Immersive Paleoart: Reconstructing Dreadnoughtus schrani and Remediating the Science Documentary for Cinematic Virtual Reality

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Figure 1: A latlong composite panorama of Dreadnoughtus' skeleton walking through the desert. 2016.

Abstract

This project is a synthesis of digital paleoart reconstruction, prototype VR pipeline design, and the remediation of structural narrative principles for immersive media. We approach common issues associated with the accurate portrayal of dinosaurs in media, Cinematic Virtual Reality (CVR) production, and the direction of viewer attention in immersive digital environments. After developing and testing a stable CVR workflow, we designed and produced a piece of scientific VR Paleoart content intended for educational outreach.

Our production methods include a state-of-the-art CGI dinosaur reconstruction informed by comparative anatomy and biomechanical simulation, stereoscopic spherical rendering, and photographic CVR film production. Our approach is validated through the completion of a CVR documentary about the titanosaur *Dreadnoughtus schrani*, one of the largest dinosaurs yet discovered. This documentary, starring paleontologist Dr. Ken Lacovara, will be made publicly available for all common VR distribution platforms. Our goal is to make scientific CVR content accessible to an audience of mobile device owners, taking advantage of the VR media disruption to establish new design guidelines for educational media.

Keywords: paleoart, virtual reality, immersive media, vr, mobile vr, pipeline design, stitching, stereo panorama, remediation

Concepts: • Applied computing~Media arts; • Applied computing~Computer-managed instruction;

1 Introduction

For over 200 years, the discipline of Paleoart has relied on imagery to educate the public about ancient life on Earth [Witton, Conway]. With the growing accessibility of cinematic virtual reality (CVR), there exists an incentive for digital paleoartists to adapt to this new medium. Using only a piece of folded cardboard, two lenses, and a magnet, a modern smartphone can play immersive video content that takes place around the viewer. The sense of presence elicited by virtual reality (VR) encourages viewer engagement, facilitates an understanding of scale

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representation, and is a promising tool for educational outreach [Bennet].

At the time of this publication, VR film production is still in its infancy. Few guidelines for stereo-spherical rendering and compositing exist, and fewer professional CVR cameras are commercially available. We develop and test a prototype camera rig for asynchronous CVR film capture that uses two Blackmagic micro studio cameras to record an immersive interview. By creating a virtual copy of this camera rig and rendering CGI elements as stereoscopic cube maps, we are able to composite photorealistic dinosaur renders into panoramic, videographic background plates.

When adapting the documentary format to virtual reality, we test a set of visual design guidelines informed by a review of structural narrative principles in photography, cinema and video games [Winters]. These methods are used to direct viewer attention towards scientific visuals in a 360-degree immersive canvas. Guided by the narration of paleontologist Dr. Ken Lacovara, we follow *Dreadnoughtus'* fossils from their excavation in Patagonia, Argentina to a life reconstruction at Philadelphia's Academy of Natural Sciences. While the main action occurs in these immersive locations, motion graphic overlays are arranged in the peripheral space to supply additional information.

A scale-accurate CGI *Dreadnoughtus* stars in this VR experience, restored from original fossil data, phylogenetically similar titanosaur relatives, and the muscular morphology of extant archosaurs [Boucher, Lacovara, Meers]. Our reconstruction process uses state of the art digital art techniques including 3D laser scanning, photogrammetry, digital sculpting, physically plausible shading, and softbody muscle simulation. By combining the immersive power of virtual reality with these digital techniques, we aim to restore Dreadnoughtus to life with unprecedented degrees of accuracy [Schilling].

2 Background Information

Three areas of study inform the design of this thesis. First and foremost, we examine paleoart as a medium and explore its prolific history of educational and media outreach. We then review the adoption of digital design tools in scientifically informed dinosaur reconstructions. Finally, we introduce *Dreadnoughtus schrani*, an exceptionally complete titanosaur specimen, and summarize the research that has already taken place on the "Dread" holotype [Lacovara]. We conclude our review of paleoart with a speculative section that identifies the shortcomings of this medium [Witton, Conway].

Next, we analyze the state of the art in virtual reality, starting with an overview of the most popular VR formats available and their unique impacts on user experience [Bennet]. We summarize the effect of "presence" on viewer engagement and list important design conventions for creating comfortable VR experiences [Wesslen]. This is followed by an overview of current CVR examples, production methods, and limitations, including live action videography, synthetic image rendering, and digital compositing.

Finally, we set up the translation of paleoart content to virtual reality space by reviewing spatial design principles in visual communication. We discuss remediation via a review of visual storytelling in film and first-person video games, highlighting elements that are medium-specific and elements that could facilitate the design of a first-person immersive animation. We reference a set of structural composition guidelines that use environment and lighting design to communicate information [Winters]. This is followed by an overview of the documentary format, and finally a critical review of select CVR experiences.
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