



Universität
Rostock



Traditio et Innovatio

Numerical Simulation of Brash Ice

Master Thesis Presentation: EMShip Week

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Objectives

- Discrete Element Method tool to simulate brash ice
 - Numerical modeling of brash ice particles
 - Develop DEM scheme
 - Generating brash ice channel
 - Cylinder experiment – Sensitivity analysis
 - Simulating ship model experiment

Brash Ice

- Accumulated broken ice in a channel

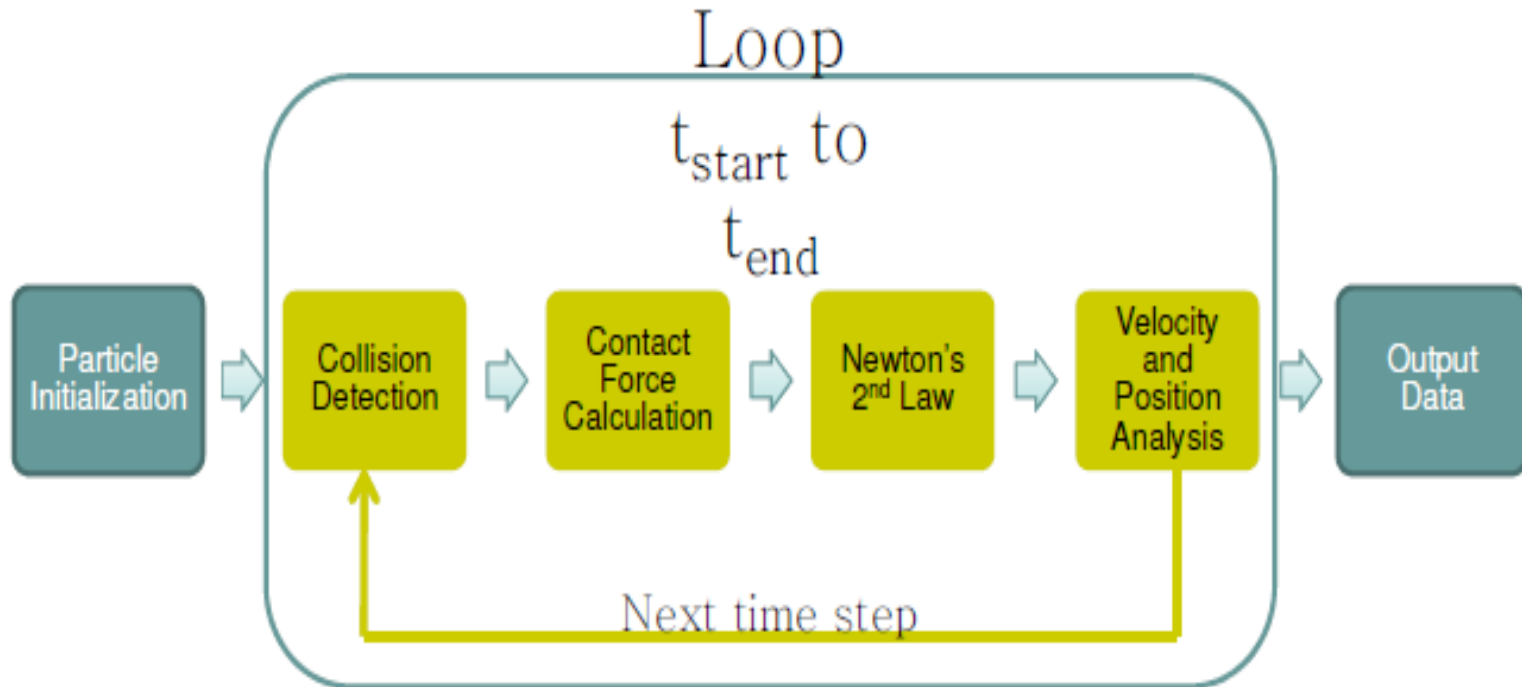


Ship navigating in brash ice channel



Brash ice particles

Discrete Element Method

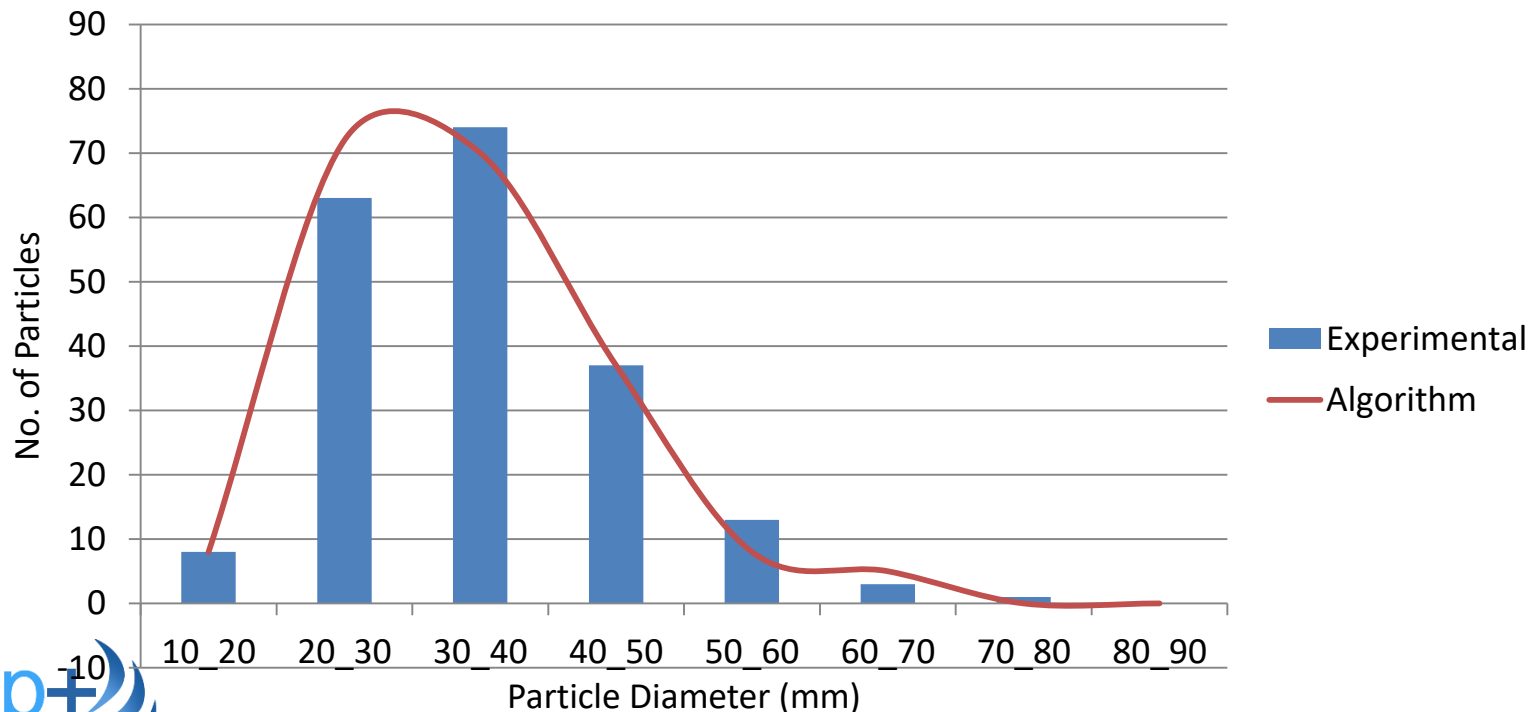


Simple Example of DEM

(source :Simulation-Based Engineering Lab, University of Wisconsin)

