The Scattering of Electromagnetic Waves from Walking Man Body Sectors by Using FDTD

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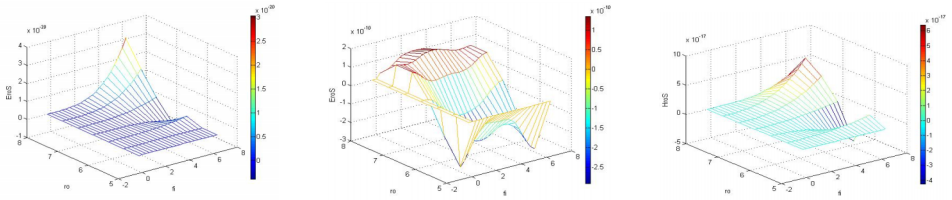
In this work, the scattering of circularly cylindrical symmetric electromagnetic waves from moving biological objects is calculated by using the finite difference time domain (FDTD) method. The identification of walking, running, and etc. human is addressed for defense purposes. Therefore, the moving object is determined as the legs and body of human as an initial approach. The movement of the moving object can be considered by calculating the electromagnetic waves scattering from the object. The criteria that cell dimensions should obey and the Courant stability condition in the determination of the time steps are provided to satisfy the uniqueness of the solution. Three cylinders model the moving object and the movement equations for these cylinders are obtained. Magnetic dipole antenna is chosen as the transmitter antenna, which is appropriate for the problem space configuration. Due to the cylindrical shape of the moving object, the equations for the incident wave are written in circularly cylindrical coordinate system. For the use of FDTD method, the equations of incident field and the movement equations for the surface of the object are transformed to the separate forms. Three different movement models those are described as normal, suspicious, and anxious behaviors of walking man are studied. The results and graphics of the scattered field for both human moving with constant velocity and with varying velocities are obtained separately.

This project is a work, which is developed with extending the details related to the modeling processes of a previous work studying on the scattering of electromagnetic waves from moving objects. The moving object is a suitably modeled walking body. The purpose is about the detecting of behavior of people for some security or defense aims by using an electromagnetically sensing algorithm. Such goals are realizable if some analytical or computational results are available for electromagnetic wave scattering from moving human body. The reason is due to the necessity of some critical data, which fit the movement of human to figure the behavior of body out in targeted region. For this purpose, the scattering of circularly cylindrical symmetric electromagnetic waves from moving body models is considered and solved with the FDTD method. The above mentioned previous work studied on solving the analytical difficulties coming with the walking processes, only; therefore, a pair of walking strait leg, like rigid steps, where both legs are on the same straight line as used in some military or social ceremonies. This paper extends the walking mechanism to a pair of walking straight leg, where each leg is on different straight paths. Beside, hip mechanism is added. Involving the chest, abdomen and waist extends the model body of the previous work. The time domain scattered field from moving target modeled in a form similar to the walking human is considered in cylindrical coordinate system. Human legs are chosen to be the moving object and modeled with two finite cylinders. The expressions for the movement of this object are obtained by using the FDTD method. The solution of direct scattering problem is given by graphics. Some results are in Figure 1.



(a) (b) (c)

Figure 1. Variations of the magnitude of scattered field versus ρ and ϕ: (a) E_ρ at z=7 and t=10 (b) E_ρ at z=4 and t=5 (c) H_ρ at z=7 and t=10. The movement is normal at a and c and anxious at b.