PhD Research

Creating High Dynamic Range Spherical Panorama Images for High Fidelity 360 Degree Virtual Reality

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Master of Science in Creative Multimedia

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STATEMENT OF ORIGINALITY

I hereby certify that the work embodied in the thesis is my own work, conducted under normal supervision. The thesis contains no material which has been accepted, or is being examined, for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made. I give consent to the final version of my thesis being made available worldwide when deposited in the University's Digital Repository, subject to the provisions of the Copyright Act 1968 and any approved embargo.

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GLOSSARY

Terminology	Description
AR	Augmented Reality
EV	Exposure Value
HDR	High Dynamic Range
HMD	Head-mount-display is usually the main digital platform of providing a VR user experience
Nadir Angle	Photographic angle facing downwards
Nadir Errors	Angle facing downwards with imaging errors.
Parallax Error	An error exists in a stitched panorama image caused by two different viewpoints
Spherical panorama	Panorama image covering full 360 degrees of capture with the ratio of 2:1, it can be wrapped and be presented as VR360 via a digital platform (mobile device, computer display or HMD).
VR	Virtual Reality
VR360	Virtual Reality with 360 imagery (or video) content

PREFACE

As a researcher with significant creative interest in computational photography, I was inspired to undertake this PhD by the capacity of VR360 to bring the finest details of images to viewers. Here, I am not only inspired to provide the affordances of detailed images to professionals and scholars such as myself, but also to a wider field of viewers of all levels of expertise, including community members at large. There is a sense of joy and wonder that can be attained from engaging in computational photography, and I wanted to share this as widely as possible whilst also taking the scholarship and technical understandings to a new level. Even a few years ago, before VR360 had become ubiquitous (though still relatively expensive for the average person), the level of fidelity which VR360 now provides, was not commonly possible using standard photographic equipment, and as a result many people did not have sufficient access to the power of image control.

Now, using VR 360, everyone with access to the equipment can, at least for one moment, immerse themselves into a different virtual world. This power, and the joy and learning that it can bring, should in my view be available to all. However, a number of off-the-shelf items of equipment and common solutions do not produce and provide VR360 images that are entirely free from imaging errors. VR360 is becoming increasingly available for use in the creative industries, with experts and newcomers alike showing interest in using it for transmedia immersive storytelling. Demand is increasing from many users of many different backgrounds, with many different aims. VR360 can be used for telling community stories, for citizen journalism, for virtual tourism, and for connected health. For example, patients with limited physical mobility can now enjoy VR360 and various virtual reality experiences as a mode of ‘virtual travel’ - this brings a new level of inclusive experience in terms of presence, active engagement and immersion.

To achieve these inclusive aims, however, a greater level of detail in the preservation and presentation of the images is required in order to achieve a high enough fidelity in reproduction of VR360 for an adequate user experience. This thesis aims to fill this gap in existing knowledge and know-how, to democratize the field of VR360 and improve the quality of the experience for all.

ABSTRACT

This research explores the development of a novel method and apparatus for creating spherical panoramas enhanced with high dynamic range (HDR) for high fidelity Virtual Reality 360 degree (VR360) user experiences. The original contribution to knowledge which this study seeks to make, is a new application of human computer interaction techniques, applied in order to gauge and understand how user experience of interactive panorama images can be virtually operated with the aim of increasing fidelity, or high definition visual similarity and clarity, closest to the original scene depicted. In this context, the term 'high fidelity' refers to the aim of producing detailed and accurate HDR spherical panorama images which resemble the original scenes captured sufficiently to afford users a satisfactory and compelling VR360 user experience. A VR360 interactive panorama presentation using spherical panoramas can provide virtual interactivity and wider viewing coverage; with three degrees of freedom, users can look around in multiple directions within the VR360 experiences, gaining the sense of being in control of their own engagement. This degree of freedom is facilitated by the use of mobile displays or head-mount-devices. However, in terms of image reproduction, the exposure range can be a major difficulty in reproducing a high contrast real-world scene. Imaging variables caused by difficulties and obstacles can occur during the production process of spherical panorama facilitated with HDR. This may result in inaccurate image reproduction for location-based subjects, which will in turn result in a poor VR360 user experience. Such problems may include but are not limited to: parallax error, nadir angle difficulty, HDR ghosting effect, insufficient dynamic range and luminance preservation. In contrast, this study presents an HDR spherical panorama reproduction approach which can shorten the production process, reduce imaging variables, and keep technical issues to a minimum, leading to improved photographic image reproduction with fewer visual abnormalities for VR360 experiences. A user study has been conducted; this shows that the novel approach creates images which viewers prefer, on the whole, to those created using more complicated HDR methods, or to those created without the use of HDR at all. In an ideal situation for VR360 reproduction, the proposed solution and imaging workflow would allow multi-angle acquisition to be accomplished in less than a minute. The thesis is comprised of this critical exegesis of the use case study and practice-based research project as outline, with a creative component comprised of a unique set of VR360s presented using the proposed method and apparatus. I hope that the thesis will be of use to future scholars and practitioners, and to the general viewer as well.