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.