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## Tapping Into Local Lore

*Toward Scalable Local Mapping and Tagging for Rural Africa Using Mobile Devices*

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# Tapping into Local Lore: Toward Scalable Local Mapping and Tagging for Rural Africa using Mobile Devices

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## ABSTRACT

In this paper we present a context-aware tool designed for mapping and tagging objects and places of importance to rural communities using sensor-enabled mobile devices. These data sets comprise comprehensive models of specific environments which we use for creating interactive visualized knowledge sharing platforms for indigenous knowledge in Southern Africa. The tool was originally created for researchers to efficiently capture large amounts of data in the field, but we realized that true scalability of the approach would only be attained when including local users. The tool has been through multiple design iterations and in-situ evaluations across several locations in Namibia, and this paper presents findings from our research into the feasibility and effectiveness of the tool to capture meaningful localized data in an efficient and scalable way. From this we conclude that it is very promising when used by trained researchers, but that the interface will need to be significantly redesigned and appropriated for local community members.

## Author Keywords

Indigenous knowledge, mobile, context-aware, pervasive, sensor-based, data capture, mapping, 3D visualization, ICT4D, HCI4D.

## ACM Classification Keywords

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

## General Terms

Measurement, Design, Experimentation, Human Factors.

## INTRODUCTION

The design process and user studies presented in this paper are part of a long term research project to share indigenous knowledge (IK) in Southern Africa and bridge the

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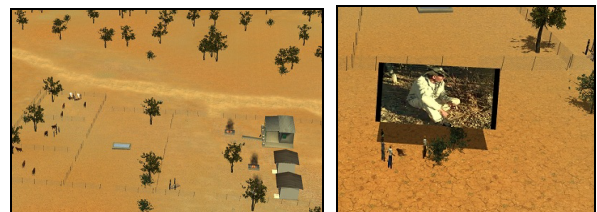
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knowledge gap between rural dwelling elders and urban youth migrants to mitigate the loss of IK [1]. Specifically, we are working with IK in the form of stories and performances captured in a growing set of audiovisual recordings from rural areas. Early project attempts to appropriate classic text based interfaces for managing and browsing this data set have failed [6]; not least due to semi-literacy, language barriers, lacking prior exposure to Western form-filling metaphors and keyboard/mouse interaction, and other reasons now commonly reported in the HCI4D literature [4]. It was evident that other solutions needed to be explored, and one of the promising directions has been to use 3D visualization[6].

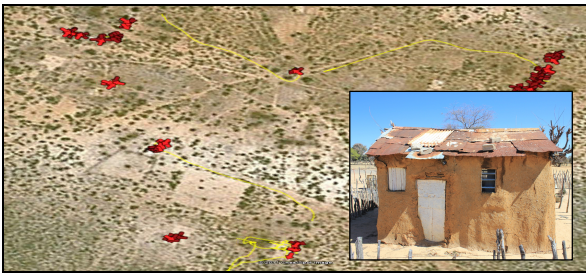
## A Visualization Approach to Contextualize Audiovisual Representations of Indigenous Knowledge

Detailing the whole premise for the research project and the 3D visualization approach is beyond the scope of this paper, and we refer to [1, 6] for further details. In short, we are embedding the audiovisual recordings of IK into a spatial representation of the local environment. At specific locations we provide further context through meaningful social activities represented as animated scenarios such as the "healing of cows" shown in figure 1.

The current 3D visualization prototype is a pilot system based on a specific village and its community but ideally each village needs its own environment modeled, including objects, scenarios and the placement of videos as illustrated in figure 1. Such customization creates dependencies on external designers to develop and maintain the knowledge sharing platforms and requires extensive field data.



**Figure 1: Screenshots from the 3D visualization system showing overview of a homestead (left) and a traditional "cow healing" scenario in with embedded video (right).**



**Figure 2: Dataset from Herero village by a team researcher visualized in Google Earth™. Each red arrow presents a data point with location and direction (insert depicts typical house).**

### Toward Scalability and Meaningful Representations

To achieve scalability in this approach we need tools for capturing information about the individual rural villages in an effective and efficient manner. We therefore explored sensor-enabled mobile devices to capture relevant information about the rural environment, such as objects and places of importance to the local communities and map these to a 3D visualization model. Besides having proximity and relative placement of objects in the environment, the uniqueness and recognition of each village is sought through using textures based on on-site photos of e.g. house facades. The designer could have a toolbox of prototype 3D objects and customize these to each village where the system will be deployed. This customization will be based on a GPS mapping (as exact as possible) of the real village, relating it to available satellite and aerial photos, and using photos and videos taken from various places in the environment to recreate a recognizable village setting. Additionally, sound clips recorded in-situ can be imbedded to recreate a soundscape from the village.

