Finite Element Method based Triangular Mesh Generation for Aircraft-Lightning Interaction Simulation

K.Vinotha, S.Thirukumaran[1]

[a]*Department of Physical Science, Vavuniya Campus of the University of Jaffna, Vavuniya, Sri Lanka*

Lightning is a natural electrical discharge process. Most common lightning strike is Cloud-to-Ground. It occurs when the negative charges accumulated at the bottom of the thundercloud traverse towards the ground to neutralize its charges with the positive earth charges induced due to the thundercloud and electrons travels along the lightning channel. The statistics shows that the commercial aircrafts directly struck by lightning strikes that are under the thundercloud once a year on average. The study of electromagnetic threat due to lightning strikes is important for flight safety and restructuring the aircraft design to mitigate direct lightning effects on the physical material of the aircraft causing damages and indirect effects on the navigation systems in it.The prime objective of this paper is to find the electric field distribution around the aircraft conductor in free space conditions under lightning scenario. For the simulation, the flash of the cloud-to-ground lightning is represented as a wave equation. Finite element method is applied to solve the wave equation for identifying potential distribution and exclusively to electric field calculations. Each of the triangular finite elements are considered and the potential at any nodes within a typical element are obtained. The equation $E = -\nabla V$ represents the relationship between electric potential and electric field which is used to determine the electric field distribution around the aircraft surface by a numerical derivative evaluation technique from the electric potential distribution already obtained. This paper presents an aircraft-lightning interaction simulation under the thundercloud and above the ground by generating two dimensional triangular mesh using finite element method. Significant electric field distribution is observed at the sharp end points of the aircraft. Due to higher radiated electric field, the aircraft-lightning interaction may result in an adverse impact on the aircraft navigation systems and cause damage to its structures. The simulation results would be very useful for studying lightning impact on the aerial vehicles struck by the cloud-to-ground lightning. During the simulation, it was assumed that an aircraft surface is a good conductor and the effects of material properties are left for future studies.

Keywords: Finite Element Method; Aircraft-Lightning Interaction; Triangular Mesh Generation

[1] Corresponding author: S. Thirukumaran; Tel.: +94-77-757-0208
E-mail address: thiruvks@gmail.com