REAL-TIME VIRTUAL HUMANS IN AR SITES

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ABSTRACT

In this paper we present our work on the LIFEPLUS EU IST project. LIFEPLUS proposes an innovative 3D reconstruction of ancient frescos-paintings through the real-time revival of their fauna and flora, featuring groups of virtual animated characters with artificial life dramaturgical behaviors, in an immersive AR environment. The goal of this project is to push the limits of current Augmented Reality (AR) technologies, exploring the processes of narrative design of fictional spaces where users can experience a high degree of realistic interactive immersion. Based on a captured/real-time video of a real scene, the project is oriented in enhancing these scenes by allowing the possibility to render realistic 3D simulations of virtual characters in real-time. Although initially targeted at Cultural Heritage Centers and Sites, the paradigm is by no means limited to such subjects, but encompasses all types of future Location-Based Entertainments, E-visitor Attractions, e-Worker training schemes as well as on-set visualizations for the TV/movie industry. In this paper we provide an overview of the project and the technologies being employed and finally we present early results based on the ongoing research.

KEYWORDS

AR Framework, Markerless AR Camera Tracker, Virtual Character Simulation, Python Character Scenario Scripting

INTRODUCTION

Since antiquity, images were used as records of both events-lifestyles, as well as decorations. The possibility of reviving them, adds a new dimension in understanding our past. However, the recreation of historic environments for serious study, education and entertainment is not new, Arnold (1), although the methods for achieving the objectives have evolved considerably over time. Before the days of widespread books and printing, story tellers would conjure up visions of events and places, providing their listeners with an impression of realities (often augmented realities) elsewhere in time and space. Theatre, fine art and cinema have added to the richness of the explicit visual experience available to the viewer. They have made the interpretations of history more accessible to the general public, but at the same time narrowing the individual's scope for personalized, interactive experience and visualization of the description of it. Historical frescos are a unique arrangement of "mise-en-scene" elements that enhance the user experience by creating a set of compelling narrative patterns, alas however in a static, two-dimensional way. Mixed Realities, Milgram and Kishino (2), and their concept of cyber-real space interplay invoke such interactive digital narratives that promote new patterns of understanding in various contexts. In the context of cultural heritage sites such as the ancient city of Pompeii, would like to observe and understand the behaviors and social patterns of living people from ancient Roman times, superimposed in the natural environment of the city. In industrial environments, we would like to 'employ' virtual workers for training and maintenance reasons, in order to assist real ones. Since recently, AR Systems had various difficulties to manage such simulations in a fully interactive manner, due to hardware & software complexities in AR enabling technologies, Azuma et al (3). Generally the setup of such systems was only operational in specific places (indoors-outdoors) or with specific objects which were used for training purposes rendering them not easily applicable in different sites. Furthermore, almost none of these systems feature full real-time virtual human simulation. With our approach, based on two efficient real-time camera tracking systems, we can setup AR experiences anywhere, quickly. With the interplay of a modern real-time framework for integrated interactive virtual character simulation, we illustrate how we enhance the experience with full virtual character simulations in Cultural heritage sites.

RELATED WORK

A number of projects are currently based on AR integrated platforms, exploring a variety of applications in different domains such as medical, ART (4), cultural heritage, Stricker et al (5) and Papagiannakis et al (6), training and maintenance, Schwald et al (7) and Wohlgemuth and Triebfürst (8), and games, Thomas et al (9). Special focus has recently been applied to system design and architecture in order to provide the various AR enabling technologies a framework, Gamma et al (10), for proper collaboration and interplay. Azuma, (3), describes an extensive bibliography on current state-of-the-art AR systems & frameworks. However, few of these systems take the modern approach that a realistic mixed reality application, rich in AR virtual character experiences, should be based on a complete VR Framework (featuring game-engine like components) with the addition of the "AR enabling Technologies" like a) Real-time Camera Tracking b) AR Displays and interfaces c) Registration and Calibration.

AR FRAMEWORK COMPONENTS

System Design

Our AR platform is based on the VHD++, Ponder et al (11), component-based framework engine developed by VRLAB-EPFL and MIRALab-UNIGE which allows quick prototyping of VR-AR applications featuring integrated real-time virtual character simulation technologies. The framework has borrowed extensive know-how from previous platforms such as presented by Sannier et al (12). The key innovation is focused in the area of component-based framework that allows the plug-and-play of different heterogeneous technologies such as: Real-time character rendering in AR, real-time camera tracking, facial simulation and speech, body animation with skinning, 3D sound, cloth simulation and behavioral scripting of actions. To meet the hardware requirements of this aim, a single DELL P4 M50 Mobile Workstation was used, with a Quadro 4 500 GL NVIDIA graphics card, a firewire Unibrain Camera or USB Logitech web camera for fast image acquisition in a video-see-through TekGear monoscopic HMD setup, for advanced immersive simulation. Our previous efforts were based on a client-server distributed model, based on 2 mobile workstations. To achieve the requirement of 'true mobility', a single mobile workstation is used in our current demonstrations, after improvements in the streaming image capturing and introduction of hyper-threading in the platform code.

