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Analysis On Remote Media Immersion

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Abstract

The Remote Media Immersion (RMI) system is the result of a one-of-a-kind combination of multiple cutting-edge media technologies designed to create the ultimate digital entertainment delivery system. The primary goal is to provide a high-quality interactive user experience. RMI encompasses all aspects of media acquisition, storage, transmitting, and final rendering. We present the architecture, technology, and exploratory implementations of Distributed Immersive Achievement, a real-time, multi-site, interactive, and cooperative environment (DIP). The objective of this endeavor is to create and develop immersive technology: a fully immersive aural and visual environment that immerses a participant or group of participants in a virtual space where they can communicate naturally despite being in different physical locations. RMI technology can effectively overcome time and space barriers, allowing for realistic interaction and collaboration among people in widely separated locations.

Keywords:

Remote Media Immersion, Remote collaboration, Distributed Immersive Performance, real-time interaction.

Introduction:

We pursue research, technology, training, and manufacturing collaborative partnerships at the USC Integrated Media Systems Center (IMSC) to develop technologies for immersive and other integrated media systems (IMS). The creation of a comprehensive audio and visual surroundings that places people in a virtual space where they can interact naturally even though they are in various physical places is our vision of immersive technology. This paper describes Distributed Immersive Effectiveness, a real-time and multi-site distributed collaborative and participatory environment (DIP). One of IMSC's primary initiatives, the DIP environment, serves as an ideal testing ground for multimedia formation, cataloguing, representation, and transmission of electronic perceptions. It facilitates new forms of creativity as a system by enabling remote musical collaborative projects. Musical collaboration necessitates a level of fidelity and directness of response, making it an ideal testbed for pushing the boundaries of both human perception and current technology. The capture, replay, and analysis of digital music signals can be used to measure and quantify the effectiveness of such an experiential system. [1]

We discuss several recent interactive experiments conducted with the system, as well as numerous technological difficulties common to the DIP scenario and a broader variety of other uses. These challenges include: (1) low latency continuous media (CM) stream transmission, synchronisation, and data loss management; (2) real-time video as well as multichannel immersive audio acquisition or rendering; (3) realtime extensive media stream recording, collection, and playback; (4) human factors studies: psychophysical, perceptual, artistic, and performance evaluation; and (5) robust interconnection of all these technical fields into a seamless presentation to the participants. [2]

We begin by describing an early implementation of immersive technology created at IMSC, an on-demand Internet application known as Remote Media Immersion (RMI). The rest of the paper delves into the concepts and technical challenges of developing a Distributed Immersive Performance Environment. We describe the DIP experiments carried out in the previous year, which included a cello master class (asynchronous playing) and two collaborative performance results (duets, synchronous collaboration), cataloguing the experimental setup and the musicians' experiences. [3].

Stages Of RMI

1. Acquisition of high-quality media streams

This authoring element is a critical link in the overall chain that ensures the good quality of the rendering result as observed by users later. As the expression "garbage in, garbage out" implies, no amount of quality control in later stages of the logistics chain can compensate for poor media acquisition.

2. Real-time digital storage and playback of multiple independent streams

Yima Scalable Streaming Media Architecture allows for real-time storage, retrieval, and transmission. The Yima server is built on a configurable cluster architecture. Each cluster node is a standard PC with attached storage systems and, for instance, a Fast or Gigabit Ethernet connection. Yima server software manages storage and network resources in order to provide real-time service to multiple clients who request media streams. MPEG-2 at NTSC and HDTV resolutions, multichannel audio (e.g., 10.2 channel immersive audio), and MPEG-4 are examples of media types.

3. Protocols for synchronized, efficient Realtime transmission of multiple media streams

A selective data retransmission scheme enhances playback quality while preserving real-time properties. A flow control element reduces network traffic variations and allows different types of streams to be synchronised at the rendering location. Compatibility with commercial systems is provided by industry standard network interfaces such as Real-Time Protocol (RTP) and Real-Time Streaming Protocol (RTSP).

4. Rendering of immersive audio and high-resolution video

Immersive audio is a technique developed at IMSC for correctly replicating the system requirements sensation and atmosphere at the client location with full fidelity, dynamic range, and directional cues for a group of hearers (16 channels of unencrypted linear PCM at a data rate of up to 17.6Mb/s). The RMI video is rendered in HDTV resolutions (1080i or 720p) and transferred at up to 45 Mb/s.

Aim of the Study:

The Integrated Media Systems Center envisions immersipresence as the next great digital breakthrough, pushing people from the current two-dimensional world of computers, television, and film to three-dimensional immersive environments with visual, aural, and haptic capabilities. The Remote Media Immersion (RMI) effort was one of its first manifestations. RMI incorporates many cutting-edge research findings from IMSC and elsewhere. It is a platform that facilitates the creation, utilisation, distribution, and communication skills of multimodal information. It is constructed using the high-level principles outlined in the Media Immersion Environment (MIE) framework. [4]

Review of Literature:

Several related projects are being continued to pursue by academia and their industry representatives. For example, the first live high resolution television (HDTV) newscast generated over the Internet reached television viewers in Seattle in April 2000 [5]. A team of engineers from the University of Washington collaborated on the demonstration, which was sponsored by the Research Channel, Sony Electronics' Broadcast and Professional Company, Enron Broadband Services, Juniper Networks, and Electric Lightwave Inc. Other research is being conducted at ATR in Japan, as well as at several universities in the United States and Europe.

