Investigation of the Bragg Scattering of UWB Signal from the Window Blind: (1) Theoretical Investigation

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1 Introduction

In indoor and outdoor propagation environments, the non-specular scattering at the walls are often not negligible. Bragg scattering may not be negligibly small for the periodic walls such as brick walls, metallic shutters and blinds. In particular, its frequency dispersive property may influence the transmission property of the UWB system. This study investigates the Bragg scattering of the UWB signal from the window blind. Moreover, this paper discusses the range of the Bragg scattering theoretically for the experimental condition.

2 Bragg Scattering

Bragg's law defines a diffraction relationship between the wavelength of an incoming ray and the period of the periodic structure [1].

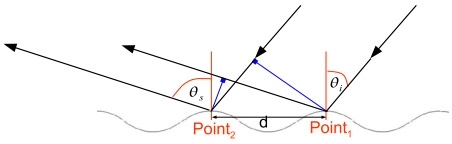

Figure 1 Bragg Scattering Illustration

Bragg scattering equation is expressed below:

$$\begin{aligned} n\lambda &= d\sin\theta_i - d\sin\theta_s \\ \theta_s &= \arcsin(\sin\theta_i - \frac{n\lambda}{d}) \end{aligned} \quad (1)$$

where n is the order of reflection, λ is the wavelength of the incident ray, d is the interplanar spacing, θ_i is the angle of incidence and θ_s is the angle of reflection

3 Experiment

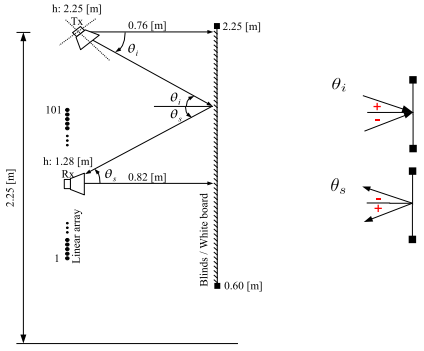

Figure 2 Experiment Setup

The measurement was performed within frequency range 3.1 to 10.6 [GHz] to determine the complex channel transfer function $H(f)$ where the transmitter(Tx) antenna was fixed and mounted on a pole, and the receiver(Rx) antenna was mounted on the arm of a scanner to perform as a virtual linear array antenna whose element spacing is 1 [cm] as shown in Figure 2.

4 Results and Discussions

From the experiment setup and blind spacing (d) of 2.1 [cm], the Tx and Rx positions bound the possible range of θ_i and θ_s to $0° \leq \theta_i \leq 65°$ and $-53° \leq \theta_s \leq 62°$, respectively. The simulation result is shown in the left-hand side of Figure 3, while the right-hand side shows the experimental results processed using beamforming and Hanning window function [2]. In the experimental results, there are 3 dominant regions in the angular frequency spectrum which are the specular reflection and Bragg scattering regions obviously observed in the theoretical model, and the LOS region.

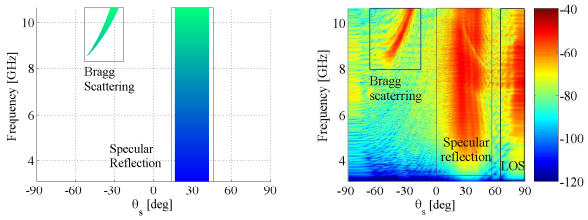

Figure 3 Theoretical model and Data Processing

5 Conclusion

This paper compares the simulated Bragg scattering with the indoor UWB measurement on window blinds. The data processing of results verify the theoretical Bragg scattering.

References

[1] M. Born, E. Wolf, "Scattering from inhomogenous media," in Principles of Optics - 7th (expanded) edition, Cambridge University Press.

[2] H. Tsuchiya, N. Lertsirisopon, M. Ghoraishi, J. Takada, and T. Kobayashi, "Investigation of the Bragg Scattering of UWB Signal from the Window Blind: (2) Experimental Investigation," 2006 IEICE General Conference, March 2006.