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Finite Difference Time Domain simulation of Active cancellation of Radar echoes

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Abstract

Radar evasion or Stealth is a technology most desirable among all the military research areas currently pursued. Research organisations have focused their attention on electronic stealth technology or cancellation of waves since it is feasible now due to the improvement of high end processing and fast electronic systems. In an attempt to increase our understanding of this field, we have analysed the phenomenon through computer aided simulation. In this paper, we have created an electromagnetic wave simulation platform and using finite difference time domain method, analysed a method of active cancellation. We have found results showing complete effectiveness of this method assured by the accuracy of FDTD method.

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*Keywords:*FDTF, Active cancellation, Antenna, Microwave

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1. Introduction:

There are four ways to make a target invisible to radar. First one is to shape the target in such a way so that all the incident waves are reflected any other way but back towards the radar [1-7]. Second one is to use materials that can absorb all of the electromagnetic waves that it would reflect otherwise. Third and fourth are active and passive cancellations where one superimposes on the reflected wave a similar wave but opposite phase so that they get cancelled out due to the phenomenon of superimposition of waves. Active cancellation is done for active radars that project electromagnetic pulses towards the targets and wait for the echo. Achieving a total cancellation can make it possible to turn any object irrespective of its shape and composition, invisible to radar. Therefore, we recognize it as a work of high importance and choose to test the phenomenon using the FDTD method to ensure as well as demonstrate that it works.

It S(t) is the signal reflected after from an object surface being projected by the radar and C(t) is the cancelation wave superimposed on the signal then according to the theory of superposition, the resultant wave:

$$R(t) = S(t) + C(t)$$

If the superimposed wave $C(t) = -S(t)$,

Then the resultant wave, $R(t) = 0$, which means that no wave will be reflected back

Finite difference time domain method is a solving method for simulating electrodynamic systems that construct a motion picture or animation of electromagnetic waves by solving Maxwell's equation in time domain. In FDTD method, values of electric and magnetic field intensities are calculated at each point in space and time. This is why it gives a high degree of accuracy in analysis of transient phenomenon compared to methods that solves infrequency domain. Furthermore, solutions given by FDTD are valid and accurate for a very wide range of frequencies. It can be used to find impulse response just by giving an impulse as an input. Presently FDTD is popular as a solving method in the domain of electromagnetic simulations which includes popular simulation tools e.g. FEKO, CST Microwave Studio and OptiFDTD to mention a few of those famous. Therefore tool to demonstrate the phenomenon of cancelation of radar echoes from the surface of a target.

transmitted wave.

2. Results:

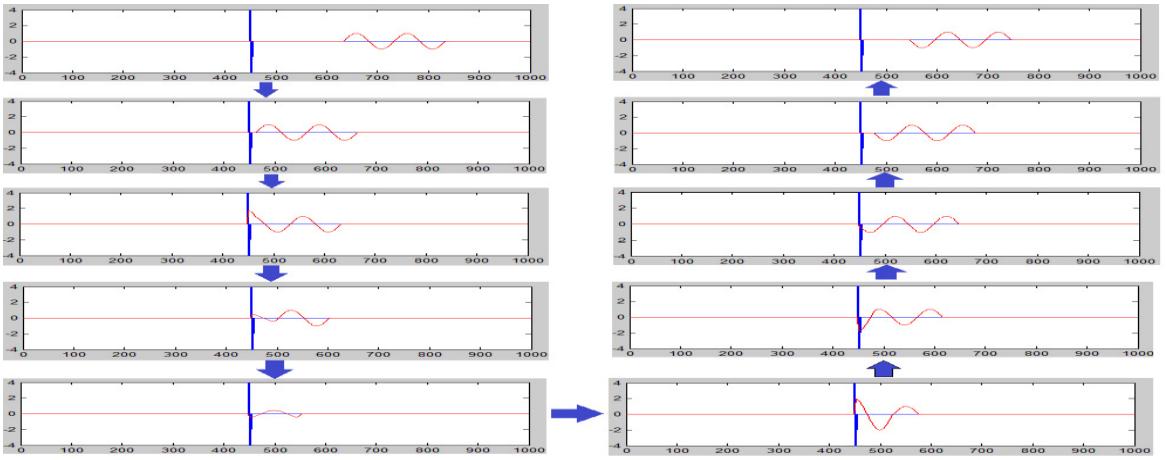

Fig. 5. (a)Sequential one dimensional simulation output of a wave hitting a plain reflector