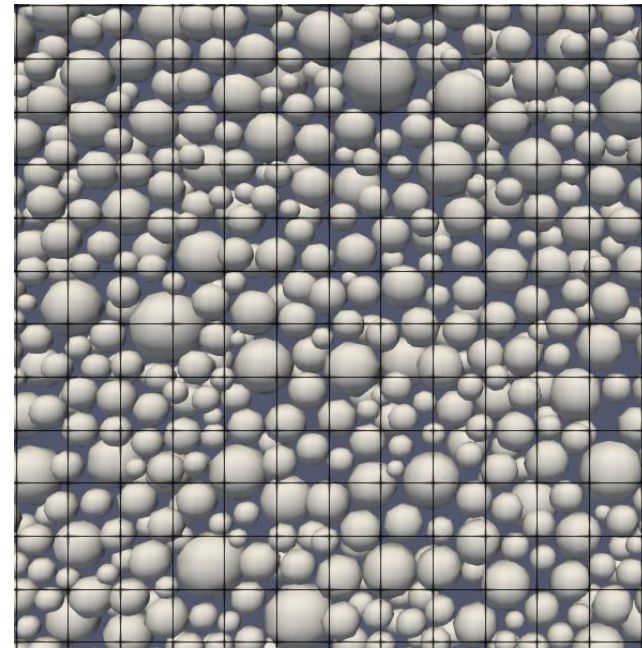
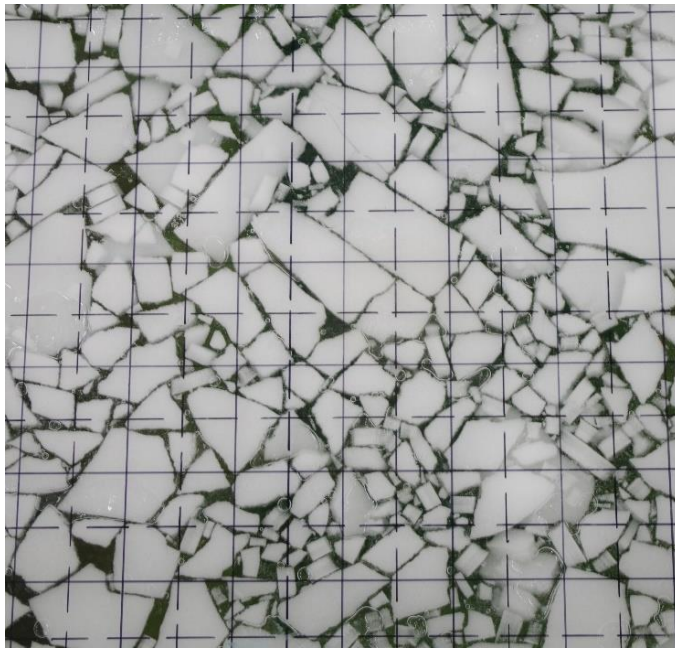
Modelling of Ice Particles

- Spherical granular particles
- Particle size distributed in lognormal - ship scale
- Scaling of ice particle size to model scale



