High-Fidelity Simulation of Landing Gear Noise

Name: Suraj suresh shetiya

UTA ID: 1001236144

People involved in the project: Mehdi R. Khorrami, Ph.D. , Patrick J. Moran, Ph.D.

The maximum noise generated by an aircraft is either during takeoff or during landing, which causes disturbance and inconvenience to any facility located in and around the aerodrome. This noise is associated to something known as “Landing Gear Noise” i.e. the noise generated due to airflow resistance around the landing gear. Since the invention of aircraft, this issue persists and has got little or no success or resource allocation due to high cost and inefficient systems availability. Coming to present day, the development in computer process and integration of computer process to solve complex mechanical (Mathematical and physical diagram) problems has become easy and cost effective as well as less time consuming. Super computer Pleiades, the 11th fastest super computer (as of June 2015[1]), is currently being used to solve landing gear noise problem as it is very complex in nature due to the intricate size and shape of the different parts of the aircraft and the wide range of noises produced by different parts. This involves enormous amount of computations and is multidisciplinary in nature, ranging across computational fluid dynamics (CFD) to visualization of computational model.

Computational fluid dynamics (CFD), which means using computer simulation to understand fluid dynamics, uses algorithms and numerical methods for analyzing fluid flows. CFD generates better results when run on faster computing platforms such as super computer. The problem of landing gear noise was solved using CFD solver FUN3D [2]. FUN3D was written in the 1980s for analyzing the algorithms of that time and to design new algorithms in unstructured-grid fluid dynamic simulations. Scientists at NASA are utilizing FUN3D in order to simulate the complex flow around Gulfstream G550 landing gear. Such simulations are essential to

- Generate details about noises and their sources
- Assist in creating noise source models which are physics-based
- Improve capabilities in predicting noises from airframe
- Helps in developing and evaluating concepts which help in noise reduction

Super computer Pleiades took two weeks of uninterrupted computing to solve the problem of landing gear noise using the FUN3D solver [3].

The model used in solving this problem makes use of finite element method (FEM) in order to solve the problem. In this method the problem is subdivided into elements, smaller parts of the entire system. The error function is then minimized in order to solve entire problem. The parts can be increased or decreased in order to vary the accuracy of the result. Different modeling methods can be used in order to solve various CFD problems. FUN3D solver makes use of Lattice Boltzmann methods (LBM) [4] in order to solve the landing gear noise problem. The LBM has been efficiently designed to work on parallel architectures.

FUN3D solver makes use of volume mesh in order to compute the flow of air around the airplane. The mesh has been subdivided into 400 million cells. Multiple iterations are performed on the model in order to check for the amount of noise generated in different scenarios. For each of the iterations performed on the G550 landing gear system, Pleiades must perform 680 billion floating-point operations over the entire volume grid. Time spectrum should be advanced in small steps in order to obtain the high frequency components of the noise spectrum while the low frequency components need tens of thousands of iterations. Pleiades has completed coarse and medium resolution simulations of the CFD model and has been deployed in repeating the iterations on a finer resolution grid.

References:

[1] http://www.top500.org/system/177259
[2] http://fun3d.larc.nasa.gov/
[3]http://www.e-ditionsbyfry.com/Olive/ODE/SCISupp/LandingPage/LandingPage.aspx?href=U0NJLzIwMTEvMDQvMDE.&pageno=MTg.&entity=QXIwMTgwMA..&view=ZW50aXR5
[4] http://www.nas.nasa.gov/SC14/demos/demo16.html