### Importance and Meaning through the Local Perspective

We have found that local rural dwellers have an astute sense of detail when it comes to fauna and flora, e.g., when the ears or tail of the modeled cows "look wrong" or the trees are "not from here". Inevitably there will be a trade-off between perceived realism and cost of modeling and running the simulation, so from a scalability point of view we must identify what matters most from a local perspective. Essential questions for each individual community are: what are the objects and places of importance, what are considered to be "landmarks" for navigation, and how can we represent these in a 3D visualization so that the local community members will easily recognize them. As external designers and researchers we are interpreting their environment through our own lenses and mental mappings, thus it is important that we develop methods and tools for local rural dwellers to map out their own environment.

### Need for Tools

The need for the tool was identified during a research trip to the village. We realized the magnitude of the data capture

and processing task involved in creating a viable model of even a relatively small area (2x2 km). Much time is consumed in walking great distances between houses, kraals (fenced areas) and other landmarks to be recorded (as shown in figure 2). Furthermore processing distinct data sets of photos, time stamped GPS data, and field notes showed to be tedious and even more time consuming. Having an Android smartphone and laptop computer at hand, an application was developed on site to unify the capturing tasks so that user input is automatically augmented with contextual information.

Initially the focus was on developing a solution for researchers in the field, but we realized that to achieve true scalability we also need to design a tool that can be used by the local communities themselves. This paper reports on our steps toward this and builds on the body of work on the usage and challenge of mobile systems for field capture [5]; specifically mobile and GPS-based systems for indigenous groups ranging from early work on animal tracking with Bushmen in Southern Africa [2] to mapping initiatives in First Nation communities in Canada [3].

### THE CARACAL SYSTEM

Here we present a tool for capturing and mapping information from rural areas to contextualize indigenous knowledge, but the scope of the CARACAL (Context-Aware Recording with Automated Capture and Logging) platform goes beyond that. The underlying context-capture engine is designed to be generic, so that only the presentation layer and user interaction needs to be tailored to capture any field data with automated annotation of contextual information. CARACAL runs on Android devices from version 2.1 and up, making it available on a large number of devices. Figure 3 illustrates the user interface and concept.



**Figure 3: Illustration of interface and interaction from a prototype: taking picture and tagging it.**

### The Captured Data

To model the village we need geospatial data and user generated meta-data on important objects and places in the local environment. The tool is designed to capture rich data in a structured way that enables reconstruction of the

dataset in various forms, e.g. KML. The geospatial data is saved as three types: Points, representing single point locations; Paths, representing a trace of points signifying e.g. walking routes of importance; and Areas, representing locations of importance enclosed by a number of points creating a polygon. A range of data types can be added to all these including pictures, video and audio clips as well as text input in free text or using a dynamic list of tags.

Currently we are utilizing the GPS, electronic compass, tilt-sensor, camera and microphone. This allows for a fairly accurate determination of where the user is, which way he/she is facing and the angle of the mobile device during capture, which is important for 3D reconstruction based on the pictures. The combination of annotated and tagged pictures, videos and audio clips gives the 3D designer an overview of the surroundings and the specific objects of importance, and the pictures are essential for the modeling as they are used for textures (e.g. for house facades).

## METHODOLOGY

In this long term community collaboration project we are applying community-based participatory design, "quasi-ethnographic" methods and action research to inform our design. Through multiple prolonged stays in the village we have been seamlessly switching between passive observation, active engagement, and co-design activities to determine further steps. The tool design and development has been intertwined in this process.

### From Designing for Researchers...

The first user study was conducted by one of the researchers (not the developer) during the aforementioned field trip in parallel with other project activities. With minimal emphasis on aesthetics and usability the first prototype was fully functional and captured the core contextual data with emphasis on locations and tagging of meta-data. An improved version was developed and tested based on the data recorded, log files, and usability issues arising from a debriefing interview with the researcher. Focus was then shifted toward whether the tool would be usable by community members and how to redesign it.

### ...Toward Designing for Local Users

The second set of user studies was conducted with local community members (5) during a field trip. This was conducted as an exploratory think-aloud field evaluation with a moderator and one video operator. The aim was to identify usability issues during a series of tagging tasks in the village. In parallel to this an unsupervised field study was conducted in a village in Northern Namibia. The unsupervised data collection was done by a native IT Masters student over a period of three days. Prior to his trip, he received 40 minutes introduction to the tool including instructions on what type and purpose of data to capture, and after his trip a debriefing interview was conducted.

## FINDINGS

### Project Researchers

The first study outlined the extent of the tagging task, and the tediousness of text input with the soft keyboard. Another key finding was the rapid battery discharge due to continuous sensing and keeping the screen alive. Considering the limited power sources in the village, being a diesel driven generator at a central water pump the need to optimize battery consumption became a priority. We found that the tool's efficiency can be further improved through extending the context-awareness to also use it to enhance user interaction during input. For instance if a picture is taken at a certain location with the camera facing a certain direction, it would be helpful to suggest a list of objects already tagged in that area (based on lens width and a threshold distance).

