Putting it in Perspective: Designing a 3D Visualization to Contextualize Indigenous Knowledge in Rural Namibia

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ABSTRACT
One design endeavor we pursue in a long-term research and co-design project is the creation of a 3D visualization interface for an indigenous knowledge (IK) management system with rural dwellers of Herero ethnicity in Namibia. Evaluations of earlier prototypes and theories on cultural differences in perception led us to further investigate the suitability of different perspectives of view for the given user group. Through a combination of drawing sessions, design discussions and a high-fidelity technology probe we explored the visual perceptions and preferences of community members; specifically focusing on representation and recognition of objects and places in their everyday environment. We report how the findings from the study have informed design decisions for our particular system while also suggesting that certain viewing angles for 3D visualizations could be more suitable for rural dwellers in general and the collaborating community in specific.

Author Keywords
HCI4D, cultural design, visualization, 3D interfaces, perception, perspective, Indigenous knowledge, ICT4D.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Numerous trends in the process of national development, such as urbanization, have resulted in an impending loss of indigenous knowledge. In many countries the conservation of this heritage is high on the political agenda and has consequently cultivated global concern. ICTs may hold the key to saving this knowledge, but they also come with great challenges – not least from an HCI and interaction design perspective. In our work, we have embarked on the exploration of an appropriate solution for Namibia, through which elders in rural areas can digitalize, store and organize indigenous knowledge and urban migrants can retrieve it [8]. Hopefully such a system can help bridge the divide between generations, which is further nurtured through different exposure to technologies and knowledge systems.

The research project has been running since 2008, with the main aim being the development of a community based indigenous knowledge management system. Our long-term community engagement in selected sites in Namibia is based on participatory action research and dialogical design principles [8]. A comprehensive unpacking of the overall research methodology is outside the scope of this paper (we refer to [5,8,1]), but the design challenge at its core is that African indigenous knowledge systems, such as that of the Herero tribe, are deeply rooted in concepts such as 'connectedness of all', holistic approaches, oral and performing expressions as well as transmission techniques. These fundamental differences have not been accounted for in current technologies although they have major design implications, and especially in a mediated representation of indigenous knowledge within the local context. Thus, we argue that a more thorough and situational study of the local worldview needs to inform decisions regarding the representation of the environment. [8,5,1].

Over the years we have acquired a substantial amount of audiovisual representations of indigenous knowledge. These have been recorded as videos by researchers or community members and include a broad range of demonstrations, interviews, and stories by local elders on topics such as husbandry, traditional healing and other customs. For organization of this knowledge base, our ethnographic observations, community and researchers discussions, as well as analysis of narrations, all pointed towards a dominance of spatial and social structures [1]. We have therefore chosen to explore the possibility to embed 2D videos of social significance into a 3D spatial model.

Towards a Suitable Spatial Representation
Earlier in the project a co-design session of a tangible physical model clearly showed that while participants navigate confidently through the bush straight to intended points, they struggled to create a geospatial aerial view representation beyond close proximity of places [8]. From personal experience, many Namibians do not use street

maps as navigation tools but rather points of references. The use of maps is a trained skill emphasized commonly in the Western world. This raised questions as to whether an intuitive spatial model can be designed for the intended users and which aspects should be considered. One design direction we are exploring is the potential of 3D visualization, which provides the context for the study presented in this paper.

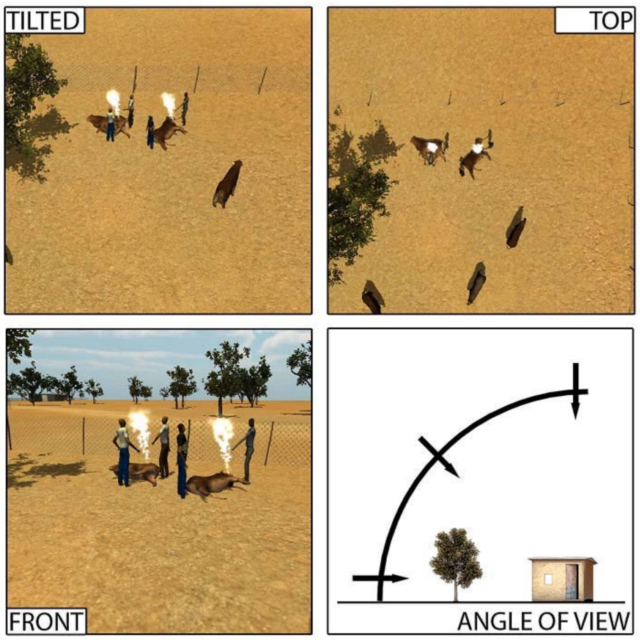

Figure 1. Screenshots from a scenario (branding of cows) in the prototype from the front, tilted and top angles.

