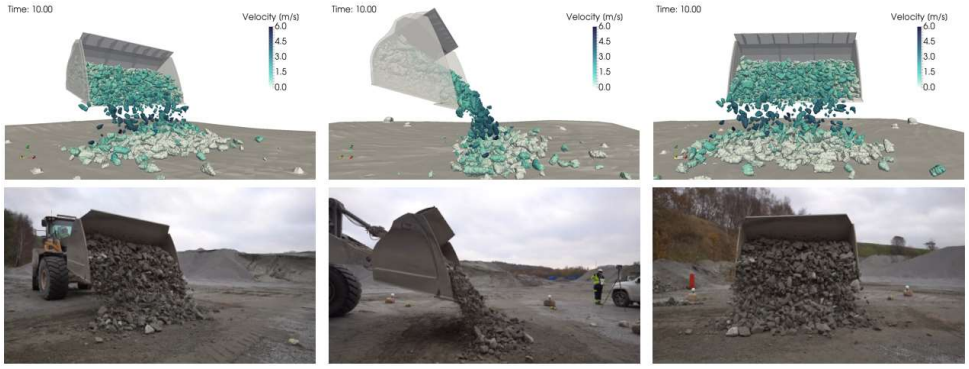
Master Thesis Proposal

The dynamics of a wheel loader handling unbound granular material

A coupled multibody and polyhedra discrete element approach



Background

Volvo Construction Equipment develops premium equipment with the vision of *Building the world we want to live in*. We are world leading in autonomous and electrified construction machines. Our machines are used during road building, mining, building schools and hospitals. Developing the best machines and having a global presence makes it possible for us to shape the future of construction industry.

A wheel loader is a machine that is very versatile and can be used for many different tasks, but usually handling and moving different materials and objects. In our vehicle simulations it is therefore important to include the interaction between bucket and material to for example extract loads on the structure, optimize energy consumption or to design a bucket that is easy to fill.

The Discrete Element Method (DEM) is a numerical method to simulate the interaction between a finite number of particles which may interact with each other through contact, friction, cohesion etc. The method is very computer intensive but by using GPU the computational times have become acceptable also for a large number of particles of almost arbitrary size and shape. Fraunhofer Chalmers Centre (FCC) has developed an in-house DEM software capable to resolve the interaction between the tools and granular materials.

The thesis project will be conducted within the framework of the Vinnova research project DigiRoad coordinated by FCC.

Description

The thesis work is suitable for two students on master level and will focus on developing an interface between a commercial software as e.g. MSC Adams or Simulink and the in-house Fraunhofer DEM software Demify®. The development includes to investigate methods for co-simulation to find an efficient and robust communication between the software's.

The work also includes to develop test procedures to access shapes and sizes of typical crushed materials to be used in the simulations. To be able to describe the material the

irregularities and shapes of the virtual gravel needs to be captured together with the typical size distribution.

Scope

The master thesis project will include:

- Development of a wheel loader model with MBS/DEM co-simulation interface
- Material characterization and calibration of rock particle model
- Validation against full scale experimental bucket load/force data

Student Profile

Required: 1-2 students from the master programs in Applied Mechanics, Mechatronics, Engineering Mathematics or similar. Self-motivated, curious and fast learner.

Application

A brief cover letter, CV and academic records from both master and bachelor studies. Good knowledge in mechanics and programming. Familiarity with the Matlab/Simulink and the Python programming language

Duration

The thesis project will start January 2021 and continue for 20 weeks. The master thesis project is 30 credits/student.

Location

The thesis project is located at Volvo Construction Equipment in Braås or Eskilstuna.

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2020-11-30

References

[1] Felix Henriksson and Joanna Minta, Bucket-soil interaction for wheel loaders-An application of the Discrete Element Method, Master's Thesis in Mechanical Engineering, Linnaeus University, Växjö, 2016, https://www.divaportal.org/smash/get/diva2:935535/FULLTEXT01.pdf.

[2] Joar Göransson Axås, A coupled multibody and discrete element approach for roller compaction dynamics, Master's Thesis in Applied Mechanics, Chalmers University of Technology, Gothenburg, 2020.

[3] Johannes Quist, Franziska Hunger and Klas Jareteg, DEM investigation of segregation of rock materials during unloading. Fraunhofer-Chalmers Centre Report: 2225-191205-629, SBUF Project 13638, Vinnova DigiRoad 2018-00606, Gothenburg, 2020.