2012**.
13. Peterson, M. P. The Development of Map Distribution through the Internet. In: *Proceedings Of The 20th ICA Conference*, Beijing, China, **2001**.
14. Frozza, A. A. Programação para dispositivos móveis. *Classes Notes*. Available online: https://bit.ly/2MYXAyl. Accessed on 10 Aug. 2018.
15. Egenhofer, M. J.; Fegeas, R.; Goodchild, M. F. Interoperating GISs Report of a Special-ist Meeting Held under the Auspices of the Za-renius Project, *Panel on Computational Implementations of Geographic Concepts*. **1997**, December 5-6, Santa Barbara, California.
16. Bravo, J. V. M.; Sluter, C. R. O problema da qualidade de dados espaciais na era das informações geográficas voluntárias. *Boletim de Ciências Geodésicas,* **2015**, v. 21, n. 1.
17. Brasil. Decreto-lei nº 5.296, de 2 de dezembro de **2004**. Aprova a consolidação das leis nº10.048 e 10.098. *Diário Oficial da União*, 2004. Brasília. Available online: https://bit.ly/2NvWzCO. Accessed on: 8 Jun. 2018.
18. NBR, ABNT. 9050. *Acessibilidade a edificações, mobiliário, espaços e equipamentos urbanos*, **2004**.
19. *World Health Organization* (WHO). 2014. Available online: at: http://www.who.int/pu blications/en/. Access 15 Aug. 2018.
20. Cambiaghi, S. *Desenho Universal: métodos e técnicas para arquitetos e urbanistas*. Senac, **2007**.
21. Manzini, E. J. Tecnologia assistiva para educação: recursos pedagógicos adaptados. *Ensaios pedagógicos*: construindo escolas inclusivas. Brasília: SEESP/MEC, **2005**, p. 82-86.
22. Lopes, M. N. N., et al. *Plano de promoção de acessibilidade para todos*. Projeto realizado em cooperação com a Divisão Municipal de Planeamento e Projeto da Câmara Municipal do Porto, **2010**.
23. Dischinger, M. Designing for all senses: accessible spaces for visually impaired citizens. *PhD Thesis* – Department of Space and Process School of Architecture, Chalmers University of Technology, 2000.

24. Morita, T. Grading of the Map Functions in Navigation System. *Internacional Conference. Cologne* – Koln. Internation Cartographic Association, **1993**.
25. Meijer, P. B. L. An experimental system for auditory image representations. *IEEE transactions on biomedical engineering*, **1992**, v. 39, n. 2, p. 112-121.
26. Almeida, L C; Loch. Ruth. Uma cartografia muito especial a serviço da inclusão social. UFSC, *Congresso Brasileiro de Cadastro Técnico Multifinalitário*, **2006**.
27. Zeng, L.; Weber, G. Accessible maps for the visually impaired. In: *Proceedings of IFIP INTERACT 2011-* Workshop on ADDW, CEUR. **2011**. p. 54-60.
28. Bradley, N. A.; Dunlop, M. D. An experimental investigation into wayfinding directions for visually impaired people. *Personal and Ubiquitous Computing*, **2005**, v. 9, n. 6, p. 395-403.
29. Rice, M. T, et al. Supporting Accessibility for Blind and Vision-impaired People with a Localized Gazetteer and Open Source Geotechnology. *Transactions in GIS*. **2012**, v. 16, n. 2, p. 177-190.
30. Neis, P.; Zielstra, D. Recent developments and future trends in volunteered geographic information research: The case of OpenStreetMap. *Future Internet*. **2014**, v. 6, n. 1, p. 76-106.
31. Ungar, S.; Blades, M.; Spencer, C. Map use by adults with visual impairments. *Professional Geographer*. **1999**, v. 51. p. 539-553.
32. Google Satellite. Available Online: https://bit.ly/2I5S7oh. Accessed on: 16 July 2018.