Anthropological conversations

Augmented reality enhanced artifacts to foster education in cultural anthropology.

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Abstract—This paper presents a prototype for an application based on a CMS (Content Management System) connected to an augmented-reality engine that allows final users to publish, read and experience multimedia content tied to specific components of physical artifacts. When the physical artifacts are placed under a webcam, a pre-trained 3D feature recognition system scans the entire figure trying to identify some specific components. If any of these elements are recognized, the system retrieves and shows educational content from selected sources (texts, videos, pictures). We created a first instance of this framework and applied it to the *Minkisi*, artifacts from Congo that are claimed to possess spiritual qualities. Studies on Minkisi play a crucial role in the history of cultural anthropology and in the current ethnographic agenda. The aim of this research project is then to create a learning tool that empowers anthropological scholars and students allowing them to publish their own content on the Minkisi and to access some of the stories that make these ethnographic artifacts alive and powerful.

Keywords-component: augmented reality; enhanced learning; constructionism; mathetics

I. INTRODUCTION

In our experience teaching cultural anthropology poses at least two specific challenges: the exposure to radically different cultural worlds, habits, ideas that often question our own mindsets and a strong operational component. Anthropology lives by research and observation techniques that are followed with particular effectiveness if flanked by experience in the field.

Within this context, the practice of teaching cultural anthropology may benefit from the constructionism paradigm [1-3]. Constructionism is a transdisciplinary approach based on the idea that learners actively construct mental models to understand and interpret the world around them. Learners' situated experience within the world, their active engagement through processes of interpretation and social negotiation of knowledge is a key component of learning processes. Moreover, as argued by Papert and his colleagues, children and adults seem to learn quickly and deeper if they are involved in activities where they are asked to actively construct new knowledge, rather than just having chunks of information poured into their minds [4-5]. Constructionist theories are also grounded on the concept that the actual activity of building tangible artifacts can speed up learning processes.

Within this theoretical account, our research project aims at producing a constructionist learning tool based on augmented-reality (AR) technologies and subsequently at thoroughly testing it on-the-ground. This paper documents the first phase of this research project (the design activity) and outlines the research agenda for the second phase (test and analysis).

II. THEORETICAL FRAMEWORK

Our research project stems from a fertile research agenda and an abundant scientific literature on AR as a framework to enhance learning processes and practices.

As stated by Eric Klopfer [6], augmented reality applications ”can place learners in real-world contexts that promote transfer of learning from one context to another”.

Focusing on the qualities of immersive learning environments, Chris Dede and Sasha Barab argue: “The more a virtual immersive experience is based on design strategies that combine actional, symbolic, and sensory factors, the greater the participant’s suspension of disbelief that she or he is 'inside’ a digitally enhanced setting. Studies have shown that immersion in a digital environment can enhance education in at least three ways: multiple perspectives, situated learning, and transfer” [7].

Dunleavy et al. [8] studies how AR simulations can create engaging, collaborative environments based on particularly effective situated-learning techniques.

Several comparative studies have been conducted to evaluate differences between AR-enhanced learning practices and traditional processes [9-11] and some key findings show that AR can be particularly effective in fostering personal (and social) engagement in learning situations that invite learners to actively explore open-ended problems and multiple pathways (within mixed realities and real-world settings). Eric Klopfer [6] reviews the most important mobile educational games and AR-based learning immersive environments recently developed, mostly in US and European research centers.

Some other projects strictly focus on AR to superimpose additional multimedia content to paper books [13-16].

Another fertile research stream, partially connected to ours, deals with learning tools based on tangible computing. Lifelong Kindergarten group at MIT Media Lab created several projects, such as *Hook-Ups* and *Twinkle* [17]. David Merrill and Jeevan Kalanithi, from Fluid Interfaces group at MIT Media Lab, developed *Siftables,* a set of small interactive computers equipped with a display, wireless communication and motion sensing that can be used in a wide array of educational games [18].

Few of the above mentioned projects are strongly focused on augmented-reality applications based on 3D pattern recognition systems that exploit tangible objects. None of them explores ethnographic artifacts as physical components of AR constructionist processes. Our idea was then to delve into the existing literature extracting the best practices for AR situated learning and applying them to a project dealing with anthropological objects and contexts.

III. DESIGN CONSIDERATIONS

Consequently we decided to design a framework where physical components of little wooden statues from Congo (e.g. their head, belly, limbs) could be read through a sensor (e.g. a webcam), processed and recognized through 3D pattern recognition systems, thus acting as triggers to retrieve and show educational content (e.g. on the screen of the computer).

We chose to focus on these wooden statues (called *nkisi*, plural *minkisi*) mostly because they are an important element in the history of cultural anthropology and especially in post-colonial studies. In traditional Congo society the nkisi is used by religious and medical experts, called *banganga*, to perform a variety of rituals of protection and healing. Minkisi are considered power figures capable of inheriting the qualities of dead people through a ritual sometimes performed at their grave. The nkisi becomes the recipient of the deceased's soul (*mooyo*) and in particular of his/her personal qualities, based on the reputation he/she had while still alive (e.g. physical strength, hunting prowess, or sexual attractiveness). The minkisi embody the deceased's personal characteristics and the banganga then pass them onto their clients who need them [19].