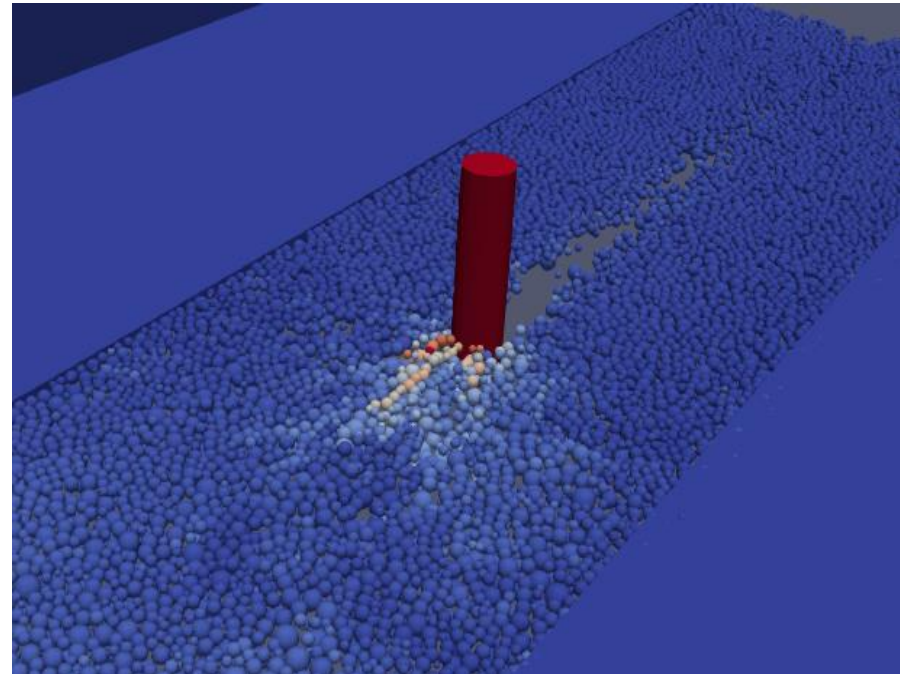
Generating Brash Ice Channel

- Input parameters – length, width, brash ice thickness and porosity
- Floating up technique