3D Visualization Prototype

For more than a year, we have been investigating an approach in which the captured videos are embedded as 2D planes in a 3D visualization at the represented locations where they were filmed contextualized by scenarios [5]. Through iterative design and evaluations of a high fidelity prototype we have shown promising results in terms of suitability and user acceptance [5]. With the emphasis on location the prototype was designed for high recognition rates and focus has been on graphical resemblance of objects in the village and their geospatial positioning. The studies however showed that while community members did recognize individual graphical elements, they did not immediately associate the 3D model with their own surroundings [5]. This caused lengthy debates among the researchers around the topics of differences in perception between developers and rural dwellers, the subjectivity of accuracy and the influence of perspectives for recognition. Figure 1 shows screenshots from the prototype and the different angles of view that we have considered during the design process. We thus decided to investigate these fundamentals further with the overarching question of how we should design for cultural differences in representing how the world is perceived.

CULTURAL DIFFERENCES IN PERCEPTION

Studies into cultural differences in perception have revealed that numerous differences are evident, in areas such as depth perception, visual illusions, categorization, and perspectives [2,3,4]. The differences in perception largely depend on acquired knowledge. One theory of visual processing draws upon bottom-up and top-down processing [7]. Bottom-up processing involves the detection of specific features of the stimulus (e.g. horizontal or vertical lines), the combination of these features into more complex forms and matching with objects already in the person's knowledge base, ultimately leading to recognition [7]. On the contrary, top-down processing begins with the formulation of a perceptual hypothesis, then features of the object are selected and examined to verify the hypothesis, and if they match the object is recognized [7]. Top-down processing is driven by experience and context, making it an integrate part of our research question, as top-down processing results in objects being more readily recognized when they are presented in their usual form, as opposed to an unusual viewpoint [7]. Only through passive experiencing or active learning the different views seen during rotation become associated and make the object recognizable when presented from different angles [6].

A study led by Deregowski in 1972, with un-schooled African children added further insight into the perception of objects from different viewpoints (as cited in [3]). The subjects were presented with two drawings of an elephant from the "top"; one was depicted like a realistic photographic representation with only the back and top of the head visible, while the other had the legs rolled out to the side making all four legs visible. The subjects rated the second picture as a more "accurate" depiction of a top view.

From this we deduce that an important element in the 3D visualization interface would be to identify the appropriate view angle resulting in a perspective that leads to high recognition rates. As the designers "from outside" the community, we perceive the world differently, as we focus on different elements in the real world. Hence, to design a 3D visualization interface we attempt to see "through the eyes of the villagers". To investigate this we conducted a two phased study focusing on representation and recognition.

METHODS

The study was carried out in a Herero village in rural Namibia with a total of 21 people participating (16 male and 5 female). 10 were classified as youth, with an average age of 21.6 (st. dev. 8.3) and 11 were elders, with an average age of 47.5 (st. dev. 8.1). The classification is made by the community and is not solely based on age, but rather the possession of knowledge and respect. Also, there is a high uncertainty associated with the reported ages, as many of the villagers do not know their exact age. It should also be noted that the researchers who moderated these sessions are fluent speakers of Otjiherero, the local language.

Figure 2. Drawing with youths (left) and elders (right).

Drawing Sessions

To investigate how the villagers represent their physical environment, we set up "think-aloud" drawing sessions where the participants were asked to draw their own homestead from memory; once from the front and once from the top ("through the eyes of a bird"). We emphasized the free nature of the exercise and disregarded drawing experience and skill. From the drawing process and dialogue we obtained an indication as to 'what' and 'how' they pictured their own environment. The drawing sessions were conducted in a semi-controlled setting with the drawing person situated outside at one of the village homesteads (not their own). For each drawing session the elders were isolated and the youth were placed in groups, so that they felt more comfortable yet in such a way that they could not see each other's drawings (as shown in figure 2). Therefore, the drawings produced are still personal and not affected by other participants.

Technology Probe Sessions

The goal of these sessions was to get qualitative feedback on how the different view angles were perceived by the villagers. The previous implementation of the 3D visualization system was modified enabling switching between three different viewpoints as shown in figure 1. Two group sessions were conducted with five youths and six elders respectively. They were all part of the drawing phase. Figure 3 shows the setup. Data was collected through observation and video recording, while systematically going through various scenarios in the prototype showcasing different view angles and having a dialogue with the participants. Essentially the goal was to identify whether the villagers could recognize the places and objects from different perspectives and qualitatively gauge how easy and readily they did it.

RESULTS AND FINDINGS

Results of Drawings as Representation

From field notes and video analysis with a written English translation, we analyzed the drawings for the occurrence of different objects, sequence of which objects were drawn and the chosen perspectives. We compared the front view drawings with their top view counterparts, as well as each drawing to a high resolution digital image of the real homestead.

