Design Concepts for Tactile Maps to Support Visually Impaired Persons

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Abstract. Maps ease spatial orientation. By far most of them are purely visual and thus not made for being read by visually impaired persons. Maps that are customized for the communication between sighted and visually impaired persons, e.g. by showing spatial information as tactile map and as color print, could help building a common foundation for multimodal representations of spatial knowledge in one form that is accessible to visually impaired and sighted people. Before the interaction of the modalities can be questioned some principles of interaction with unimodal tactile maps need to be investigated. This presentation focuses on questions on how to transform a concept for an exemplary class of maps to the tactile domain and exemplifies the difficulties and questions that arise. First experiments on how to realize one part of the interaction between language and these tactile maps for visually impaired persons are proposed.

1 Motivation & Key Interests

Maps today are in most cases a visual medium, adapted to the abilities of visually capable people. There are inaccessible to visually impaired persons (VIPs). Even if they were not, some concepts or conventions used in maps would not make sense to some VIPs, because they might not know the (visual) concept used to encode information, e.g. color. Thus, when producing appropriate maps for VIPs special care has to be taken. Information from the visual map has to be conveyed through other senses. One solution is to represent the environment through relief profiles, which the map-reader explores with his fingers and hands. With exploration progressing, the map-reader integrates the numerous contacts to form one 'mental model' (Johnson-Leird 1980) of the represented part of the world. With tactile exploration VIPs can build up spatial concepts of the world that help them, e.g. with independent planning or with wayfinding.

A major drawbacks of tactile exploration are that it is limited to the peri-personal space (defined by the arms' length); it is serial in nature (i.e. point after point), and it is of low detail (in comparison to visual scanning). As a result, the map-readers do not have fast access to all the information represented in tactile maps. Imagine a VIP explores a tactile street map and feels an intersection at some point. Usually he would not know to what part of the city the different roads lead until he will have explored (one after the other) where each road runs to. Thus, tactile maps provide spatial information to VIPs, but using them introduces problems, most notably caused by the low information density. The low information density in tactile maps is believed to be counterbalanced by providing information through multimodal representations, e.g. information as language and (other information) as tactile relief. The importance of augmenting tactile maps with audio has been shown by Siekierska and Müller (2003). Augmenting tactile maps with language is commonly done when labels are added or a description attached to the map. But in situations where the map-reader cannot decode text information or needs help with reading the map, the communication about a map becomes important.

The key interest of this research is in investigating the design of one exemplary class of maps that are used in a setting of multimodal communication between visually impaired persons and sighted persons. Design in this context is not meant to be artistic – nevertheless it is the art of producing meaningful and useable multimodal maps for the target population. The aim is to identify cognitively appropriate concepts and usable solutions to convey information via a multimodal map to help VIPs communicating with sighted people. More precisely, a system of conventions on how to systematically transform spatial information from visual maps or geographical data into visual-tactile form to support the production of maps is developed empirically. The resulting multimodal spatial representations are tested whether they support visually impaired people in navigating the represented world independently and whether the communication between sighted and visually impaired persons about space is eased by the multimodal character of the representation.

2 Research Agenda

In this dissertation project, we have identified potential problems in the use of a special class of maps – so called You-Are-Here maps[1] – by VIPs (Habel & Graf 2008). Now I am about to develop concepts of how to design multimodal maps that serve the special requirements of VIPs. Later, I want to evaluate the concepts in practical interaction scenarios and communication situations.

Initially the target population is limited to late-blind people and the represented world is limited to parks, zoos and university campuses. Amongst the population of the visually impaired persons, late-blind people are the biggest group (Resnikof et al. 2004) – thus it advisable to firstly focus on them. The restriction to environments like parks, zoos and campuses holds the advantage that they are limited, well defined and structured in a similar way (e.g. in terms of areas and routes between these areas) – that eases the definition of tasks for user testing and helps to make statements about

[1] Gaining survey knowledge of a complex spatial environment has proven to be facilitated by so-called You-are-here (YaH) maps (Marquez, Oman, Liu 2004; Richter & Klippel 2002). The explicit representation of the spatial environment helps the map-user to build up survey knowledge (Levine 1982; O'Neill 1999). Using this knowledge, or 'cognitive maps' (Tolman 1948), the map-user is likely to navigate his environment successfully, i.e. accomplish his tasks in that environment.

validity of the results.

