A Software-Based Solution for Distributing and Displaying 3D UHD Films

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As an alternative to traditional hardware-based ultra-high definition (UHD) multimedia systems, the proposed software-based approach offers a better cost-benefit ratio and might help facilitate large-scale deployment.

Although motion pictures have existed for more than a century, digital video quality has not been able to match the quality of 35-mm films until recently. The first commercially available ultra-high definition (UHD) cameras, with resolution around 4,096 × 2,160 pixels (4K), started to appear on the market in 2006. In 2010, *The Social Network* was the first feature film shot and projected in 4K resolution, followed in the same year by *Toy Story 3*, the first 4K-3D feature film.

Today, it is possible to capture, edit, and exhibit digital videos at ultra-high resolutions, profiting from the inherent advantages of digital-over-analog media without losing image quality. With the advent of high-resolution cameras, digital projectors, modern digital-image-compression standards, high-speed networks, and faster and larger storage devices, it became possible to build systems that allow for the packaging, distribution, and playback of UHD content, thus enabling the development of the digital cinema era.[1] Nevertheless, few movies are distributed or even displayed in 4K resolution, even though 4K projectors are available in many movie theaters. For the vast majority of moviegoers, 4K and 4K-3D movie screenings are still relatively rare.

Most current solutions for handling UHD multimedia content rely on dedicated single-purpose hardware. These hardware-based approaches are hard to deploy, maintain, and update, which might have contributed to the slow adoption of this technology. This article proposes a software-based solution to handle UHD multimedia content using commercially available off-the-shelf (COTS) hardware. We have developed a system that can transmit and display 4K multimedia content (with or without stereoscopy) that is scalable to higher resolutions, presents a low cost of deployment, and is highly flexible and customizable. Our software-based system offers a better cost-benefit ratio and might help facilitate the large-scale deployment of such systems.

System Description

All earlier works in UHD video exhibition share several characteristics: they require dedicated and expensive hardware; are hard to deploy, maintain, and update; and provide low flexibility and poor customization. Such solutions rely on the use of dedicated single-purpose hardware to deal with 4K videos. This approach presents several limitations, including higher production and deployment costs, which makes its adoption more difficult. (See the ''Related Work in UHD Transmission'' sidebar for more specific details.) Our solution requires COTS hardware only and relies on specialized software components for encoding, transmission, decoding, and playback.

Our solution is flexible in terms of screen resolution and codec choice and thus is able to deal with various encoding and decoding schemes. For example, we could easily integrate novel encoding standards, such as the High Efficiency Video Coding (HEVC),[2] which aims to provide a 50 percent increase in compression efficiency over the H.264/AVC standard. To avoid increasing costs, we choose to use cheaper graphic cards, with output interfaces able to deal with resolutions lower than or equal to 2K. Therefore, we must coordinate the operation of the software components controlling the different graphic cards in order to exhibit 4K, 2K-3D, and 4K-3D content.

Some graphic cards, such as Nvidia's Quadro Plex 7000 (www.nvidia.com/object/product-quadroplex-7000-us.html), are capable of

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A Software-based Solution for Distributed Playing of 3D UHD Films

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Abstract—By 2006 the first commercially available Ultra-High Definition (UHD) cameras started to appear in the market. Despite the fact that UHD projectors have been present in movie theaters for a while now, most movies are not displayed at that resolution. The first occurrences were in 2010, but UHD movie screenings are still very rare and distant from the vast majority of the moviegoers. Current solutions that handle UHD multimedia content rely on dedicated hardware, which is hard to deploy, maintain and update, what may have contributed to the slow adoption of this technology. We propose a software-based approach to handle UHD multimedia content. Our approach relies on an architecture of distributed and parallelized software components that enables the building of functional and cost-effective UHD systems using commodity hardware. This represents an alternative to traditional UHD systems, presenting a better cost/benefit ratio and may be useful to facilitate the large-scale deployment of such systems, especially in contexts where the access to technological innovation is limited. This is the case, for instance, of large and developing countries like Brazil, where there are about 4.800 cities without a single movie theater.

Index Terms—Ultra-High definition video, Digital Cinema, 4K, stereoscopy

Content before edit

1 Introduction

Theatrical motion pictures have existed for a long time, but digital video quality did not reach a level of comparability to the quality of 35mm films until recently.

By 2006 the first commercially available Ultra-High Definition (UHD) cameras, with resolution around 4096 x 2160 pixels (4K), started to appear in the market. 2010's "The Social Network" was the first feature film shot and projected in 4K resolution, followed in the same year by "Toy Story 3", the first 4K-3D feature film.

Therefore, it is now possible to capture, edit and exhibit digital videos at Ultra-High resolutions, profiting from the inherent advantages of digital over analog media without losing image quality.

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Unfortunately, despite the fact that 4K projectors have been available in movie theaters for a while now, most movies are not distributed or even displayed in that resolution. 4K and 4K-3D movie screenings are still relatively rare and distant from the vast majority of moviegoers.

With the advent of high resolution cameras, digital projectors, modern digital image compression standards, high speed networks, faster and bigger storage devices, it became possible to build systems that allow for the packaging, distribution and playback of ultra high definition content, thus enabling the development of the Digital Cinema era [1].

Most current solutions for handling Ultra-High Definition multimedia content rely on dedicated single-purpose hardware. These hardware-based approaches have several drawbacks, among them the difficulty to deploy, maintain and update the system, which probably contributed to the slow adoption, and uptake of this technology.

In this paper we propose a software-based solution to handle Ultra-High Definition multimedia content using commercially available