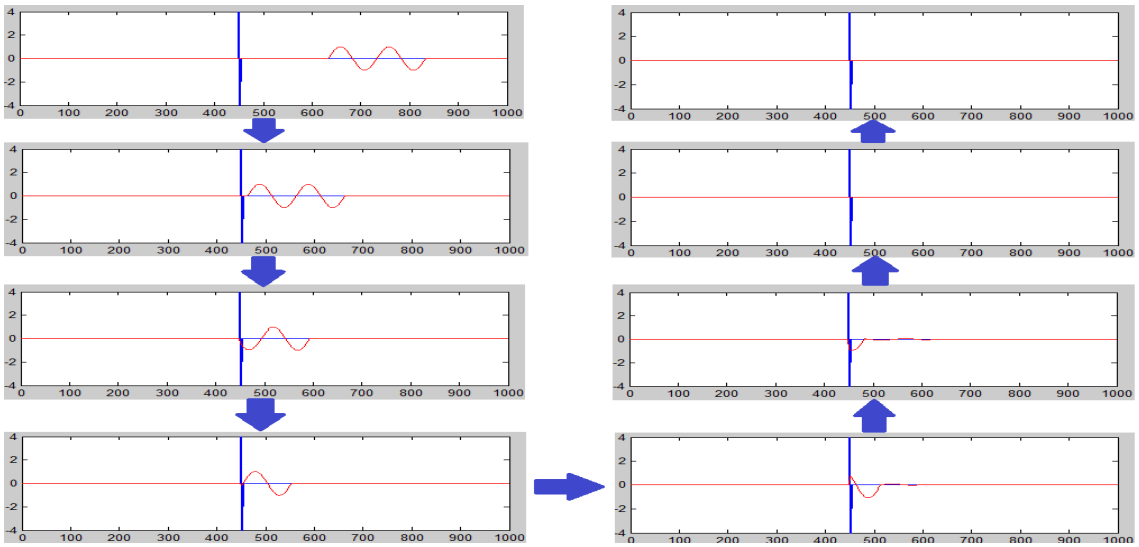

Fig. 5. (b)Sequential one dimensional simulation output of a wave hitting a plain reflector and an active cancellation source

Three dimentional simumuation results of plane waves inciedent on a reflector with active cancellation source is shown in the figure below at different stages.

