Altair EDEM 2022

Release Notes

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Contents

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EDEM 2022

This Release Notes document contains the following information about EDEM 2022:

- Key Features
- Enhancements
- Bug Fixes
- Known Issues

Key Features

EDEM GPU Solver (CUDA) Multi-GPU Solver Engine

The newly developed EDEM Multi-GPU Solver (CUDA) enables users to solve bigger simulations with more particles than ever before. By making full use of the latest Nvidia graphics cards, this cutting-edge EDEM Multi-GPU Solver automatically balances computation workload and memory usage on the GPU devices to maximize the utilization of the hardware. This doesn't require any additional user input and delivers good scalability across multiple GPU cards with larger particle numbers.

The EDEM Multi-GPU Solver is compatible with Polyhedral, Sphero-Cylinder and Multi-Sphere particles as well as supporting most of EDEM API functionality. For full details of the GPU capabilities, see the table at the end of this document.

Database for Powder Material Models

A database of powder material models has been added to EDEM. This is a set of materials which can be sorted based on the static angle of repose and the steady-state shear stress responses. Once the appropriate result has been selected, scaling rules can be applied to the result to generate an appropriate material model for the application.

EDEMpy Custom Properties for post processing

EDEMpy now supports the option to Add, Remove and Edit custom properties in a simulation deck. This can be used in post-processing to add user defined time-dependent attributes to particles, geometries, contacts, or the whole simulation. This information is then saved within the deck, where it can be visualized and exported using the standard EDEM Analyst tools.

Volume Packing improvements

The Volume packing functionality has been extended to support Bulk Materials which have a User-Defined Particle Size Distribution, support periodic boundaries and no longer require a material block to be generated.

It is still possible to generate a material block from the generated material, however this is not done by default. This will improve performance and avoid the material

database increasing in size.

The Periodic boundaries can be used in conjunction with the block factory tool to generate large beds of materials or generate silos with a defined solid fraction. This allows simulations where there is a repetition in the material to be set up much quicker.

The Volume Packing tool now supports the Bonded and Heat Transfer Physics models. This means that volumes can be filled using the packing tool and then bonded and volumes can be generated with particles which have specific temperatures and heat flux values.

Tavares UFRJ Breakage Model for CPU

The Tavares UFRJ Breakage model has been added to the internal physics models. This model captures the various body breakage mechanisms that occur during particle collisions. Specifically, it describes the adaptation of a detailed breakage mechanism of brittle materials. It accounts for the variability and size-dependency in breakage probability and weakening by repeated stressing, and delivers the final size distribution of the material.

Analyst tools have also been added to better understand the breakage in the model. These tools include the ability to plot and export particle size distributions in Breakage simulations. This incorporates the distribution of "fines": particles that are below the minimum cut-off diameter of the simulation. Although fines are too small to participate in the simulation, their mass and size is still accounted for in this distribution.

Wet Mixing Model (Experimental)

A wet mixing model has been added to the experimental physics models. The model is primarily aimed at concrete mixing. Particles with different moisture contents are added to the system. The transfer of moisture between particles is modeled and the cohesive interaction between the particles is modified depending on the amount of moisture.

Spray Coating for Polyhedral, Multi-Sphere and Sphero-Cylinder Particles

A spray coating model has been added to the Physics models. This model captures a spray of coating material hitting particles and adding that mass to those particles. This model was previously available as an API model on the user forum, this is now available within EDEM and has been updated to be compatible with all particle types and is available from the GUI. The transfer of spray between coated particles is not modelled, however a post-processing Python model is available to analyze this.

Additional Enhancements

Creator

Use CAD file name for Geometry Sections

An option has been added to use the CAD file name for geometry sections when importing them into EDEM. By default, EDEM will continue to use the part name located within the CAD file itself. This option will allow more control of geometry names if the name within the CAD file is not found. If the CAD file is composed of more than one geometry section a numerical suffix will be added to the name.

Particle Limits applied periodically

Particle limits can now be looped: they can be applied periodically throughout the simulation. This can be used to remove excess movement of particles from the simulation. This is particularly aimed at scenarios where large numbers of particles are placed quickly into a simulation and would normally result in a particle explosion. This acts as a calming function, where velocities are repeatedly reset to a low value until the overlap is small.