Cylinder Experiment

- Calibrate parameters
- Compare channels
- Validate forces

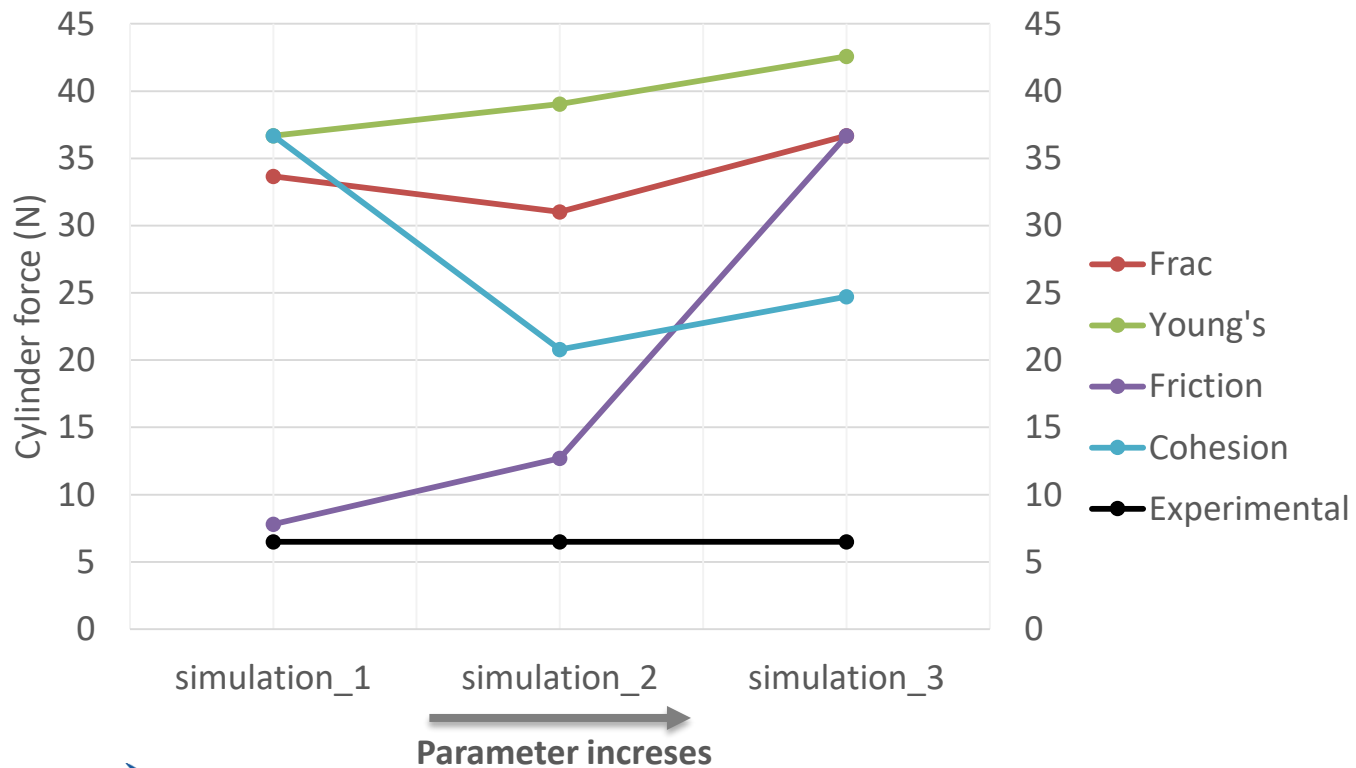


Cylinder experiment simulation



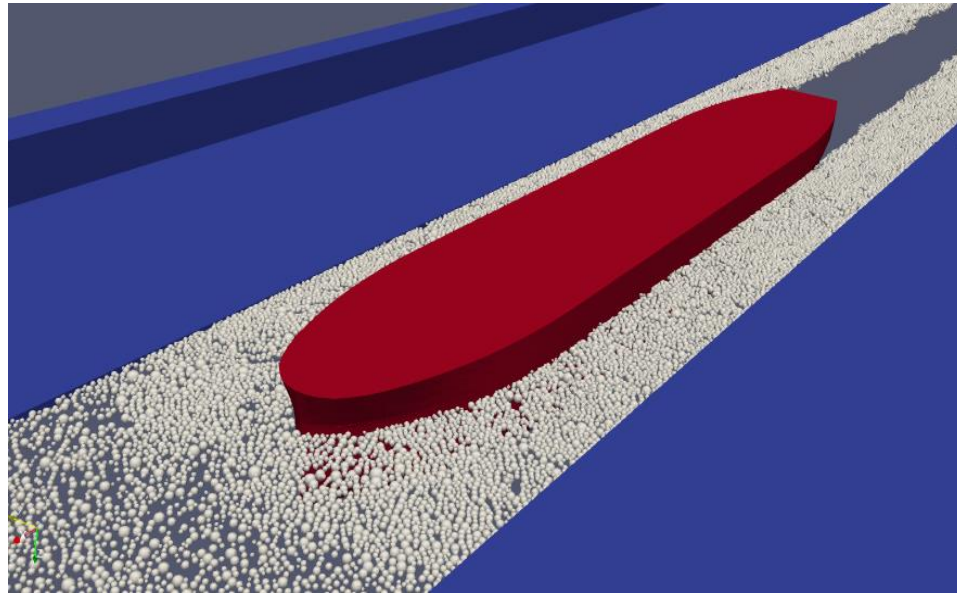
Sensitivity Analysis

- Parameters: Time step(frac), Young's Modules, Friction Coefficient, Cohesion Coefficient