REAL-TIME MARKERLESS CAMERA TRACKING

Introduction

Real-time markerless camera tracking presents two main problems, namely the absence of easily recognisable markers and a demand for high-speed computation. Using markerless tracking is often a necessity as applying markers within the tracking area is not suitable or possible (especially on cultural heritage sites). This then requires accurate tracking to be done with only natural features present, often with sharply varying light sources, shadows, motion blur and occlusions. Performing this tracking in real-time necessitates the use of algorithms specially adapted to fast operation, and thus disqualifies many algorithms that are perfectly suitable in offline applications.
The LIFEPLUS application utilizes the 2D3 camera tracking solution, 2d3 (13), based on the approach that the system should be able to self-initialize anywhere within the tracking environment without any intervention from the user. In effect this means that instead of calculating *relative* changes in rotation and translation, we calculate *absolute* rotation and translation for every frame. This has the advantage of avoiding the problem of drift, and also ensures instant recovery after tracking was lost due to excessive motion blur or occlusion.

EXPERIMENTS & RESULTS

Heritage AR Simulation: Pompeii and the thermopolium of Vetutius Placidus

In order to validate that our integrated AR framework for virtual character simulation operates in different environments, we have tested the system directly in the ruins of Pompeii. However, in order to further continue AR tests in our, a real 'maquette' was constructed in order to resemble the actual Pompeii site that we visited for our first on site tests. This allowed us for extra fine tuning and improvement of our simulation and framework, without having to visit numerous times the actual site. With the help of the Superintendence of Pompeii, POMPEII (14), who provided us with all necessary archaeological and historical information, we have selected the 'thermopolium' (tavern) of Vetutius Placidus and we contacted our experiments there. The results are depicted in the following figure 1.

CONCLUSIONS AND FUTURE WORK

With the current result of our AR Framework, we are able to manage augmented reality full virtual character simulations (body, face and clothes) in real-time cultural heritage environments through a markerless AR tracking system. However, there is still a lot of space for improvement. Firstly we will improve the real-time camera tracking, in order to get higher frame rates in both methods. There is also a lot of work to improve the interaction between the real object and the virtual scene, more accurate registration and automatic set-up phase of the virtual world and the occluders. Finally the 'illumination' registration between the real and the virtual scene is currently been addressed with the introduction of High Dynamic Range Image Based Lighting for virtual character simulations in AR.

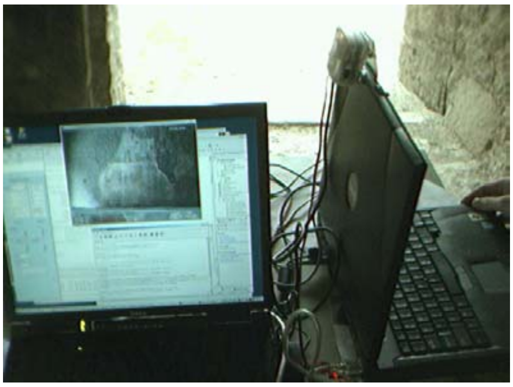	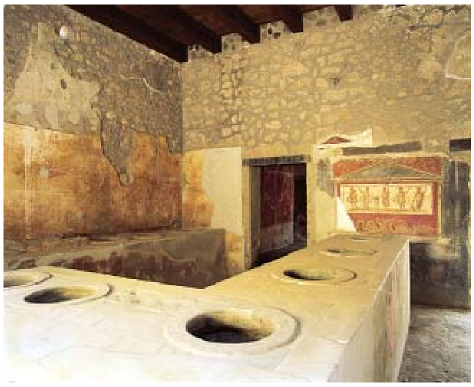
Initial Set-up of 2 mobile workstations on-site (inside the 'thermopolium')	The Pompeian 'thermopolium'
	
Real-time virtual male Pompeian characters (in the thermopolium maquette)	Real-time virtual Pompeian female characters (with scene occlusions in the thermopolium maquette)

Figure 1. AR Results

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