A number of DIP-related projects are being pursued by academia and industry. In April 2000, the first live high resolution television (HDTV) newscast produced over the Internet actually achieved television viewers in Seattle in a one-way non-interactive experiment [6]. The demonstration was a collaborative effort between the University of Washington and several industrial partners. Other research is being conducted at ATR in Japan, as well as at several universities in the United States and Europe. The European Union's Information Technologies Program [7] is currently funding a multi-year project on Multisensory Expressive Gesture Applications (MEGA) [8]. The study focuses on sentimental content modelling, real-time analysis, and synthesis in live performances. While one of the proposal's stated goals is to develop performance projects that make use of networked musical communication systems, the event descriptions currently lack evidence of networked media.

Objectives:

The goal of DIP is to invest in technology for live, immersive musical performances in which the participants - subsets of musicians, the conductor, and the audience - are in various physical places and are interrelated by very high fidelity multichannel audio and video links.

Research Methodology:

The Remote Media Immersion (RMI) project is a testbed that incorporates many of the technologies developed at IMSC and elsewhere. The following components comprise the current operational version in the USC laboratories. (IMSC technologies are detailed in other reports in this volume; we present a summary here.)

Result and Discussion:

Rendering:

The rendering side of the RMI system is made up of several components. The video and audio streams are received on a personal computer running two instances of the Yima playback software over a sufficiently fast IP network connection. This media player is divided into several components, only one of which communicates with the actual media decoder. This enables us to plug in multiple software and hardware decoders and thus support a wide range of media types. One of the players interacts with a Cine Cast for RMI. [9]

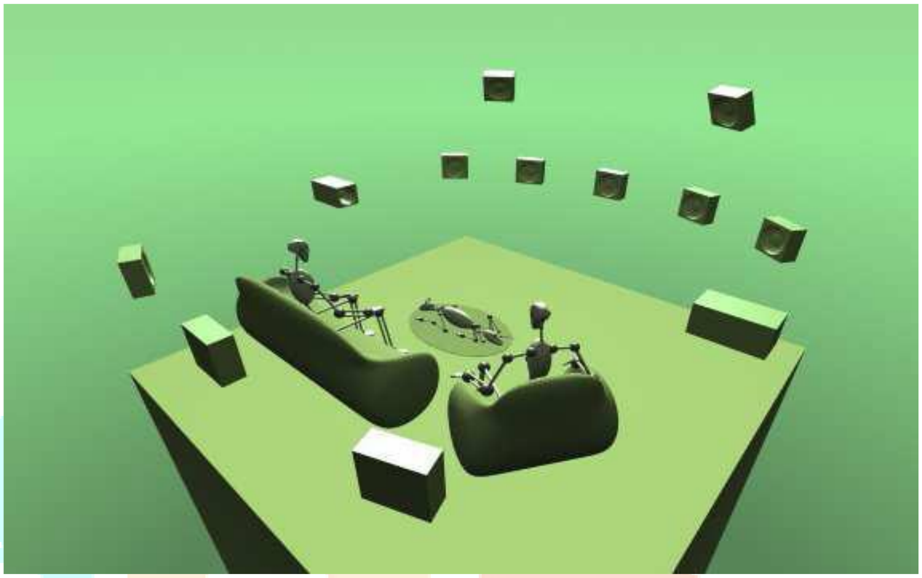

Figure 1: Immersive environment

Immersive Audio

The use of audio can help to create a fully immersive experience for a group of participants. To accomplish this, the spatial limitations of traditional two channel stereo must be overcome. Several rendering methods that use digital filters to represent the spectral characteristics of sound sources coming from different directions in 3-D space have been proposed. These methods rely on the accurate representation of Head-Related Transfer Functions (HRTFs), which represent the modifications to sound imparted by the head and pinnae. In order to deliver the desired sound to each ear, these methods also require precise cancellation of the crosstalk signals generated by the opposite side loudspeaker. As a result, they are only effective for a single listener in a specific position. Multichannel surround sound systems, which use three front channels and two surround channels to provide a sense of envelopment for multiple listeners, have also been developed. Although these systems may work well in conjunction with movies, they are not appropriate for immersive systems. The main reason for this is that they leave significant spatial gaps in the azimuth plane (for example, at 90 degrees to the side of the listeners) and no coverage in the median plane (no elevation cues). To minimise localization errors, the number of loudspeakers must increase linearly with the listening area width. A listener who moves just a few centimetres away from the designated listening spot suffers from high imaging distortion and no longer receives the correct localization cues. Increase the number of loudspeakers to address this issue. The psychoacoustics literature indicates that human listeners can localise sounds very precisely in the front hemisphere and less precisely to the sides and back hemisphere. [10]

Distributed Immersive Performance (Dip): The Vision And Three Experiments

Our current project, Distributed Immersive Performance, is a real-time, multi-site, interactive specific realisation of the immersive environment (DIP). Remote Media Immersion experiments and demonstrations relied heavily on unidirectional transmissions and off-line audio and video processing. The DIP project extends the capabilities of RMI technology to multi-directional, multi-participant, and real-time interaction in synchronous and collaborative music performance. The DIP project's goal is to create technology for performances in which the participants - subsets of musicians, the conductor, and the audience - are in different physical locations but are linked by high fidelity multichannel audio and video links, as shown in Figure 2.

