ADAPTIVE TIME-STEPPING FOR GRANULAR MEDIA SIMULATION

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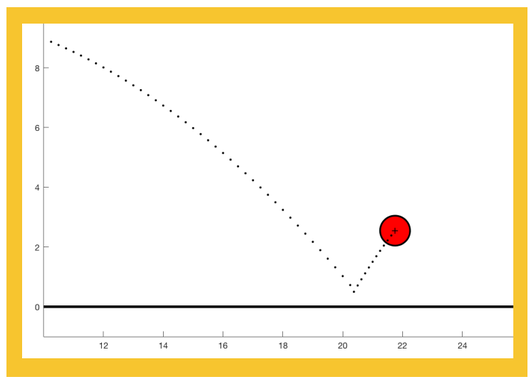
INTRODUCTION

WHY GRANULAR MEDIA?

- Second most handled material in the global industry
- Applications in engineering, physics, computer graphics, video games, etc

COMPUTATIONAL CHALLENGES

- Must focus on interactions between individual collisions and particle interactions
- Modeling relies on principles from solid mechanics, fluid dynamics, and statistical physics
- Position of particle is continuous; however it is not differentiable



OBJECTIVES

VERSATILE, HIGH-FIDELITY COLLISION SIMULATOR WITH USER INPUTS

- Number of particles, Mass, Diameter, Restitution, Tolerance, Solver

HEURISTIC ADAPTIVE TIME STEPPING METHOD

- Since particle interactions are non-smooth, standard adaptive time-stepping methods are not useful
- Must use alternative error estimate while assuring rigid particles do not deform nor penetrate one another

APPROACH

- Information from the particles starting position and velocity is used to advance the simulation over a specified period of time using various time steps(dt)
- Two issues must be solved when developing an adaptive method for this non-smooth case; the lack of error estimates and the issues created by aspects of the collision
- The number of iterations correlates to how much the optimization method "struggles" to solve the problem
- The iteration value will serve as our "error estimate" and determine if dt must be increased, decreased, or left as is while assuring no particle overlap or passing through
- This will allow us to investigate how optimization solvers work under various conditions

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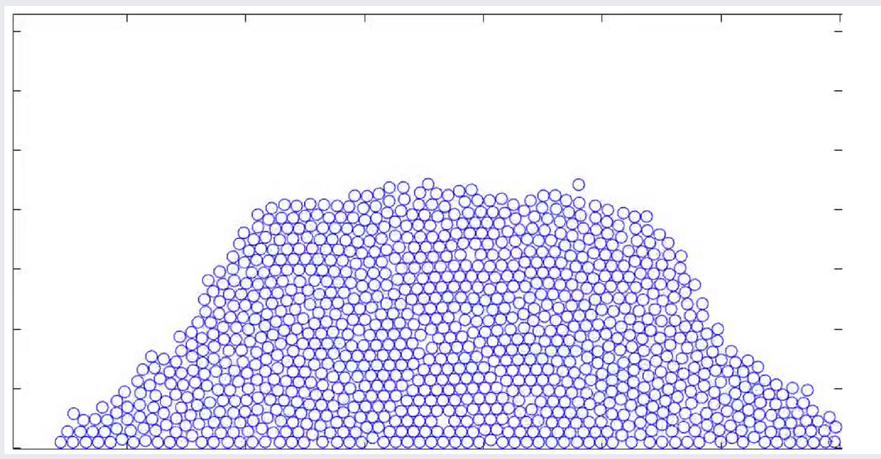
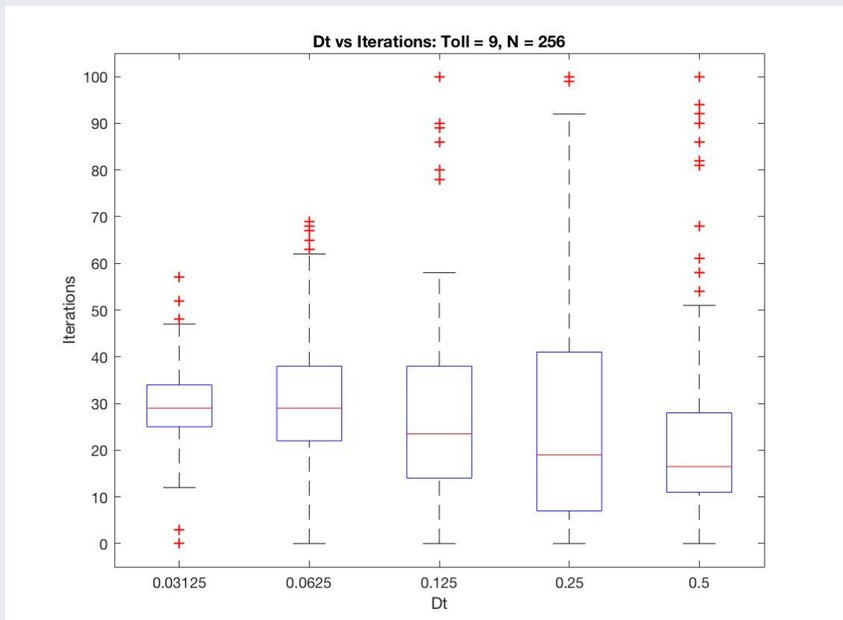
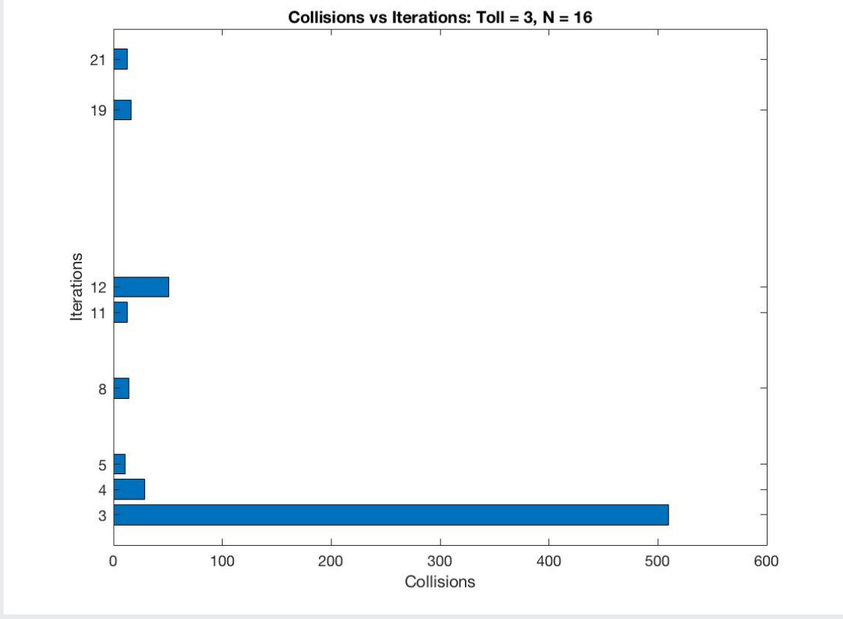
RESULTS



Collision Generator: N= 1024 particles, Solver = MinMap Netwon, Tolerance = 1E-9



Relationship between number of iterations and size of time-step



Number of iterations increases with number of collisions

FUTURE WORK

- Determine how to alter dt such that it is adaptive
- Continue test cases and experiments
- Apply and adapt findings to fluid suspension case; applications include adaptive nanomaterials