URSI AP-RASC 2019, New Delhi, India, 09 - 15 March 2019

Electromagnetic Scattering analysis due to a colliding system using Quasi Stationary - Finite Difference Time Domain Method

Babu Linkoon P Meenaketan* (1), Srikanta Pal (2), and Neela Chattoraj (3)
Birla Institute of Technology, Mesra, Ranchi, India
(1)linkon1987@gmail.com, (2)pal_srikanta@yahoo.co.uk, (3)nchattoraj@bitmesra.ac.in

The objective of this paper is to present an analytical and computational technique for the electromagnetic scattering analysis due to a colliding system. A needed inverse technique is also provided to find out the targets' spatial definition and time of the collision from the scattered field data.

A Quasi-stationary based Finite Difference Time domain (QS-FDTD) method is used to simulate the forward scattering phenomenon due to a dynamic system, where two objects are under the action of the collision. This technique is used to introduce multiple moving non-perfectly electrical conductor (signal penetrable) objects in a single computational platform, which is not possible using currently developed relativistic boundary condition base FDTD technique or Lorentz transformation based technique[1-2]. In this QS-FDTD technique, the future electric and magnetic fields are computed with instantaneous dielectric properties of the computational platform and keeping the update parameters constant for the same FDTD time iteration.

A Centre of momentum frame (COMF) is used to integrate the dynamic environment with QS-FDTD. The COMF is a unique centre of mass (COM) frame where the net momentum of the collision system vanishes and COM is always in rest in COMF. This approach helps to simulate scattering analysis owing to all possible types of head-on collision in a single computational arrangement such as elastic, non-elastic and superelastic collision. Even if in the case of very high velocities this technique works where Newtonian mechanism fails.

Due to the presence of multiple boundaries in the collision platform, the electromagnetic signal sufferers from higher order reflection. A mathematical model is provided in the frequency domain with a sinusoidal excitation to calculate all possible Doppler shift due to these moving boundaries. Which also help us to find out the pre and post-collision velocities of the moving targets. A time domain mathematical model with an impulse excitation is also presented to find out the targets' dimension and exact collision time. These mathematical analyses also help us to validate our purposed computational model.

1. F. Harfoush, A. Taflove, and G. A. Kriegsmann, "A Numerical Technique for Analyzing Electromagnetic Wave Scattering from Moving Surfaces in One and Two Dimensions," IEEE Trans. Antennas Propag., 37, 1, pp. 55–63, 1989,doi: 10.1109/8.192164

2. B. L. Michielsen, G. C. Herman, A. T. de Hoop, and D. de Zutter, "Three‐dimensional relativistic scattering of electromagnetic waves by an object in uniform translational motion," J. Math. Phys., 22, 11, pp. 2716–2722, 1981, doi: 10.1063/1.524853