Panel I

Computer-Generated Music and Multimedia Computing

***Moderators*:**

Antonio Camurri, DIST — University of Genoa
Roger Dannenberg, Carnegie Mellon University

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Moderators: *Roger B. Dannenberg and Antonio Camurri*

We will address the roles of computer music research in multimedia and vice-versa in a set of short presentations followed by a panel discussion. At least some of these roles are summarized here, and we intend to explore these topics further with the panel. In addition, we will have brief introductory statements from the panel illustrating current directions in computer music. This description is based in part on input from the panel members: Henkjan Honing, University of Amsterdam; Bruce Pennycook, Dale Stammen, and Jason Vantomme, McGill University; Robert Rowe, New York University; Tamas Ungvary, Royal Institute of Technology, Sweden; and Noel Zahler, Connecticut College. Any errors or omissions are the fault of the first author.

There is already an interesting overlap and exchange between the fields of multimedia and computer generated music, and in fact the definitions of these fields are constantly changing. Nevertheless, we will assume a gap between these fields and describe some of the flow from one to the other.

Contributions of Computer Generated Music

Starting with computer generated music (or simply "computer music"), what ideas and technologies might be of interest to the multimedia researcher? To answer this question, it is helpful to examine some of the properties of music. Music is structurally rich. Traditional music was once considered to be a branch of mathematics, and formalisms abound. Music can be organized into rhythmic (temporal) structures consisting of beats, measures, sections, and movements. Music pitch structure results in keys, scales, chords, and chord progressions. At these high levels of representation, music can be analyzed, processed, notated, and generated with a wide variety of techniques. A study of these techniques and current practice in computer music might help researchers to envision future directions for other media. For example, music notation and representations can be applied to human motion description.

One of the reasons music processing has advanced quickly is that music processing is computationally tractable. High-quality stereo audio without compression requires no more bandwidth than medium quality compressed video. Audio can be processed in real-time or near real-time using relatively simple software and hardware. One might consider the state of music processing today to picture what multimedia systems will be like in the future. In particular, video is often seen as data that can be recorded and played, but not manipulated. In contrast, analysis, manipulation and synthesis are primary concerns of computer music research.

One could make similar arguments that text is a rich medium amenable to computer-based analysis, manipulation, and synthesis (or publishing). However, music is a time-based medium as are video and animation, and this temporal element seems to be an important feature of today's multimedia systems. Computer music systems, representations, languages, and formalisms all have time as an important ingredient, and there are decades of experience represented in the computer music literature. A classic example is an article by Mathews and Moore, "A Program to Compose, Store, and Edit Functions of Time," CACM 13:12 (Dec. 1970), pp. 715-721. This system, constructed in the 60's, could record, process, and play back gestural information from multiple sensors, including a 3-D position sensor.

Some of the lessons learned from work with computer music include an understanding of what the technology is good for. First, computer-based music offers a level of interaction that cannot be achieved otherwise. By placing some intelligence into computer music systems, we can create artificial orchestras, performers, and composers that respond in real-time to input from humans. By keeping humans in the loop, we can achieve synergy between humans and machines. A second benefit of computers is the precision offered by digital processing. Musical sounds and compositions can be precisely specified and controlled by computer, and this gives composers and researchers a powerful new tool for their work.

Contributions of Multimedia

Multimedia can offer much to the computer music community. One of the exciting possibilities of multimedia is the integration of systems and media, which creates new opportunities and new applications for computer music. For example, there is increasing interest in the area of games and interactive fiction. Could computer generated music enhance the emotional impact of an interactive drama? Will there be composers who create interactive virtual opera? Many composers are already experimenting with synchronized animation, choreography, and video.

Another potential contribution from the multimedia community is systems support. All time-based interactive media need real-time systems, and future applications will rely increasingly on real-time networks. Although the basic techniques are now understood, these technologies have not made their way into common practice. In fact, most computer music systems run on simple personal computers. Real-time processing is handled at the interrupt level for lack of real-time process support, and a simple serial interface (MIDI) is used for communication. Systems standards are another area where the multimedia community can make great contributions to computer music. The problem is really a diversity of competing standards for audio and other media, which makes systems less compatible.

Education is one application area for multimedia, and music education based on multimedia systems is an exciting possibility. Music education products are now being introduced to the marketplace at a very high rate, and future products are sure to incorporate video, voice, and other media. Interactive music education systems can provide an interesting model and testbed for new education techniques. Dannenberg and Zahler have each worked on interactive music systems for piano instruction.

Finally, multimedia can offer new perspectives to computer music. For the most part, the computer music community has been relatively isolated from "mainstream" computer science and centered at music departments where composition of contemporary and experimental works is the primary focus. The multimedia community seems to be more focused on practical matters and mass-market applications such as broadband networks and video-on-demand. The computer music community has tended to overlook opportunities in popular music, film scores, and games, and perhaps new problems raised by multimedia will attract computer music researchers.

Emerging areas tied closely to multimedia and computer music are virtual reality and sonification. Virtual reality systems use music and sound to enhance the experience of the participant. Sound can be used to create a more realistic virtual world through sound effects, aural location, and navigation cues. Alternatively, sound and music can become "objects" to explore in a virtual space. Sound might also provide more abstract feedback, such as substituting for facial expression. Sonification is concerned with direct communication of data via sound to a human listener. Sonification can make use of knowledge from composition, music cognition, music perception, and computer music to develop better representations for data.

In summary, we see a number of ways that research in computer music and multimedia are related. We see a rich experience with time-based media in the world of computer music, and tremendous new opportunities for integration and applications in the world of multimedia. We hope this panel will foster an interesting exchange of ideas, and perhaps uncover new commonalities.