EDEM File Compression

The 'saving last timestep' message will prevent EDEM from closing until the data compression is complete, this ensures all time step data is compressed and that users benefit from the reduced file size data compression offers.

Meta-Particles for Sphero-Cylinder and Multi-Sphere Particles

The GPU CUDA solver can generate Meta-Particles composed of Multi-Sphere or Sphero-Cylinder particles. Using these with the Bonded V2 physics model will allow users to simulate flexible particles with complex shapes. The Meta-Particle interface has been added to the Sphero-Cylinder options. Multi-GPU factories will not generate Meta-Particles which cross the boundary between two GPUs. This will affect the random nature of particle generation.

Simulator

Fixed velocity particles

Particles now have the option to preserve the velocity they are generated with. This means that particles generated will travel at a constant speed. This is applied on a per particle basis. This allows some particles to have a fixed velocity. A notable application using this feature is fiber modeling, where the 'root' of the stem can have a fixed velocity and the rest of the fiber is free to move.

Plot Particle Size Distribution against the expected distribution

The solve report now includes graphs comparing the particle size distribution of each particle type against the distribution that was requested. This helps users identify cases of factories being too small to allow larger particles to be generated. This is applicable to all solvers.

Multi-Sphere Factory using Physical Radius for CUDA solver

The ability to use the physical radius option for factories has been added to the CUDA solver, this matches the behavior of the CPU and OpenCL solver.

Preserve contact across elements on CUDA

An option to preserve contacts across geometry elements has been added to the Multi-Sphere CUDA solver. This preserves the contact history between the particle and the geometry and eliminates the contact force spikes when a particle moves between elements.

Analyst

Copy particle ID into manual particle selection list through "Copy and Paste" style

The ability to paste particle IDs into the manual selection has been added to the Analyst. This functionality allows the study of specific individual particles or groups of particles which would have otherwise been difficult to select.

Polyhedral Particle contact attributes

Three additional attributes are available for Polyhedral particle contacts. These are the Penetration Depth, Overlap Volume and Contact Normal. These attributes can be used in the Analyst Queries, Data Export, Selection Contact data and contact coloring. Only the Contact Normal coloring is available when using legacy rendering.

Rendering improvement for Cones and Vectors

Rendering of particle cone, particle vector, and contact vector representations has been improved to be smoother.

GPU

Residence Time on EDEM GPU Solver (CUDA)

The particle data query 'residence time' tracks the amount of time each particle has spent in the simulation. Previously this was not implemented for the CUDA solver, but it has now been implemented and may be used in the same way as for the other solvers. Note that decks with pre-existing particles created using the CUDA solver and earlier versions of EDEM will not have correct data for this property. Only new simulation runs with the CUDA solver will have correct values.

EDEM GPU Solver (CUDA) Direct Force Adding

An option to 'Use Direct Force Adding' has been added to the CUDA solver. This reduces memory usage, particularly in simulations with wide particle size distribution. This functionality requires a Graphics Card which supports CUDA Compute Capability 6.0 (Pascal architecture or above). Older cards will continue to run using the CUDA solver, however they will not be able to use this feature.

Note: If a contact model is using a particle custom property value to calculate the same custom property value delta, then the contact calculation can get an updated particle custom property value instead of the original one. None of the internal models are impacted, as the same value is not read and modified at the same time. Using this option can lead to minor variations between repeated simulation runs, however this variation will not affect the overall bulk behavior.

EDEM GPU Solver (CUDA) Performance for Size Distributions

Alternate optimizations have been made to the EDEM GPU Solver (CUDA) to improve performance, these include contact sorting in global memory rather than shared memory and significant improvements in the contact detection filtering. These changes are particularly apparent where there is a large particle size distribution.

Miscellaneous

Add a warning for Block Factory usage with all CUDA solvers

When using Block factories on the CUDA solver, they will generate particles, but they currently don't have contact information. When a simulation is run on CUDA using block factories, a warning message will appear.

Default Solver Precision settings in the CUDA Engine Settings

Default Solver Precision settings moved to CUDA Engine Settings. OpenCL Alternative contact detection will use double by default in new decks.