Brash Ice Ship Model Test

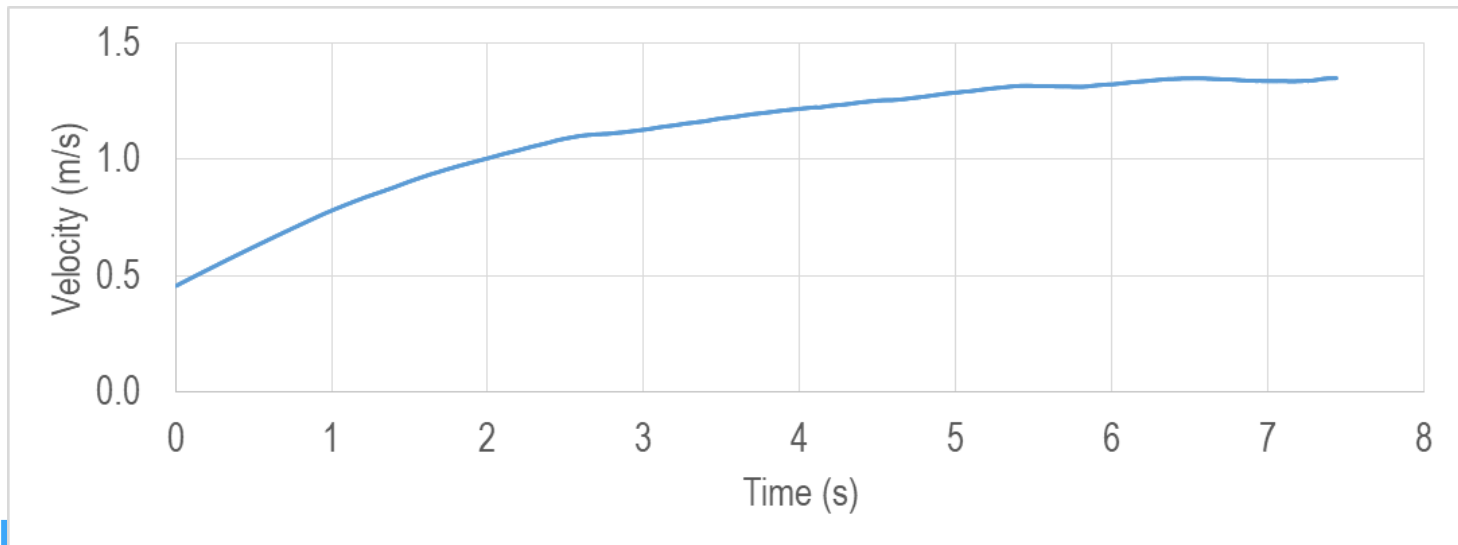
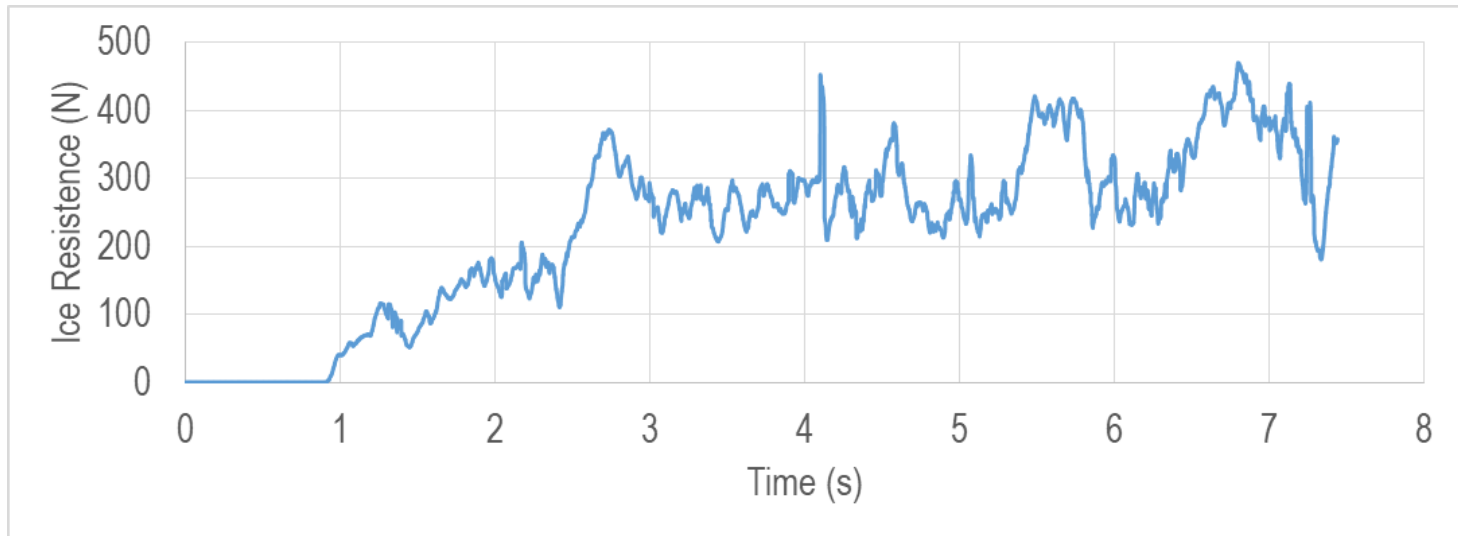
- Self propulsion test
- Input : Ship Model and Propeller Curve
- Output: velocity, acceleration, thrust force and ice forces



