

A Deterministic Approach to the Position, Trajectory, and Collision Prediction of Particles within Bounded Two-Dimensional Environments

Ranganathan, Arvind

Dynamical systems is an area of mathematics dealing with the study of constrained movement of particles or objects. This project investigates a common instance of such a system: a particle(s) with known position and velocity vectors, situated within a bounded environment composed of elementary shapes (rectangles, triangles, and circle sectors), located on the two-dimensional Cartesian plane. With these constraints, this work derives minimal-length deterministic methods to calculate (i) the position and velocity vectors of the particle at some time t , and (ii) whether or not any collision between two such particles in the environment occurs before this time t . The former is achieved through the formation of shape-specific mappings that convert the easily-determinable "linear position" of a particle to the more complex and desired "true position" within the environment. The latter is determined through the use of recurrences and number-theoretic methods. As the algorithms derived are deterministic - as opposed to probabilistic or discrete-event simulation-based - the results provided are exact, and can be wholly determined in a finite time. In addition, the potential uses in chaos theory and applications in fuel-cells are also briefly explored.