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# Finite Element Analysis & Augmented Reality based Mechanical Product Simulation Platform for Small-Medium sized Enterprise Industry

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**Abstract.** In this paper, we propose finite element analysis (FEA) & augmented reality (AR) based mechanical product simulation platform which provide two or more SME(Small Medium-sized Enterprise) and customers working together to achieve engineering product design goal. The main structure of the platform and the simulation process between each application modules are proposed. The challenges for implementing platform for SMEs were discussed. Moreover, integration with a kind of FEA and AR simulation method is presented.

**Keywords:** High performance computer, Small-and medium-sized enterprise (SME), Finite Element Analysis, Augmented reality

## 1 Introduction

Manufacturing industry has been playing a central role in the economic development of South Korea. According to Delloite's report, manufacturing industry of South Korea shares 30% of GDP and it's manufacturing competitiveness index ranked 5th in 2013. South Korean manufacturing companies have grown rapidly in the past decade, but productivity gains and overseas expansion have made it "jobless growth". The employment and job creation of South Korea have shifted from the manufacturing sector to the service sector after 1990s [1].

Modeling and simulation of digital products are essential to test their functionalities and characteristics, which can result in higher stability, better maintainability, and less potential errors of the products before manufacturing. To overcome the global economy crisis, SME industries must take a revolutionary step and look for modeling and simulation modern technologies.

(AR) is considered to be an excellent user interface for various applications such as face-to-face collaboration [2], ubiquitous car service [3], manufacturing planning [4], and e-learning [5]. Interactions with these entities occur in real-time providing convincing feedback to the user and giving the impression of natural interaction. Thus, AR is considered to complement virtual reality by providing a natural and intuitive interface to a three-dimensional information space embedded within physical reality

The finite element method divides the solution domain of complex geometric shapes into simply shaped regions or elements [6]. It is a method of computational

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technique for the numerical solution of engineering problems such as elasticity analysis, heat transfer [7]. Much commercial finite element software is available to be used in the diversified field of engineering discipline.

CODE_ASTER on Linux [8] is one of them, which can perform the elasticity, fatigue, crack, heat transfer analysis using a Multiple Processing Unit (MPU). It is not provide fancy tool, colorful post-processing to simulation. Several tools can be used to create a mesh and to visualize the results, as far as an import/export module exists in Code_Aster. But recently researches have not integrated AR post processing.

The intensifying focus on product quality also create demand for expand IT capacity, as hundreds of simulations may be required to predict product performance and expectation over the full range of expected real world operation. To meet these requirements, FEA and AR Solution is a critical component of an effective IT environment for simulation.

Despite the importance of computer simulation in engineering product design, software programs have two main problems in SMEs's application –difficult user interface, and lack of reality visualization method. The programs are too complex and heavy for novice and casual users such as industry worker to learn and use for their purpose. In addition, the role of other stakeholders must review design model and analysis results to verify and improve quality of products in augmented reality environment.

In this paper, we propose a FEA & AR based mechanical product simulation platform for small-medium sized enterprise industry. The proposed approach provides web based FEA simulation environment and AR based post visualization. The remainder of the paper is organized as follows. Section 2 explains proposed service platform. Section 3 explains an implementation case. Finally Section 4 concludes with some remarks.

## 2 Finite Element Analysis & Augmented Reality based Mechanical Product Simulation Platform

The proposed framework can be divided into six layers as shown in Fig.1. A user service process can be represented vertical line as shown in Fig.2 user can easily and use FEA service using web based interface and naturally verify analysis result in AR environment.

**2.1 Supercomputer Resource Layer**. Supercomputer Resource Layer manages the job monitor and job scheduler.

**2.2 Engine Layer.** The division of the engines adheres to the principle of high cohesion inside the engines and low coupling between the engines, as well as the characteristics of the FEM service platform in order to provide convenient integrated support with the method of service set for the upper layer

**3.3 Business Service Process Model Layer.** It is a business process definition layer oriented to the business requirements of the users. So the users can call different service modules to response to different business requirements.

**3.4 Web User Interface Layer.** It provides the user visiting and browsing service interactive web interfaces, and use FEAs service of user's requirements. It is the platform of the information exchange between the users and systems.

**3.5. AR Post Processing Layer.** The AR post user interface layer support tracking of marker. The result is used for natural visualization with digital engineering products analysis in natural marker such as dawning cad paper, photo, and image.

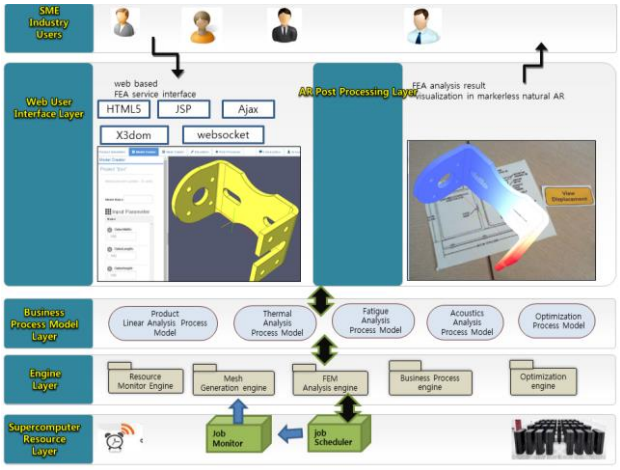


**Fig. 1.** Proposed Finite Element Analysis & Augmented Reality based Mechanical Product Simulation Platform

The proposed approach takes the following step: (1) connect web based FEA service interface, (2) uploading product CAD model, (3) rendering CAD Model in web environment, (4) generating mesh, (5) creating boundary condition by web interface,(5) solve model, (6) convert analysis result to augmented reality data model, (7) rendering analysis result in augmented reality environment

 

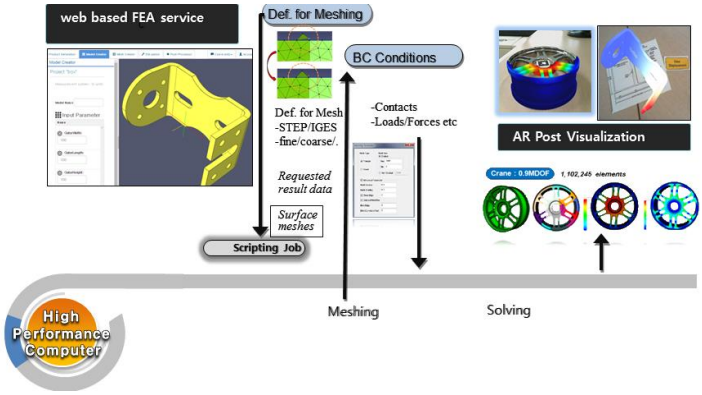


**Fig. 2**. Proposed Finite Element Analysis & Augmented Reality based Mechanical Product Simulation Process

## 4 Conclusions

A Finite Element Analysis & Augmented Reality based Mechanical Product Simulation Platform has been presented for simulation. Our propose system utilizes the FEA, AR technic to provide simulation service according to the SME customer's demand. For future work, we are currently enhancing the platform to deal with a variety of product engineering design and simulation sharing through platform service among multiple SME users.

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