### Unsupervised Field Study

The data set captured by the student proved very interesting as it covers an area unknown to the external design team and the village structure and homesteads differ substantially from the Herero villages. While aiming to evaluate the usefulness of the tool to inform 3D design from afar, the focus of this study was also on the usability. The student used the tool to track paths while walking with a village elder, adding photos of landmarks and comments along the way, as shown in figure 4. While the participant did not report any serious problems or usability issues during the debriefing session, the incompleteness of the captured data set revealed that he often did not tag objects in their places but solely annotated pictures, presenting us with a challenge to reconstruct the scenes. This informed the need for built-in guidance ensuring that users capture complete datasets.

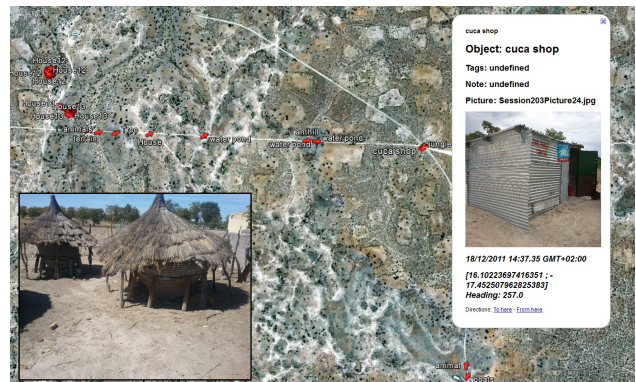


Figure 4: Shows data captured by the student while walking with an elder in his village to identify landmarks and objects of importance visualized in Google Earth™ (Insert shows typical Ovambo buildings).

### Local Community Members

Before formally redesigning the tool we decided to conduct an exploratory study to investigate which aspects from the "researcher version" could be reused in new appropriated interfaces for the local community members. Figure 5 shows situations from the user trials.



**Figure 5: Three usage situations from the third user study: an elder taking a photo (left), a youth perform a slide gesture to reach off screen tags in a list while shielding the sun with his hand(middle) and kids cooperating to map their home (right).**

Generally, the tagging tasks proved to be rather difficult and not intuitive for local participants; especially for the elders who had no prior exposure to smartphones. Two kids were the best performers and quickly picked up most of the functionality. As expected, we found a range of usability issues and errors in line with other work in HCI4D [4]. The key findings were however, that the conceptual idea of "points" and underlying purpose of "tagging" was not well understood by the participants. This resulted in participants forgetting to add important details when tagging objects as well as not distinguishing between taking a picture of a landmark from a distance and tagging the very same from close proximity. This exposed how we as external designers are using and imposing preconceived concepts through the design without realizing it, and underlines the importance of dialogue and co-design to ensure common understanding.

#### DISCUSSION

While other tools exist for geo-tagging and context capture in general, this is to our knowledge the first tool to combine user generated meta-data about habitat with rich media automatically augmented with contextual information. It is also unique in the application area of identifying and tagging meaningful places in rural indigenous cultures.

We believe such tools can play important roles in the sharing and conservation of IK and other ICT4D projects, especially if they can be appropriated to local communities. Obviously there are many ethical issues to consider, not least privacy and social/cultural implications of introducing technology into indigenous communities. We are also concerned with accessibility and affordability of the technology, but with trends pointing toward new and cheaper low-end smart phones with the necessary sensors built in, as well as growing commitment to mobile connectivity in rural areas, we believe the solution will be technically feasible and deployable in many areas. The key obstacle to overcome will be the HCI issues in making it clear and usable by local experts to map and tag their own world from their own perspective.

#### Future work

While we will continue to refine the tool for researchers, the emphasis in the next phase of the project will be put on redesigning the interface for the local community members

- especially the elders who hold the IK. In view of scalability, we intend to eventually deploy the tool to a number of other communities who have not been part of the project through longitudinal field studies, and thus we need to ensure that the interface is intuitive and no further training is needed. We plan to use multimodal techniques and principles from dialogue systems to help focus on specific activities in contrast to the generic input interface created for researchers. This will help to provide more guidance for the users and ensure that they capture more complete datasets. The plan is also to release CARACAL as an open platform which could then be used directly or indirectly by other researchers and NGOs.

#### CONCLUSION

The tool has shown great potential in its ability to capture relevant data through contextually augmented user input and proven efficient to use for trained researchers. This is critical in our endeavor to streamline the capturing of meaningful location data to map it into 3D visualizations for contextualizing IK. However, we found a range of HCI issues and lack of understanding for the local participants and thus to achieve the desired scalability of the approach, we will need to design new interfaces to ensure usability for rural community members.

#### ACKNOWLEDGMENTS

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