NOTE

Interdisciplinary Learning: Motion Capture Course for the Arts and Sciences

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We have designed an interdisciplinary undergraduate course "The Body in Motion: Applications of Motion Capture for the Arts and Sciences" that will take place in Winter 2006 at the University of Michigan. The goal of the course is to enable students to both quantitatively and creatively visualize human movement using motion capture technology. By working in interdisciplinary teams on scientific and artistic problems, students learn the biomechanical principles that underlie the quantification and visualization of human movement and will explore the profound artistic implications of this rapidly developing – and increasingly ubiquitous -- technology. Fundamental to the design of the course is an interdisciplinary approach to human movement – student learning is importantly enhanced by the integration of the traditionally separate quantitative/scientific and visual/artistic disciplines. The careful attention to the nuances of human movement essential to research in Movement Science happens to be the same kind of attention required of artists working both in digital animation and in many of the performing arts. The sophisticated rhetoric of digital visual communication, which is the stock and trade of artists, designers, and performers, is also of great interest to scientists: communicating one's data coherently and succinctly is as important as conducting experiments.

The course takes advantage of a core facility at the University of Michigan motion capture system to provide a sophisticated learning opportunity. Students learn the fundamentals of motion capture and then apply their knowledge to biomechanical and artistic projects. These projects might range from the animation of a simple skeleton with motion capture data to address a rehabilitation question, to the integration of a complex virtual actor into a world of human performers; the careful measurement of specific, 3-dimensional movement behaviors, to the sonification of motion capture data into an abstract gestural symphony. We encourage our students to develop and cultivate their own diverse research interests, assisting them with our own expertise, and exposing them to a wide variety of existing applications for this technology – from visual effects to biomechanical studies. By working in interdisciplinary teams, students are exposed to different perspectives on the human body while learning a common language for describing human movement. Students from Movement Science, Art and Design, Dance, Film/Video Studies, and Performing Arts and Technology are enrolled in the course.

Improvement on existing practice. The course represents an important improvement on existing practice for undergraduate students. One of the core areas in the undergraduate Movement Science curriculum is biomechanics. The basis for many biomechanical studies is motion capture technology that is used to quantify the motion of the body. The 3-dimensional locations of anatomical landmarks are tracked over time, and biomechanical variables of interest (*e.g.*, joint angles) are calculated from these x, y, z coordinates. Thus, it is important for Movement Science students to understand the theory and practice of the motion capture methods that form the basis for much of their biomechanical knowledge. In the Visual and Performing Arts, motion capture has used by everyone from video- game developers, to visual effects artists, to dance companies. The School of Art and Design is committed to developing the 3D Animation

component of its curriculum, and a course in Motion Capture would be the first upper level course in this area.

Learning outcomes. The course is designed with two levels of content – basic and advanced. The basic component is offered first and provides the fundamentals for understanding motion capture. Then, the advanced component is offered in module form. The learning outcomes for the components are given below.

- Motion capture basics – students will understand how:
  - the anatomy and mechanics of the major joints of the body are related
  - to palpate anatomical landmarks for marker placement
  - marker images in individual cameras are identified and tracked
  - images from multiple cameras are used to calculate 3D marker coordinates
  - the geometric relationship between marker locations and joint centers are related
  - how to design a marker set to meet the goals of a motion capture project
  - to conduct a successful motion capture session
  - to operate a state-of-the-art motion capture system
  - to evaluate the quality of motion capture coordinate data
  - to create a kinematic skeleton from the marker coordinate data
- Biomechanics module – students will understand how:
  - coordinate systems are defined for body segments
  - laboratory and segment coordinate systems are related
  - 3-dimensional kinematic variables are calculated from the coordinate data
  - to generate 3-dimensional joint displacement, velocity and acceleration data
  - to interpret 3-dimensional biomechanical outcomes
- Animation module – students will understand how to:
  - create a virtual body using animation software
  - attach a virtual body to a kinematic skeleton
  - animate a virtual body with motion capture data
  - blend and mix motion capture clips
  - create loopable animations for games and multimedia
  - potentially apply to live performance
  - apply mocap data to non-human and abstract forms
  - transcode data to other media (sound, light, etc.)
  - use motion capture in pre-visualization and visual effects work

Course evaluation. Evaluation of the success of the course at meeting the learning objectives will be based on a comparison of students' knowledge of motion capture techniques and biomechanical or animation applications conducted at the beginning and end of the semester. Gross has used this course evaluation method previously (Gross, M.M. Analysis of human movement using digital video. *Journal of Educational Multimedia and Hypermedia* 7:375-395, 1998). Evaluation of the success of collaboration among students will be based on collaboration journals and other methods to be developed with the assistance of University of Michigan staff from the Center for Research on Learning and Teaching.

Summary. Our course represents an interdisciplinary approach to the study of the human body in motion. It provides a unique opportunity for undergraduate students to use motion capture technology in their investigations of scientific and artistic problems. Success of the course will be determined both by disciplinary learning and collaborative interactions among the students.