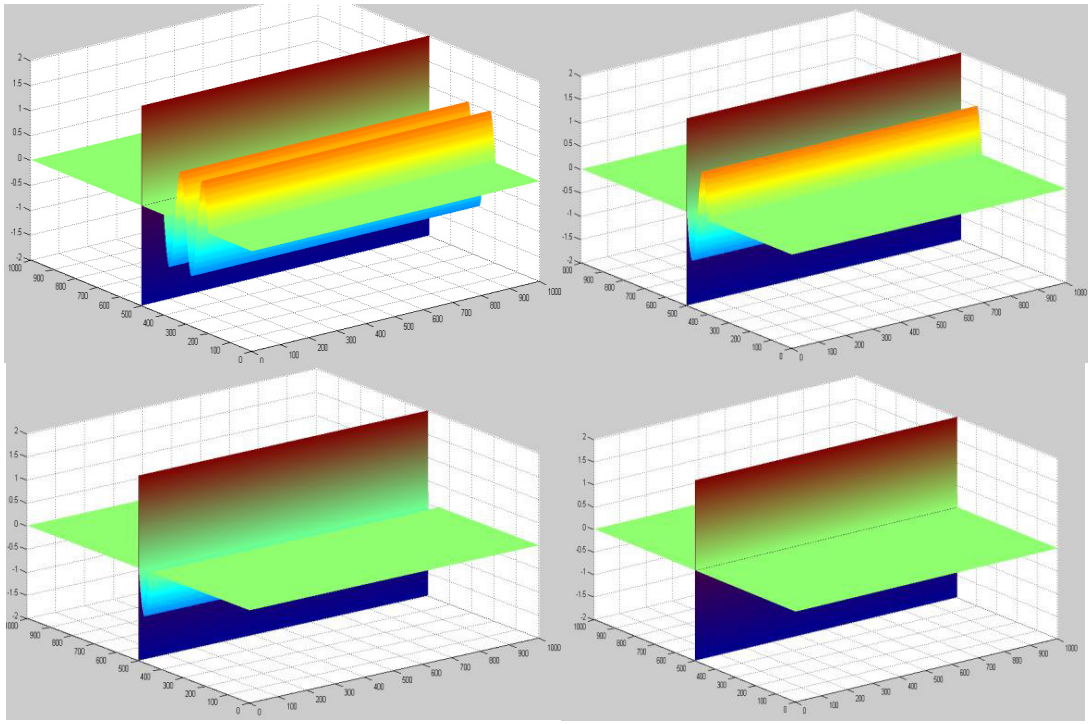

Fig. 5. (a) Simulation output at iteration no. 380; (b) simulation output at iteration no. 450.;
(c) Simulation output at iteration no. 500 ;(d)Simulation output at iteration no. 600

3. Conclusion:

The FDTD simulation platform showed behavior in complete analogy with the real world behavior of electromagnetic waves. We are able to create and alter properties of the materials or senarios to be simulated.

We have simulated a senario in which an electromagnetic wave is inciedent to a reflecting surface. The results were similar to what we witness in a similar physical inciedent. Now we have implemented situations where a cancel wave is created and superimposed on the reflecting wave. After runing the simulations, we have observed that the wave is cancelled and there is no energy reflected.

Therefore, we have reasons to believe that active cancellation works and if it is implemented in any target perfectly, it will not be detected by a Radar

Reffenerces:

1. M. Ho, J. M. Cioffi, and J. A. C. Bingham, "Discrete multi-tone echo cancellation," IEEE Transactions on Communications,1996, vol. 44. no.7, pp. 817-825.
2.K. S. Yee ,"Numerical solution of initial boundary value problems involving Maxwell\'s equations in isotropic media", *IEEE Trans. Antennas Propagation , vol. AP-14, no. 5, pp. 302-307, 1966*
3. A. Taflove , Computational Electrodynamics: The Finite-Difference Time-Domain Method*1996, Artech House*
4. X. Guo, H. B. Sun, and T. S. Yeo, "Interference cancellation for highfrequency surface wave radar," IEEE Transactions on Geosciences and Remoter Sensing, 2008, vol. 46, no.7, pp. 1879-1892.
5. G. Sun and C. W. Trueman "Some fundamental characteristics of the one-dimensional alternate-direction-implicit finite-difference time-domain method"*IEEE Trans. Microw. Theory Tech., vol. 52, no. 1, pp. 46-52, 2004*
6. J. Chen and J. Wang "A 3-D hybrid implicit–explicit FDTD scheme with weakly conditional stability" *Microw. Opt. Tech. Lett., vol. 48, pp. 2291-2294, 2006*
7.Letao Xu; Dejun Feng; Yongcai Liu; Xiaoyi Pan; Xuesong Wang,A Three-Stage ActiveCancellation Method Against Synthetic Aperture RadarSensors Journal, IEEE,Volume: 15, Issue: 11