Figure 3. Sessions with youths (left) and elders (right) with system prototype on laptop powered by car battery.

All drawers, with one exception, did not draw an expected top view of their homestead. We recorded participant statements such as "I have never been on my roof, so how should I know how it looks like?" The only person who did draw a more realistic top view was a youth currently schooling in the capital city, only spending his holidays in the village, assumingly trained in the abstraction of perspectives.

Six participants drew the top view as a scaled down version of their front view drawing - while maintaining the same perspective. One elder stated that "if I am looking from a bird's perspective, everything looks smaller because I am high up". Further comparing how others transformed the front drawing into a top drawing we counted four who drew almost identical views, four who shifted their drawing down to the bottom of the page (possibly to signify air above), three participants tilted the view, and three drew a mix of objects seen from front and top (as in figure 4).

The effects of rotation exposure can be observed in the top view drawings of the participants. The fire place was one of the features that participants were able to draw from the top as they had rotation exposure from naturally viewing it from the top when standing over it. When looking at the depictions of cows it becomes clear that participants had never seen a cow from the top and drew it from the angle they were used to seeing it.

Looking at the perspective of the front drawing only, we can see that nearly half the participants drew elements (mostly of the house) in a 3D perspective, while also the 2D drawings contain a number of elements such as dimensions and relative placements giving the illusion of a tilted angle view (as can be seen in figure 4).

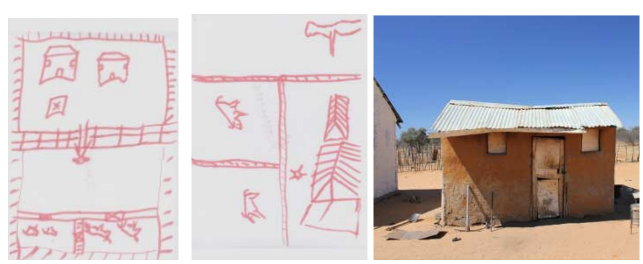

Figure 4. Drawings examples from one participant front (left) and top (middle) in relation to the real homestead.

Results of Recognition in the 3D Prototype

We looked at how the participants reacted when presented with new scenarios from different angles of view. Specifically, how readily they identify objects and places in the different scenarios, the level of detail in which they discussed what they saw and the degree to which they engaged in design oriented discussion about the objects. Based on this, we found that both the front and tilted views are valid in terms of understanding the visualization, as both groups quickly and actively engaged in discussions. From the tilted view, they readily discussed the levels of realism and accurateness of objects, showing that they relate the virtual model to their own worldview, e.g., the youths remarked that “the cow’s heads are looking like pigs” and that they “walk funny”.

The front view seemingly provided better detail of the action in a scenario, as participants expressed that they felt “closer”. In the branding scenario shown in figure 1, elders explained that the people were not burning the cows on their heads, hence it was a branding not a burning horns scenario. Both groups expressed preference for this view, but it should also be noted that both youths and elders suggested the option of having several views and switching.

Results from the top view were less positive. Only one elder showed a clear understanding of this perspective; he was able to identify the exact location of a given scenario and comment on missing objects. The youths did comment on some objects and places, but recognition was slower and uncertain. Neither group had preference for this view.

DISCUSSION AND CONCLUSIONS

The combination of using a high fidelity prototype evaluation with drawing sessions confirmed results from the scarce literature on cultural and individual differences in perception relating to 3D visualization. We found that the top view is indeed inappropriate for the local villagers. This is supported by the drawing exercises where only one (arguably trained) participant could draw a top view, the lack of recognition in the prototype as well as the literature which states that the ease of recognition is increased when objects are represented from a familiar angle.

Our results agree with previous ethnographic work suggesting the suitability of a front view, representing an ego-centric point of view, as this is most familiar to local rural dwellers [1]. However, both phases of the study further support that a tilted perspective is also appropriate. These findings are important for our design, because using a tilted perspective allows for a better overview of spatially distributed knowledge such as scenarios and embedded videos which constitute an essential aspect of navigating and interacting with our system. The tilted view also allows for more contextual information to be visible than the front view, so from a top-down processing point of view it should aid recognition of specific objects and places in the 3D model.

In this paper we have addressed the importance of perspective in 3D visualizations and local differences to inform a culturally specific design. Obviously, there are many other factors that play a role in achieving the desired recognition. Thus, in current and future work we are conducting a number of related studies on the importance of colors, textures, sizes, proximity and relation of objects and their animation to appropriate the interface to the target users' natural ways of perceiving the world.

While it is premature to generalize the results due to the scale and limitations of the study, we find it plausible that these findings will hold true for people in other Herero villages and similar cultures. If the findings can indeed be replicated, then it could have major implications on how we can design suitable 3D visualizations for and with rural communities and cultures.

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