There are generally two types of participants, each with their own set of objectives and requirements. We categorise the participants as active or passive based on their level of interaction and the amount of latency they can tolerate. In a teleconference application, for example, all participants are generally active. Active participants (musicians in a concert, athletes in a sporting event, panellists at a meeting whose primary actions are those of doing, of physically engaging in the activity) and passive participants are present at a performance event (the audience, whose primary actions are seeing and listening). Figure 2 depicts one example of a distributed immersive performance involving five different sites: three player sites (each with one or more musicians), a conductor site, and an audience site.

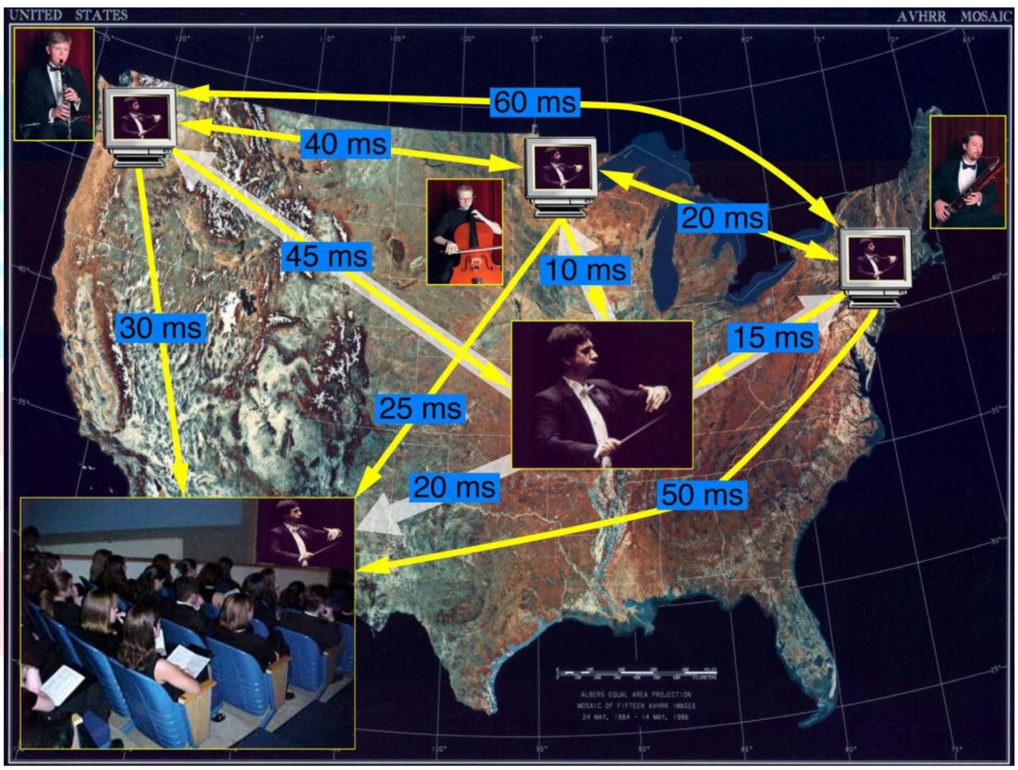

Figure 2: The concept of Distributed Immersive Performance (DIP) and typical transmission latencies.

It is worth noting that musicians can overcome inherent audio transmission latencies among themselves during live performances, at least for distances within a concert hall. [11-12]

Conclusion:

To achieve our goal, we had to overcome a number of unique challenges and devise novel techniques to make RMI a reality. We presented the error and flow control algorithms, as well as the immersive audio aspects of RMI, in this report. Most home users cannot afford the current RMI setup. A number of technological advances will be required for widespread adoption, which will lead to lower prices and make the RMI system suitable for high-end home use. For example, to achieve our desired visual quality, we are currently employing the MPEG-2 algorithm at a low compression ratio. In the future, improved compression algorithms and more affordable hardware will almost certainly make the same quality available at lower bit rates (MPEG-4 is a candidate here). As a result, we anticipate a tipping point in the coming years when the bandwidth required for RMI falls below the bit rates that new high-speed residential broadband technologies can provide (for example very high-speed DSL, or VDSL). Furthermore, we are working to simplify and automate the setup and calibration procedures that are currently required. As a result, these signal processing algorithms can be easily integrated into multichannel home receivers at a low cost.

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