SIGGRAPH 1994

21st International Conference
On Computer Graphics and
Interactive Techniques

Orange County Convention Center
Orlando, Florida
July 24-29

Course Notes 12

SOUND SYNCHRONIZATION AND SYNTHESIS FOR COMPUTER ANIMATION AND VIRTUAL REALITY

Organizer
James K. Hahn
The George Washington University

Lecturers
Robin Bargar
University of Illinois at Urbana-Champaign

Wayne Lytle
Cornell University

Gary Rydstrom
Skywalker Sound

Tapio Takala
Helsinki University of Technology

12. Sound Synchronization and Synthesis for Computer Animation and VR

Full Day
Intermediate Level

COURSE DESCRIPTION

The course will give the participants a general understanding of the problems involved in synchronizing sounds to motions as an integrated process. These include techniques to go from motions to sounds and sound descriptions to motions. Some of the current research topics in sound as they relate to computer animations and virtual reality will be discussed. Sound effects techniques that are being used in animations as well as motion pictures will be presented along with case studies ("Luxo Jr.", "Tin Toy", "Jurassic Park," "Terminator 2," "More Bells and Whistles," "Sound Rendering," "The Listner," etc.). The participant will gain an understanding of the fundamental problems as well as techniques that they can use to make their next animations.

COURSE PREREQUESITE

Basic knowledge of computer graphics and computer animations is assumed.

INTENDED AUDIENCE

Scientists, animators, and anyone interested generating a more effective soundtrack for their next animations.

COURSE CONTENT

A. Introduction — James Hahn

- a. The sound synchronization and synthesis problem
- b. Sound in computer animation
- c. Sound in Virtual Reality (VR)

B. Sound Rendering (Generating sound from motion parameters)

- a. Sound generation — Tapio Takala
  - Basic sound theory
  - Synthesis techniques
  - Composition of sounds
- b. Mapping motion control parameters to sound parameters — James Hahn
- c. Rendering sounds — Tapio Takala
  - Transformation from object space to microphone space
  - Resampling problem
  - Sound propagation
  - Environmental effects

C. Music Animation (Generating motion from sound parameters) — Wayne Lytle

- a. Background
  - Visuals driving audio vs. audio driving visuals
  - Brief overview of MIDI (just enough for this context)

b. The Music Animation Production Process
    Current process
    Ideal sound/graphics environment
c. Music-to-graphics mapping
    Methods of mapping musical data onto graphical data
    Classification of graphical "instruments"
    Functions useful for modulating animation parameters
    Details of music animation system
    Constraints on real-time implementation
d. Examples
    Case study: "More Bells and Whistles"
    Works in progress
    Out-takes and early tests: what was wrong?

D. Film Sound: How is it done in the real world? — Gary Rydstrom

a. Creating sound effects
    Recording real-world sounds
    Synthesis
    Processing into "new" sounds
b. Editing sound
    Methods old and new
    Philosophy
c. Mixing the finished sound track
    Methods
    Contrast and dynamics
    Sound choices and focus
d. Dramatic potential of sound
    Music
    Emotions from sound effects
    Enhancement and clarification of image
    Picture and sound together
e. Case studies
    "Luxo Jr.," "Tin Toy," "Jurassic Park," "Terminator 2"

E. Real-time considerations — Robin Bargar

a. Technique
    Interactive sound synthesis
    Synchronizing sound to a graphics pipeline
    Parallel rendering engines
b. Perception
    What in sound do we want to control, at which rates, and why ?
    Preferred synthesis methods

c. Production

Why is this different from existing media post-production ?

What does it have to offer ?

Emerging design principles

d. Case Studies

Video examples, including "Garbage," "The Listener," "Data Driven"

VROOM examples, including "Stepping into Alpha Shapes" "Hyperspace Walkabout" "Sounds from Chaos in Chua's Circuit"

F. Summary James Hahn

COURSE ORGANIZER'S BACKGROUND

James K. Hahn

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James Hahn is currently a faculty member at the George Washington University where he is leading research in motion control, sound, virtual environments, and scientific visualization. He has been involved in previous SIGGRAPH tutorials as well as authoring SIGGRAPH technical papers. His animations have been shown at the SIGGRAPH film and video shows as well as a number of television programs and museum exhibits around the world. Recently he has been involved in pioneering work in sound synchronization and synthesis in computer animation and virtual environments.

He received an M.S. in physics from the University of California, Los Angeles and an M.S. and a Ph.D. in computer and information science from the Ohio State University.

SPEAKER BACKGROUNDS

Robin Bargar

Composer / Research Programmer
Virtual Environment Group
National Center for Supercomputing Applications
Beckman Institute for Advanced Science and Technology
University of Illinois at Urbana-Champaign
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Robin Bargar is a composer of instrumental and computer music works that include video and computer graphics. His compositions are presented in the United States, Europe and Asia. He has performed real-time multi-image works with artists including the Cleveland Orchestra, National Symphony, and Cincinnatti Symphony. Recent performances and presentations include the 1992 and 1993 International Computer Music Conference; the Second International Symposium on Electronic Arts; the SIGGRAPH 1991 and 1993 Electronic Theater; Computer Animation '91, Geneva, Switzerland; and the 1991 Asian Contemporary Music Festival, Seoul, Korea. Mr. Bargar was a finalist in the 1991 International Electro-Acoustic Music Competition in Bourges, France. In Tokyo, Japan his computer graphic collaborations received the NICOGRAPH 1990 and

1991 Arts and Entertainment Award and the 1991 Special Multimedia Prize. This work is currently syndicated on MTV's Liquid Television. After several years on the composition faculty, School of Music, UIUC, he is now project leader for Audio Development at NCSA.

Wayne Lytle

Animator / Programmer / Musician
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Wayne Lytle is a computer graphics animator and an electronic musician. For the past 5 years he has produced scientific visualizations at the Cornell Theory Center. His interests include the integration of parameter-driven and hand-keyframed animation techniques, and is especially concerned with how this applies to music animation. His SIGGRAPH '90 animation "More Bells and Whistles" was produced with his first-generation music visualization software. He has since been enhancing these techniques and has other music visualization works in progress. His other SIGGRAPH animation over the past 5 years: "Visualization of Simulated Treatment of an Ocular Tumor" ('89), "Evolution of Gravity and Effective Topography on Phobos" ('91), "Does This Pulsar Have Orbiting Planets?" ('92), and "The Dangers of Glitziness and Other Visualization Faux Pas" ('93), have earned him such prestigious awards as "Longest Title in the Film Show".

Immediately before starting at the Cornell Theory Center in 1988, he received an M.S. from the Program of Computer Graphics at Cornell University. Wayne owns a synthesizer recording studio with 8 synthesizers and various pieces of digital gear, where he is completing his first CD.

Gary Rydstrom

Sound Designer and Re-recording Mixer
Skywalker Sound, a division of Lucas Digital, Ltd.
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Gary Rydstrom is a sound designer and re-recording mixer for Skywalker Sound, a division of Lucas Digital, Ltd., where he has worked since 1983. He has worked on feature films including "Jurassic Park," "A River Runs Through It," "Terminator 2," "Backdraft," "The Hot Spot," and "Colors" as well as theme park attractions: "Captain EO," "Star Tours," and "Muppetvision 3D." In addition he did the sound work for a number of Pixar computer animated short films, "Luxo Jr," "Red's Dream," "Tin Toy," and "Knickknack." In 1991 he won two Academy Awards, for Best Sound and Best Sound Effects Editing on "Terminator 2."

He graduated from the University of Southern California School of Cinema in 1981.

Tapio Takala

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