Ship model simulation



Numerical Results

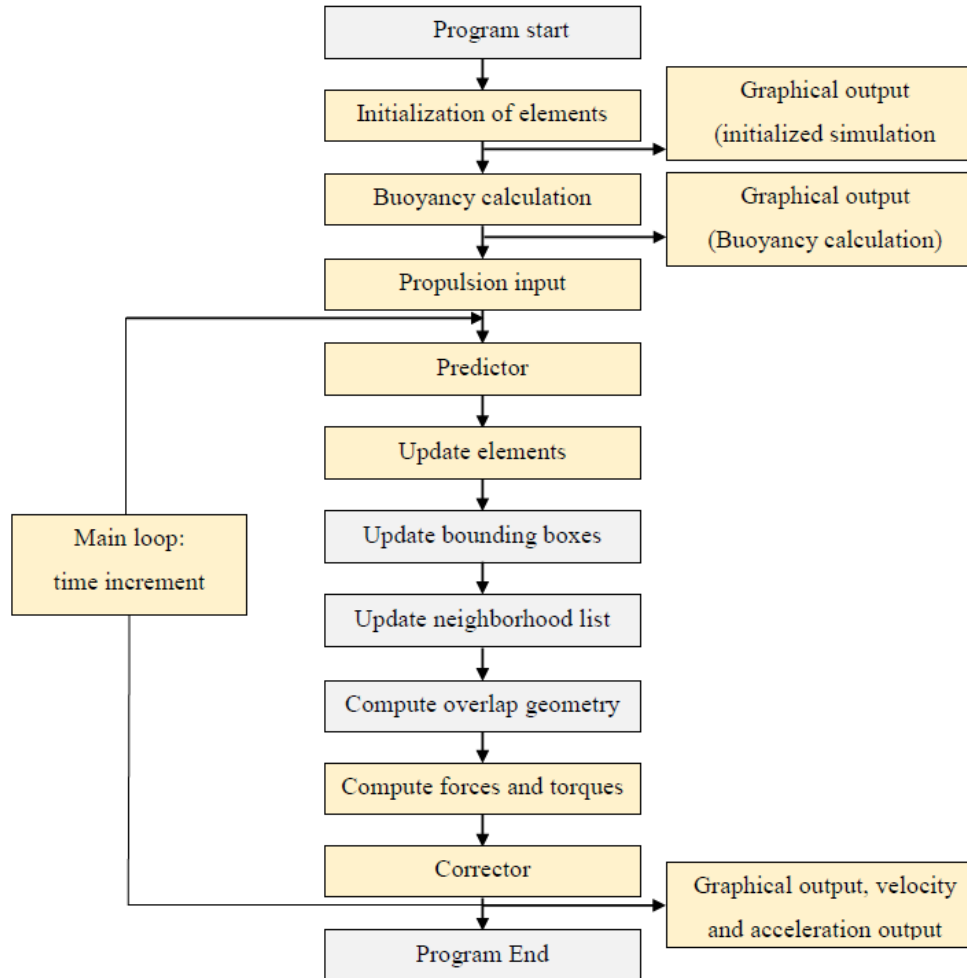


Conclusions

- DEM for ship-brash ice interactions
- Visualization tool
- Force model has to improve

Thank You !

DEM Algorithm



DEM algorithm in code