NRD Guide Pulse Radar for Range Finding of Multi-layered Targets at 60 GHz

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Research and development of radar front-ends have been undertaken for novel wireless sensing applications such as remote sensing systems, car warning radar systems and so forth (H. H. Meinel, IEEE Trans. Microwave Theory Tech., Vol. 43, No.7, 1995). From among the applications, the tank level estimation system is indispensable technology in manufacturing plants and the level sensing was evaluated at 5.8 GHz and 24 GHz (P. Gulden, M. Vossiek1, M. Pichler, and A. Stelzer, Proceedings of the 33th European Microwave Conference, 2003). From the viewpoint of multi-reflection environment in the tanks, millimeter waves are an attractive candidate as the radar frequencies because compact antennas with pencil beam patterns can be easily obtained. With this in mind, a pulse radar front-end was fabricated by using the NRD-guide technology at 60 GHz, and moreover, an FPGA-based digital signal processor including high-speed counting, memorizing, and averaging was developed. To improve range-finding errors, we applied the sequential sampling technique (N. C. Currie and C. E. Brown, "Principles and Applications of Millimeter-Wave Radar," Artech House, Inc., Norwood, MA, 1987) into the signal processor, and besides, we also improved the signal processor to detect the multi-layered targets in this paper.

Figure 1 shows a measurement setup of multi-layered targets, where a dielectric substrate (Duroid substrate) with a cross-sectional area of 30×30 cm^2 and a metal plate with a cross-sectional area of 80×90 cm^2 were located as targets #1 and #2 in a narrow corridor having a height of 3 m and a width of 2.6 m. Figures 2 shows the demodulated pulse waveforms, being observed to be 4 pulses, where the distance between the radar front-end and the target #1 was placed at 230 cm, while the distance between the radar front-end and target #2 was fixed at 350 cm. These pulses were inputted in the FPGA-based digital signal processor, and the distances of the targets #1 and #2 were estimated. The error of the range finding was successfully decreased to be within ± 8 cm

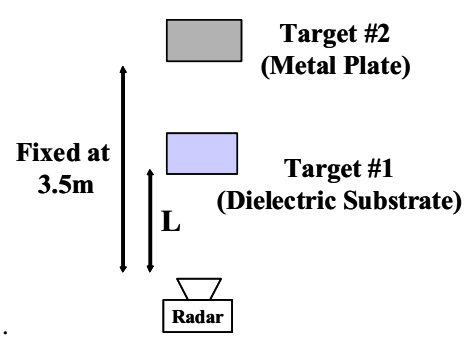

Fig. 1. Measurement setup of multi-targets.

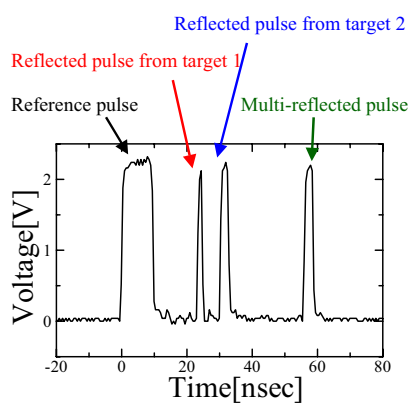

Fig. 2. Received pulse waveforms.