CCEC Seminars
Presents
Closest Point Maintenance for Haptic Rendering of Hybrid Dynamical Systems

with

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Abstract:

A vital piece of enabling technology for computer animation, CAD software, and interactive virtual environments is a fast and reliable collision detector—or even better, a fast and reliable closest point algorithm. For parametric models, closest point algorithms are usually based on Newton's Iteration, enjoy only local convergence, and possess rather touchy convergence rates. In this talk I will present a new collision detector based on a re-formulation of the closest point algorithm as a nonlinear control design problem. Control design and analysis tools allow us to solve the problem with considerable flair and to outfit the controller with such attractive features as global convergence. We time-differentiated the geometric minimization problem to form the differential kinematics, then solved the inverse differential kinematics with a feedback stabilized controller. The controller selects parametric speeds that drive any pair of initialization points to the true closest points on two convex surfaces. Two switching rules based on Voronoi diagrams extend the controller to objects made of tiled-together surface patches. Global uniform asymptotic stability of the hybrid dynamical system is proved with a common Lyapunov function.

I will also review work in our lab on a hybrid systems approach to other applications in haptic rendering, including robot-assisted rehabilitation, vehicle controls, and automated modeling. We are particularly interested in hybrid system dynamics because the human sensorimotor system seems to be keenly adept at exciting such dynamics and extracting desired behavior from hybrid dynamical systems.

About the Speaker:

R. Brent Gillespie received a B.S. in Mechanical Engineering from the University of California, Davis in 1986, and a Master's in Music (piano performance) from the San Francisco Conservatory of Music in 1989. After working four years for Hewlett Packard in Silicon Valley, he returned to graduate school at Stanford University where he earned his Masters and Ph.D. in Mechanical Engineering in 1992 and 1996, based on work on haptic interface applied to electronic musical instrument interface. From 1996 through 1999, he held a NSF postdoctoral fellowship at Northwestern University, where he worked on cobots. In September of 1999 he began his present position as an Assistant Professor in Mechanical Engineering at the University of Michigan. Professor Gillespie won the Presidential Early Career Award for Scientists and Engineers (PECASE) in 2001.