Target Detection Using Ultrawide-band Time Reversal Techniques with Multilayer Dielectric Slabs

Tien-Hao Liao, Po-Chuan Hsieh, and Fu-Chiarng Chen*
Department of Communication Engineering
National Chiao Tung University
1001 Tahsueh Rd., Hsinchu 300 Taiwan
TEL: +886-3-571-2121 ext. 54562, Fax: +886-3-571-0116,
E-mail: i4u999ncku@yahoo.com.tw, fchen@mail.nctu.edu.tw*

Time reversal techniques had been utilized by Fink in acoustics, and can be extended to electromagnetic field. In a homogeneous medium (channel), an array of transducers receives the signal emitted by a localized source, time reverses and re-emits it into the channel. The re-emitted wave is inclined to focus near the original localized source location. The refocusing phenomenon in a homogeneous channel using broadband signals can help reduce spurious Fresnel zones.

It is proved that in a multiple scattering environment, time reversal techniques can provide a more complex channel behavior and can be used to detect targets with improved performance beyond the diffraction limit of the original homogeneous channel. Therefore, how to effectively make use of the characteristic of multiple scattering is what we care about. In this paper, we simulate the target detection case with a new structure called a multilayer dielectric slab between transducers and targets to overcome the difficulty for precisely detecting targets. A multilayer dielectric slab is made up of many dielectric layers which have different relative dielectric constants. At the central part of the multilayer dielectric slab are the layers whose dielectric constants are equal to 2 or 3 iteratively. Both the upper and lower layers that are neighbor to the center slab will have dielectric constants equal to 3 or 4 iteratively. The rest dielectric constant distribution can be deduced by analogy, so the upper and lower edge of the dielectric slab will finally have the dielectric constants equal to 9 or 10 iteratively. Simulation results show that the structure of the dielectric slab can therefore improve resolution limit and hence reach the super-resolution phenomenon due to the multiple scattering effect the dielectric slab structure offers. The detail numerical simulation process and working principle will be discussed in further presentation.