

DEVELOPMENT OF A WEB-BASED OPEN SOURCE CAE PLATFORM FOR SIMULATION OF IC ENGINES

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ABSTRACT—Computer Aided Engineering (CAE) software has become an essential element in design, simulation, manufacturing and even marketing in the automotive industry as well as in other major manufacturing companies. Multi-physics simulation of IC engines may be one of the most challenging areas both technically and scientifically, since it requires sound basis and experience for diverse physical phenomena. There are quite a few commercial softwares currently available for various elements of CAE, which require substantial investment cost for licensing, personnel and computing facilities. There is a current consensus for the need of low cost CAE based on open sources through which professionals may contribute to new modeling features and validation through a free access web-based platform. There are several high quality open sources available under General Public Licence (GNU-GPL) which allow free utilization and development. Some of them have features as competitive as their commercial counterparts, whereas their interface in general may not be as user-friendly as most commercial software. In this work, we introduce a web-based platform with selected open source programs and their performance will be shown for some example cases. All these programs are downloadable, while remote job access and post-processing can be performed by cloud computing facilities.

KEY WORDS : Open source, CAE, CFD, FEA, Multi-physics, Web-based platform, OpenFOAM, Code_Aster

1. INTRODUCTION

The needs for computer simulation have increased substantially in the 2000s with development of manufacturing industries, computer aided engineering and low cost cloud computing capabilities. There are many excellent commercial CAE softwares, e. g. ANSYS Fluent (2019), ANSYS CFX (2019), ABAQUS (2019), which involve the limitations of high licensing cost and closed program structure with hidden source programs. The era of the fourth industrial revolution involves combination of the online and offline spaces for a more efficient process from design to manufacturing, marketing and customer support. One of major constraints for small and medium-sized enterprises may be the substantial investment cost required for software licencing, trained personnel and supercomputing facilities. In diverse disciplines, there have been a recent paradigm shift from licenced softwares to open source programs which allow more efficient cooperation and development, e.g. Linux operating system and machine learning programs in artificial intelligence. There are an increasing number of open sources currently available with continued development and support by active user community around the world, such as OpenFOAM (2019), SU2 (2019) and REEF3D (2019) in Computational Fluid Dynamics (CFD) analysis and

Code_Aster & SALOME-MECA (2019), Calculix (2019) and CAELinux (2019) in finite element analysis. FreeCAD (2019) and OpenSCAD (2019) are well-known open source Computer Aided Design (CAD) programs. OpenFOAM was written in object-oriented C++ and distributed as open source CFD software in 2004. SU2 was also written in C++ and developed as a CFD tool specialized in aerodynamics with the features of potential flow, electrodynamics and chemical reacting flow. REEF3D is an open source hydrodynamics tool based on finite difference method (FDM). Code_Aster described in Chapter 2 is an open source tool in computational solid dynamics based on finite element method (FEM). Calculix is also based on FEM and can perform static, dynamic and thermal calculations. FreeCAD is an open source 3D CAD software in a multi-platform format and described in detail in Chapter 2. OpenSCAD can use script files to create CAD files for solid 3D structure. These open source programs are free, and usually subject to the GNU General Public License (2019) imposing responsibility to release the sources open for continued free access and development in the society. Most open sources maintain the organized modular structure and are available through the Linux operating system. It is, therefore, relatively straightforward to modify the existing program or to combine a new routine with modular open sources with good scalability. However, there is a need for improving the Linux-based, TUI (Text-based User Interface) systems

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