Calibration Kit - Cone Penetrometer Test

The Cone Penetrometer method has been added to the Calibration Kit. This test is used for characterizing ground materials. The kit contains an input deck and EDEMpy post processing kit. This can be found in the EDEM installation folder and can be used in conjunction with EDEMCal to develop a ground material model which matches the experimental cone penetrometer results.

Updated Calibration Kits

Calibration Kits have been updated to the latest version. These updates include removing any specific IDE requirements and using the latest version of EDEMpy.

Deprecated Features

Linear Cohesion contact model removed

The Linear Cohesion model has been removed from EDEM. This has been replaced by the Linear Cohesion model V2 which addresses the physics issues in the Linear Cohesion model. If a simulation is opened which had Linear Cohesion selected in the physics section, the model will automatically be converted to Linear Cohesion V2. The results will differ between the two contact models, particularly when using a size distribution.

Sentinel (legacy) licensing removed

The legacy license system is no longer supported. EDEM is now available on the Altair Units licensing system and will not work with the legacy license system. Users still on legacy licenses who are paying maintenance should contact their account manager.

EDEMpy

EDEMpy retrieve physics properties of EEPA model

A function has been added to return all user defined parameters for the EEPA model. The existing equivalent function for getting Hertz-Mindlin with JKR parameters has also been updated to return the whole data set instead of just the first entry.

Retrieve Kinematic properties using EDEMpy

A kinematics class has been added. This contains functions to get information on kinematic attributes, start point, end point and point of application from the EDEM simulation.

Implement "getPressure" method in EDEMpy

A getPressure() method has been added to the timestep geometry class which returns an array containing pressure per triangle.

Bug Fixes

EDEM 2022 contains fixes for the following issues:

- Using volume packing with the position optimization option selected would not fill the volume properly.
- Particle generation failed when generated particles intersected dynamic domain boundaries.
- The auto-grid size option defined in the GUI was not overwritten by the grid cell size written in the command line. Using the auto-grid and -g flags together in the command line interface will now give the user a warning. Using the -g flag in the command line interface will automatically set auto-grid to false.
- An issue could occur with the transfer of tangential overlap between timesteps, this could lead to the contact not acting exactly perpendicular to the contact normal. This issue was not common but may result in a change of trajectories to individual particles.
- Particles could be generated outside the volume when using the volume packing tool with volumes with sharp edges.
- The CUDA solver would produce particles with large ID numbers, they are now assigned ascending and continuous ID values.
- Simulations with large particle size distributions would fail when run on the GPU solver (CUDA).
- The graph settings would not be preserved in the interface. This meant that graph settings would need to be re-entered multiple times, these setting are now saved, so graphs can be modified without needing redefined.
- Static factories were never marked complete in the solve report when the factory was defined with 0 particles.
- Simulation data could become corrupted at the end of a GPU solver simulation if the coupling disconnected, or the simulation stopped unexpectedly.
- A crash could occur when kinematics were added to a simulation through the Coupling Interface.
- A crash could occur if multiple geometries were deleted when contacts existed with those geometries.
- Contacts were not hidden when using the 'Hide Out of Bounds' coloring option and contact transparency was not supported using standard or instanced rendering.
- Rendering Sphero-Cylinder particles in legacy mode or while simulating could cause EDEM to become unresponsive.
- A crash could occur when using the Hysteretic Spring model on the CUDA solver, due to invalid values for the tangential overlap.
- Simulator settings were not fully transferred to new versions of EDEM.
- A crash could occur when selecting a Meta-Particle before selecting a particle.
- Particles of interest would not be fully populated with all custom properties on the GPU CUDA solver.
- The 'Contacting Neighbours' custom property was removed from the EEPA contact model, this was an unused custom property, but will still be visible for old simulations in the Analyst.

