CSE 3541 (Approved): Computer Game and Animation Techniques

Course Description

Fundamental algorithms and mathematics in production of computer animation and video games, emphasizing control and rendering of animated characters.

Prior Course Number: CSE 683
Transcript Abbreviation: Comp Game Animatn
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Undergrad
Student Ranks: Junior
Course Offerings: Autumn, Spring
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: CSE 3901 or CSE 3902 or CSE 560
Exclusions: Not open to students with credit for CSE 5541 or CSE 683
Cross-Listings:

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.0901
Subsidy Level: Baccalaureate Course

Programs

Abbreviation	Description
BS CSE	BS Computer Science and Engineering

Course Goals

Be competent with basic interpolation techniques, speed control along a path, and automatic banking into curves along a path.
Be competent with forward and inverse kinematics or articulated linkages
Be competent with physics-based animation.
Be competent with behavioral animation.

Be competent with the generation and processing of sound in games and animation.
Be competent with the use of AI techniques in games.
Be competent with software architectures for computer games.
Be competent with the concept of a rendering pipeline and graphics state.
Be competent with hierarchical scene graphs and hierarchical animation.
Be familiar with computational issues associated with computer animation.
Be familiar with control devices for computer games and framework support for event notification.
Be exposed to computer animation production technology.
Be exposed to motion capture technology and its use in computer animation.
Be exposed to the history of animation and computer animation.

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Overview, history, and foundation of computer games and computer animation	2.0							
Matrices and transformations	1.0							
Path-based animation; linear, cubic interpolation; splines, path following; acceleration, speed control; ease-in/ease-out; orientation rep., interpolation; quaternions, path following; Frenet Frame, banking, interpolation-based animation	3.0							
Hierarchical modeling and animation: inverse kinematics, other IK techniques	3.0							
Review of numerical integration	2.0							
Constrained motion: ground clamping, collision detection, constrained physics	1.0							
Review of physics: gravity, friction, rigid body, spring-mass systems, particle systems, collision response	3.0							
Human figure animation: anatomy, biomechanics	3.0							
Mocap, including visit to mocap lab; motion databases	2.0							
Behavioral animation: flocking, prey-predator model	2.0							
Crowd modeling: cellular and continuous models	1.0							
Flexible body animation: non-uniform scaling, spring-mass-damper systems, blend shapes	3.0							
Efficient and effective basic human motion modeling: reaching, grasping, walking/running, expressions, speech	3.0							
Sound: physically based, sound effects	2.0							
Rendering overview: models, textures, lights and cameras	6.0							
Overview of AI in computer games	2.0							
Scene management using octrees and cells and portals	3.0							

Representative Assignments

Write a program, using piecewise cubic interpolation, that passes through an arbitrary number of points in 3-space
Write a program that controls the velocity (speed and direction) of an object that smoothly traverses a curve based on time constraints at arbitrary points along the curves. Additionally, the object should bank into curves.
Write a program that animates a linkage based on given angles at given times.
Write a program that animates a linkage based on given positions and orientations of its end effector at given times.
Write a program that animates a rigid body using gravity while it collides and bounces off of obstacles.

Write a program that animates a particle system.
Write a program that animates a flock of birds using principles of flocking behavior.
Write a program that incorporates both sound and principles of AI into the flocking animation previously written.

Grades

Aspect	Percent
Lab assignments	60%
Midterm	15%
Final	25%

Representative Textbooks and Other Course Materials

Title	Author
Computer Animation: Algorithms & Techniques	Rick Parent

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
***	a	An ability to apply knowledge of mathematics, science, and engineering.
**	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
***	c	An ability to design a system, component, or process to meet desired needs.
	d	An ability to function on multi-disciplinary teams.
*	e	An ability to identify, formulate, and solve engineering problems.
*	f	An understanding of professional and ethical responsibility.
*	g	An ability to communicate effectively.
*	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
**	i	A recognition of the need for, and an ability to engage in life-long learning.
**	j	A knowledge of contemporary issues.
*	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

BS CSE Program Outcomes

Course Contribution		Program Outcome
***	a	an ability to apply knowledge of computing, mathematics including discrete mathematics as well as probability and statistics, science, and engineering;
**	b	an ability to design and conduct experiments, as well as to analyze and interpret data;
***	c	an ability to design, implement, and evaluate a software or a software/hardware system, component, or process to meet desired needs within realistic constraints such as memory, runtime efficiency, as well as appropriate constraints related to economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability considerations;
	d	an ability to function on multi-disciplinary teams;
*	e	an ability to identify, formulate, and solve engineering problems;
*	f	an understanding of professional, ethical, legal, security and social issues and responsibilities;
*	g	an ability to communicate effectively with a range of audiences;

Course Contribution		Program Outcome
*	h	an ability to analyze the local and global impact of computing on individuals, organizations, and society;
*	i	a recognition of the need for, and an ability to engage in life-long learning and continuing professional development;
*	j	a knowledge of contemporary issues;
**	k	an ability to use the techniques, skills, and modern engineering tools necessary for practice as a CSE professional;
***	l	an ability to analyze a problem, and identify and define the computing requirements appropriate to its solution;
***	m	an ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices;
**	n	an ability to apply design and development principles in the construction of software systems of varying complexity.

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