Minkisi played a crucial role in the histories of Congo: as perspective constructs, they collected radically different narratives, memories, beliefs, and emotions, all woven into a reactive, complex, animated artifact. The minkisi act as the material embodiment of invisible, strong powers: imagined worlds or multiple worlds constituted by the historically situated imaginations of people or by phenomena pertaining to different levels of reality [20].

IV. THE FIRST PROTOTYPE OF THE LEARNING TOOL

In December 2010 we built the first prototype of the application. When a photo of an nkisi is taken with the camera of a PC, a pre-trained 3D feature recognition system scans the shape, trying to identify specific components. When these elements are eventually recognized, the system will retrieve and show content from selected anthropological sources. Additional content is collected through a CMS (Content Management System) that can be freely used to load content and to attach this content to specific areas of the nkisi.

The pilot system is composed of an end-to-end hardware and software system, an ecology of algorithms allowing the system to recognize classes of 3D patterns on the artifacts and a CMS to allow people to select 3D patterns from the identified ones and to associate personalized digital content to each of them. The contents accessible from the nkisi can take many forms including texts, videos and pictures, but also spatialized soundscapes from sacred rituals, interviews, and visual

tracings of the ritual gestures performed by the banganga on the artifacts, thus describing a digital aura representing and making accessible the mystical, religious, philosophical domains that create the artifact's cultural and spiritual value.

The CMS is probably one of the core elements of the system as regards its educational potential. Our idea is that students can use the CMS to publish AR information on the nkisi. CMS is initially presented to the students with a limited amount of pre-loaded information: only some physical components of the minkisi will actually be connected to digital content already loaded into the platform. There will be some physical components of the minkisi that will be connected to the CMS but not contain information (e.g. the typical hole at the center of the belly that plays a really crucial role in rituals). The students will be granted the access to the CMS to publish this additional content. In order to select appropriate content to be published over these 'empty' physical components of the minkisi, the students (together with their educators) have to investigate the history, the functions, and the role of these power figures. There are a lot of websites, books, journal articles, conference proceedings dealing with the social and cultural importance of the minkisi. The students have then to scout, browse, and select the information they want to publish, trying to evaluate the consistency and the reliability of all these sources. Through this process they not only refine their anthropological knowledge on the minkisi, but develop some important meta-skills [6] such as engaging in sustained reasoning, managing complexity, browsing information structures and evaluate information, collaborating with other students, communicating to other audiences, thinking about information technology abstractly.

Fig.1 nkisi nkondi from Congo. Screenshot from the CMS showing patterns recognition areas where users can publish content.

V. TECHNOLOGY

The technological framework of the system stems from a first exploratory project we carried out in the spring 2010 [21]. The main architectural components of the system are: the computer vision and feature recognition algorithms; the Content Management System that allows interrelating content to 3D features; the capture/display system.

The computer vision system used for the 3D feature recognition functionalities is centered on SURF (Speeded Up Robust Features) [22] technologies. SURF is a robust image detector and descriptor presented in 2006 by Herbert Bay. SURF algorithms associate images to the description of their significant visual features (borders, color change edges, spikes, curves, textures...), expressed in a symbolic form. In the system each nkisi is processed using a SURF-centered procedure: the whole figure of the artifact as well as several of its most outstanding and specifically recognizable parts are processed under controlled, optimal lighting conditions, and the resulting symbolic descriptors of the identified (and identifying) features are stored on a database. The database is designed in a way that is optimized for a parallel search on multiple descriptors.

The CMS and the presentation layer (display) are based on open source technologies (mostly WordPress) for both back-end and front-end programming environments.

VI. FUTURE WORK

The main objective of the first phase of this research project was to build a prototype of the application and this milestone has been achieved.

Our next step will be to test the system in a real education environment. We have already planned some tests with professors and students at La Sapienza University in Rome for the first months of 2011. Several instances of the prototype will be tested and users' data will be gathered mainly through interviews and participant observation and then analyzed together with the logs of the system.

We hope to collect a first important feedback in order to refine the application and to prepare it for a subsequent thorough dissemination activity.

VII. CONCLUSIONS

Our plan is to build a robust system that can be subsequently instantiated for some other learning projects based on physical objects. If released as an open platform, the system will allow a high level of personalization by educators who will be able to apply the pattern recognition system (and the CMS) to other physical objects either ethnographic artifacts or more common everyday objects. In other terms, the system will be distributed to researchers and educators on an open source basis and hopefully will be therefore thoroughly tested on several other research projects.

Although still at an early stage, this project shows promising directions to enhance current teaching practices for cultural anthropology. We are aware that AR learning-tools pose new technological, managerial and cognitive challenges to teaching and learning [8], [23], [6]. The final aim of this research project is then to explore some of these challenges giving a contribution to the current research agenda in AR.

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