- Big simulations run using the CUDA solver used a large amount of memory on the GPU.
- The geometry position could be affected by interacting with it in the Simulator and transparent geometries did not appear when switching to the simulator.
- The EDEM coupling failed to connect to RecurDyn VR4. Users are now required to open the 'EDEM1_1_0.xml' in a text editor and add the full path to the EDEMRecurDynCouplingClient.dll where it is indicated to do so.
- An issue could occur with simulations containing multiple factories when run with the CUDA solver. If there was more than 1 active factory generating particles, then the particles could be created in the wrong place.
- The Edinburgh Elasto-Plastic Adhesion model would report an error when using a User Defined Size Distribution sum was not exactly 100%.
- A crash could occur when using the Volume Packing with particle containing very small spheres.
- The API function isSphere() would return false where is should have returned true.
- The Total Over Time query in the Analyst was not displayed in the query name, leading to misleading query titles.
- Simulations could not be saved to a network drive while using data compression if hard drive was not mounted or mapped.
- A crash could occur when recording a video using older and compute GPU cards.
- An incorrect particle size distribution could be generated when scaling by radius was used in the user defined size distribution options.
- Factories on the CUDA solver would not behave correctly in certain situations.
- The API function getNodeIDs() would return false where is should have returned true.
- Export to STL did not account for partial time steps.
- If a material block contained bonded particles, only the first block would be created with bonds.
- The last time step could become corrupted if it's selective and compression were used.
- The default coloring for Stress Tensor, Axial Stress and Von Mises attributes would be a uniform color unless minimum and maximum values were updated.
- Memory usage was high when using Geometry Bin Groups.
- Expired coupling motions or deleted kinematics could leave a velocity on simulation elements when running on the CUDA solver. This may also cause some very minor results differences on some existing CUDA simulations, however these will not be significant.
- There was inconsistent behavior between Sphero-Cylinders and Polyhedral simulations when run on command line with the invalid flag to use the OpenCL solver.
- Particles could explode when using periodic boundaries with the CUDA solver.
- Meta-particle factories could corrupt a simulation deck if a particle size distribution was used, and the particles type was updated in the factory.

Known Issues

GPU Solver Compatibility

The EDEM GPU Solver Engine has some restrictions on the types of simulations it can run in the current version. These are documented in the EDEM help files (GPU guide) and summarized in the table below.

	Multi-Sphere CPU	Multi-Sphere OPENCL GPU/Multi-GPU	Multi-Sphere CUDA GPU/Multi-GPU	Sphero-Cylinder CUDA GPU/Multi-GPU	Polyhedral CUDA GPU/Multi-GPU
Creator Features					
Meta-Particles	✓	✓	✓	✓	×
Editable Particle Shapes	✓	✓	✓	✓	✓
Transfer Material	✓	✓	✓	✓	✓
Electrostatics	✓	×	×	×	×
GEMM Database	✓	✓	✓	×	×
Factories	✓	✓	✓	✓	✓
Size Distributions	✓	✓	✓	✓	✓
Support Multiple Materials/Particles	✓	✓	✓	✓	✓
Shape Library	✓	✓	✓	N/A	✓
Import/Export Particle	✓	✓	✓	✓	✓
Simulator Features					
MBD Coupling Interface	✓	✓	✓	✓	✓
CFD Coupling Interface	✓	✓	✓	✓	✓
Dynamic Domain	✓	✓[2]	×	×	×
Linear Periodic Boundaries	✓	✓	✓	✓	✓
Cylindrical Periodic Boundaries	✓	×	×	×	×
Track Collisions	✓	×	×	×	×
Auto-Timestep Setting	✓	✓	✓	✓	✓
Auto-Grid Setting	✓	✓	N/A	N/A	N/A
Contact Detection: Active Cell	✓	✓	×	×	×
Contact Detection: Z-Order	×	✓	×	×	×
Contact Detection: BVH	×	✓	✓	✓	✓
Euler Time Integration	✓	✓	✓	✓	✓
Verlet Integration Methods	✓	×	×	×	×
Batch Mode	✓	✓	✓	✓	✓
Kinematics	✓	✓	✓	✓	✓
Selective Save	✓	✓	✓	✓	✓
Block Import Factory	✓	✓	✓[1]	✓[1]	✓[1]
Analyst Features					
Clipping Planes	✓	✓	✓	✓	✓
Tools	✓	✓	✓	✓	✓
Manual Selections	✓	✓	✓	✓	✓
Geometry Bins	✓	✓	✓	✓	✓