The focus of the current work phase is on finding appropriate concepts for tactile maps for VIPs. Tactile maps are low detail representations that can only convey a limited amount of information. The original data is in another representational modality, namely as mathematical and categorical data (if it originates from geographical information systems (GIS)) or as a visual map. To convert it to a low-detailed representation that can be realized as tactile map for visually impaired users with graphical elements for the sighted user, a subset of features has to be identified. After this subset is identified, concepts on how to arrange and modify these features must be employed to form a map that is discernable and intelligible to the user. Especially the last aspect will be in the focus of this paper.

One common task when beginning to use a map is finding the 'entry point', the location in the map where the map-reader has to find to begin solving the task at hand. The map user has to relate his frame of reference to the reference system shown in the map, i.e. identifying some features in the world that are represented in the map as well. As example, the position of a map-reader while reading the fixed YAH map is in front of the map. The location of the YAH map (and the map-reader collocated with it) in the world is the YAH point. The YAH point should (in well formed YAH maps) coincide with the location of the constituent of the YAH maps, the YAH symbol (others call it the 'YAH marker', e.g. Marquez, Oman, Liu 2004).

3 Work in progress

At present, my research is about the question how visually impaired persons can find the entry point to YAH maps fast and easily. A high success rate in identifying the YAH symbol is essential for the purpose of this type of maps. But the solution optimal for this criterion must not cause interference in the normal exploration of the map. It is hypothesized that four factors influence the process of finding the YAH point of which two are detailed here:

1. <u>Design of the symbol</u>: the more the symbol distinguishes from the surrounding the faster it can be found (rational: a very different object is easy to detect amongst otherwise similar object).
2. <u>References to the symbol</u>: Directions or guidance to the position of the symbol will shortcut search (rational: having references can limit search space).

To test these hypothesizes different tactile maps are produced and tested against each other. The first evaluation criterion is objective search time until the YAH point is found. To exclude solution that are solely optimized on finding the YAH point but thwart the purpose of the map, i.e. helping the map-reader in orientating himself and learning about his environment, a second criterion is introduced: perceived ease-of-exploration of the map.

The following experiments are proposed to test the influence of the two design factors on finding the YAH point. The maps used in the experiment are only different in the way how the YAH symbol is presented. Otherwise they are completely identical and everything is realized as raised lines of different elevations. The maps show the spatial configuration of a zoo with points-of-interest (POI) as symbols which very learned in a training session – e.g. entrances, animal areas, buildings – and walk-ways between the POIs. In the baseline version “A” of the map, the YAH symbol that was designed and tested to be detectable by VIPs is made from raised lines too.

a. In a first experiment the map A is compared with a map B in which the YAH symbol is mounted on a platform that clearly elevates the symbol above the rest of the map. It is expected that finding the YAH point in the map B takes significantly less time than in A. It is not expected that usability of map B will significantly drop compared to A.
b. In a second experiment the map A is compared with a map C on which the YAH symbol is not composed from raised lines but a very distinctive tactile object that is of the same height than A. It is expected that finding the YAH point in the map C takes significantly less time than in A, but more than with map B. It is expected that usability of map C will be better than B.
c. The experiment compares the map A with a map D that contains an explanation of the position of the YAH point as a pre-taped audio description. It is expected that finding the YAH point in the map D takes significantly less time than in A.
d. The experiment compares the map A with a map E that contains a guiding line from the border of the map to the YAH point. An explanation how to find the guiding line is pre-taped. It is expected that finding the YAH point in the map E takes significantly less time than in map D.

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