MOTOR Newsletter

April 2017

Dear Reader,

It is my great pleasure to warmly welcome you to the second edition of the MOTOR Newsletter, which will be sent out every six months from now.

The first half of the project is over and it has brought many exciting developments. Core components for the advanced modelling and manipulation of the complex geometries of our industrial partners have been created and are now available in the open-source library G+Smo. The development of geometry-aware simulation and optimisation tools is in full swing and starts to receive attention from peers in our networks. The integration of the new tools into the design workflows of our industrial partners has started showing already tremendous reduction of computing times by 30% for some use cases.

However, the journey is not over yet. The MOTOR consortium is very much looking forward to the second half of the project, which will focus on the integration and usage of the developed tools for automated design optimisation of four demonstrators selected by the industrial partners.

Best regards,
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(Project Coordinator)

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Progress Report

Visualization Module

Visualization is crucial to gain essential insights and understanding of calculation results and data. Hence the cycle of design, simulation and optimisation of a geometry deeply involves visualization.

The goal of the visualization module is to create a visualization package in G+Smo which provides access to state-of-the-art techniques with emphasis on fluid flow and structural mechanics. This package works directly on results from Isogeometric Analysis without conversion that is required to apply other, general-purpose visualization software packages. In February, deliverable D3.4 was submitted containing implementation and utilization details about the visualization module. Multiple application examples for all visualization methods were given. Adaptation to our project partners' needs and further interface development are ongoing, the integration as a G+Smo product is imminent.

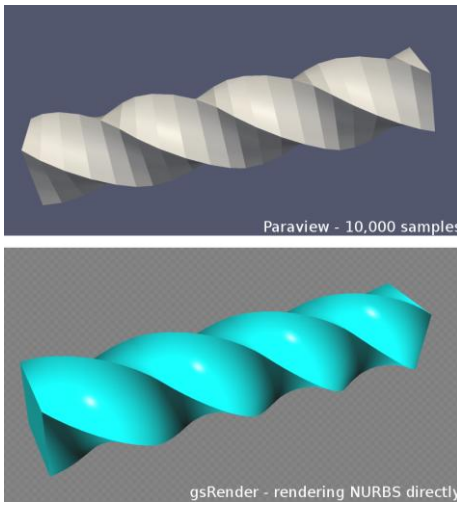

Figure 1. Example of visualisation techniques

Simulation modules

An incompressible fluid flow solver module was developed within the first period of the project. The solver was implemented in the G+Smo software framework and is now available to all MOTOR partners.

The mathematical model is based on Navier-Stokes equations, either in their steady, or unsteady formulation. The solution of this system of partial differential equations is based on the so-called isogeometric analysis. Computational domains are described by 2D/3D NURBS (Non-Uniform Rational B-Spline) objects. The solver allows to use single- and multi-patch conformal and non-conformal NURBS geometries as computational domains.

In MOTOR the incompressible fluid flow solver is mainly used to simulate fluid flow in water turbines, rotation of a computational domain and periodic (cyclic) boundary conditions were implemented. Periodic boundary conditions are necessary to reduce the size of the problem solved and the computational effort needed.

Events

June 8, 2017
MOTOR Midterm review, Brussels, Belgium

July 19-20, 2017
Presentation TU Kaiserslautern at EDM CAE Forum, Stuttgart, Germany

Past

February 1 & 2, 2017
G+Smo and parameterisation days Delft, The Netherlands

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Simulation modules

A novel isometric solver for inviscid compressible flows has been integrated into the open-source library G+Smo. The solver is able to handle geometries with curved boundaries and produces accurate, non-oscillatory approximations to flows with shock waves and solutions with steep gradients. A just-in time compilation framework has been implemented, which compiles device-independent compute kernels into hardware-optimised executables at run time. The core of the flow solver is realised with the newly developed open-source C++ library, which provides expression templates for the essential Fluid Dynamics Building Blocks.

Ship propellers

A free-form deformation (FFD) of a generic marine propeller surface was developed, balancing a large shape variability of the surface and small number of total degrees of freedom. Such a surface offers larger flexibility to describe the propeller blade and the deformable propeller surface can be directly employed to deform the calculation mesh. This mesh deformation technique can be used to use a stock propeller mesh, potentially shaving days of the calculation preparation.

Partner: JKU

The Institute of Applied Geometry at Johannes Kepler University Linz (JKU) performs research in Computer Aided Geometric Design, Isogeometric Analysis, Kinematics/Robotics and Computational Geometry. It was established in 2000. The Institute of Applied Geometry is one of several mathematical institutes at JKU, which form the Department of Mathematics. The department is one of the leading institutions in the field of Applied Mathematics in Austria.

In a close cooperation with other MOTOR partners, JKU develops the open source software library "Geometry + Simulation Modules" (G+Smo). The goal is to disseminate the G+Smo library as an attractive tool both for scientists and in the commercial sector by developing ready-to-use application examples for compressible and incompressible fluid flows, turbulent flows, structural mechanics, and fluid-structure interaction problems and offering advanced interactive visualization tools. G+Smo library is promoting to become a community-supported open-source toolkit and to bring the outcome of MOTOR effectively to the lead-users in industry and academia.

Partner: MTU

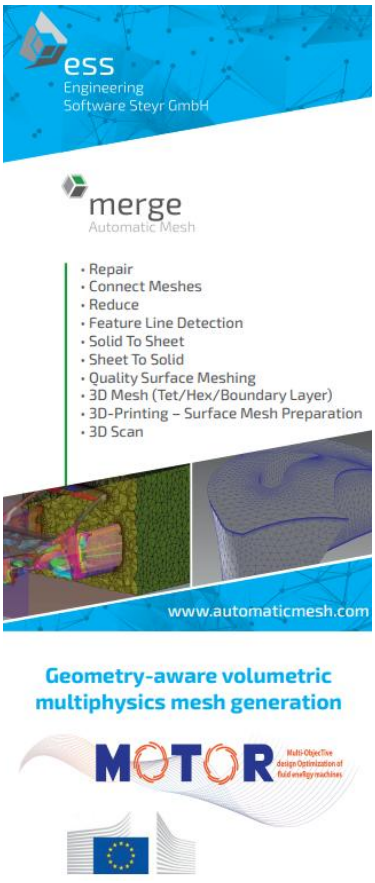
MTU Aero Engines is Germany's leading engine manufacturer and an established global player in the industry. The company engages in the design, development, manufacture, marketing and support of commercial and military aircraft engines and stationary gas turbines. Operating affiliates all over the world, MTU has a local presence in major regions and markets.

MTU Maintenance is the world's largest independent provider of commercial engine MRO (maintenance, repair and overhaul) services in terms of sales. The primary focus is on providing support for engines in which MTU is a risk- and revenue-sharing partner.

MTU's technology portfolio comprises some 150 projects. The high degree of networking with industrial partners, universities and research establishments and sustained funding by the public sector are decisive prerequisites for the successful development of new technologies.

Partner: ESS

ESS Engineering Software Steyr GmbH a simulation software developing company and known for its paint shop simulation software ALSIM and automatic meshing tool MERGE exhibited at the biggest automotive conference in the world the SAE world conference in Detroit (booth 3708) from 4th – 6th April 2017 (see rollup above). The pre-processing software MERGE gained new capabilities like tet-meshing, hex-meshing and boundary layers meshing, which can be applied to the triangulated surface mesh inside and outside in a conforming way. This is only possible, since in previous steps MERGE performed data cleaning and remesh of the surface.



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