	Multi-Sphere CPU	Multi-Sphere OPENCL GPU/Multi-GPU	Multi-Sphere CUDA GPU/Multi-GPU	Sphero-Cylinder CUDA GPU/Multi-GPU	Polyhedral CUDA GPU/Multi-GPU
Grid Bins	✓	✓	✓	✓	✓
Export Data	✓	✓	✓	✓	✓
EDEM API					
Contact Models	✓	✓	✓	✓	✓
Particle Body Forces	✓	✓	✓	✓	✓
Factories	✓	✓	✓	✓	✓
Field Data Import	✓	✓	×	×	×
Particle Replacement	N/A	✓	✓[2]	✓[2]	✓[2]
Deformation (API)	✓	×	×	×	×
Deformation (Coupling Interface)	✓	✓	×	×	×
Custom Properties	✓	✓	✓	✓	✓
Physics Models					
Hertz Mindlin	✓	✓	✓	✓	N/A
JKR	✓	✓	✓	✓	N/A
JKR V2	✓	✓	✓	✓	✓[3]
Edinburgh-Elasto-Plastic-Adhesion Model	✓	✓	✓	✓	N/A
Bonded (Deprecated)	✓	×	×	×	N/A
Bonded V2	✓	✓	✓	✓	N/A
Archard Wear	✓	✓	✓	✓	N/A
Relative Wear	✓	✓	✓	✓	N/A
Oka Wear	✓	✓	✓	✓	N/A
Linear Spring	✓	✓	✓	✓	N/A
Linear Cohesion V2	✓	✓	✓	✓	N/A
Hysteretic Spring	✓	✓	✓	✓	N/A
Electrostatics	✓	×	×	×	N/A
Heat Transfer	✓	✓	✓	✓	N/A
Standard Rolling Friction	✓	✓	✓	✓	N/A
RVD Rolling Friction (Deprecated)	✓	✓	✓	✓	N/A
Tavares UFRJ Breakage Model	✓	×	×	×	×
Spray Coating Model	✓	✓	✓	✓	✓
Wet Mixing Model[3]	✓	×	✓	×	×
Hertz Mindlin Effective	N/A	N/A	N/A	N/A	✓
Hertz Mindlin Nassauer Kuna	N/A	N/A	N/A	N/A	✓
Volume Spring Model[3]	N/A	N/A	N/A	N/A	✓
Spinning Friction	N/A	N/A	N/A	N/A	✓

[1] Contact history is not preserved when using material blocks on CUDA
[2] Not supported on Multi-GPU
[3] Experimental model

Note: Existing EDEM API models need to be converted to work on the GPU solver. This process is not automatic, but information is provided to help guide the user

through the process [EDEM Documentation > Programming Guide > GPU API Guide]. The model will need to be updated to the latest version of the API before activation of the GPU solver is possible. Most of the challenges arise from moving the code from C++ to OpenCL, this normally involves checking for C++ functions which are not supported. EDEM has also provided additional helper functions to assist with this process to cover many tools commonly used in the API.

EDEM Help Search box is not working in Internet Explorer 11

Other browsers such as Microsoft Edge, Google Chrome and Mozilla Firefox do not have this issue.

MotionView Geometry import issues

To use the parent-child functionality in EDEM with a rotating geometry imported from MotionView, the geometries local origin must be moved using the local origin offset to the center of the geometry. If the local origin is not at the center of the rotating geometry, the child will move around an axis relative to the automatic local origin (0,0,0). This will cause the child to move in unwanted ways.

EDEM CPU utilization can be higher than expected

On some computers, the Windows Task Manager can show that EDEM is using significantly more CPU threads than the user is expecting. This will typically happen when there are many idle CPU threads available. To stop this happening, the user can create the following environment variable: OMP_WAIT_POLICY=passive This will restrict the number of CPU threads EDEM is using to the number expected by the user. Testing has not shown this to have any noticeable effect on simulation performance.

Deprecated: Bonded V1

The Bonded V1 model has been marked as deprecated. This has been replaced by Bonded model V2. Users will be able to analyze simulations previously run using the Bonded V1 model but will be unable to re-simulate these decks without upgrading to Bonded V2.