EUREKA COA-CFD

Cloud-based Online Access to Computational Fluid Dynamic Simulations

Programm / Ausschreibung	IWI 24/26, IWI 24/26, Basisprogramm Ausschreibung 2024	**Status**	abgeschlossen
Projektstart	01.03.2024	**Projektende**	28.02.2025
Zeitraum	2024 - 2025	**Projektlaufzeit**	12 Monate
Keywords			

Projektbeschreibung

CFD-Simulationen werden bei der Entwicklung neuer mechanischer Teile in der Automobil-, Luft- und Raumfahrt- und Militärindustrie eingesetzt, um die Effizienz zu steigern. CFD-basierte Experimente sind im Vergleich zu konventionellen Methoden kostengünstig und können Eigenschaften abschätzen, die nicht empirisch gemessen werden können. Engineering Software Steyr GmbH (ESS) ist ein Innovator auf dem Gebiet der CFD-Simulationen und hat neue CFD-Fähigkeiten (partikelbasierte Methoden) in Form von vier neuen Solvern entwickelt und diese hybridisiert, um die Benutzerfreundlichkeit zu erhöhen. CFD-Simulationen erfordern großes Fachwissen, das kleinen und mittleren Unternehmen (KMU) oft nicht zur Verfügung steht. Dies schränkt ihre Wettbewerbsfähigkeit als Anbieter für die verarbeitende Industrie ein. Das Ziel des Konsortiums COA-CFD (Cloud-based Online Access to Computational Fluid Dynamic Simulations) ist die Demokratisierung von CFD-Simulationen bei gleichzeitiger Förderung modernster IKT-Fähigkeiten. Dies wird die Nutzung durch Nicht-Experten ermöglichen und das Feld für ein breiteres Publikum und breitere Märkte öffnen. Die Demokratisierung wird durch die Hybridisierung verschiedener Solver und durch die Verbesserung der Schnittstelle zur menschlichen Interaktion erreicht. Dies wird eine On-Demand-Cloud-Lösung ermöglichen. Darüber hinaus wird die Universität Kaiserslautern (TUK) ein Framework zur Designoptimierung in die Lösung integrieren, um eine noch bessere Benutzererfahrung zu ermöglichen. Scientific Solutions Systems (SSS) und IONOS werden die GAIA-X1-konforme Cloud-Hardware-Basis und Konfigurationsmechanismen entwickeln und aufbauen, um eine nahtlose Bereitstellung von Software-Plattformen zu ermöglichen, die hohen Arbeitslasten standhalten. Es werden Algorithmen des maschinellen Lernens entwickelt, um die geplante Auslastung der Cloud-Ressourcen vor der Aktivierung von Simulationen vorherzusagen und so die Fähigkeit zur Planung und Zuweisung von Ressourcen für anspruchsvolle Aufgaben in einer dezentralen Cloud-Umgebung voranzutreiben.COA-CFD umfasst die Demonstration spezifischer Anwendungsfälle, um die Plattform in realen Szenarien auf den eCargo-Fahrrädern von Citkar (CIT) und Top-Coating-Anwendungen auf Fahrzeugen von AUDI zu testen, die von MYB Mühendislik Yazilim A.S. (MYB) entwickelt wurden.

Endberichtkurzfassung

In the project year 2024-2025, ESS has worked with all partners on the management and implementation of the project work, the project progresses well and is aligned with the initial work plan.

Successful management . We continue working on building a consortium with a cooperative spirit, capability, motivation, and hard work. Together, the consortium managed the project financially and organizationally, and the frequent communication, discussions, and problem-solving ensured the smooth implementation of the project work and guaranteed good progress. The consortium also successfully prepared the mid-term review from EU and we achieved a very good feedback.

Improved solver capability . All the individual solvers were enhanced in terms of usability, efficiency, and accuracy. Planned functionalities were added. The hybrid solver was preliminarily ready for customization for different industrial problems. Besides, the design optimization of the solutions reached a higher maturity level. An algorithm to design the painting path and reduce the degrees of freedom in robotic operations was developed based on geometrical principles and physical needs, which gives rise to a uniform paint flow rate onto the surface regardless of the surface geometry. The target functions and customer parameter ranges are determined, and the RoDeO library was integrated into the coating process. With the work from the last project year, the solvers are ready to be tested and customized for complex industrial and engineering applications, such as the applications from the use cases.

Improved testing and GUI development process . An integrated process for automatic solver testing was developed based on self-developed python scripts, and GitLab flow controller, which includes automatic version control and check, code security check, unit tests, functional tests, and automatic deployment. The functional tests are designed with reference data from analytical or experimental solutions, which guarantee the correctness of the code. With this process the solver testing is much simpler and rigorous. Furthermore, the first version of Module GUI creator is finished and is under testing.

Brandnew cloud frontend. In the last year, we have continued improving the backend of the cloud to enhance its security, stability, and efficiency. However, the most important work is the redesign and re-development of the frontend. The frontend is based on new UI/UX design with much modern concepts considering the user preferences. All the related part, like the resource management and online simulation workflow are reworked to be compatible with the new frontend.

Top coating application . The development of the hybrid solver was finished and customized for the top coating simulation. The top coating solver can be used to simulate complex industrial cases. Numerical simulations were performed to help the design of the new suction atomizer from the project partners, design improvements were suggested.

Wind farm application . The interface to include topological and meteorological data of wind farms were developed in the LBM solver, which are used as solid boundary condition and time-dependent inlet boundary condition. The LBM solver was enhanced to include the functionality to calculate turbulence intensity. The needs for GUI development and user preferences were discussed with partners and the design requirements were fixed. The workflow of wind farm simulation was investigated with the partners and determined.

Chemical reactor application . The theory and formulation of diffusion-advection flow were developed and implemented in the LBM solver, which can simulate complex flows with multiple solutes. New mixture theory based model is developed to model complex flows in porous media, which is the key physics of the flow in catalyst granular bed. A reactor model is obtained from the partner and the numerical model was established

In general, the development work followed the initial project plans. We have stepped closer to the goal of a cloud-based CFD framework for various industrial and engineering applications.

Projektpartner

- ESS Engineering Software Steyr GmbH