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Recommended Citation

Dumoulin, A. et al. (2012) Optimised Tapered-Slot Antenna for Real Time Location Systems. *Communications and Radio Sciences Research Colloquium 2012>/i>, Dublin, Ireland, Royal Irish Academy doi:10.21427/D7VG62*

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Optimised Tapered-Slot Antenna for Real Time Location Systems

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***Abstract*— The design of a directional UWB tapered slot antenna for use within an asset tracking system is reported. The spline-based geometry was refined with a local optimization algorithm and a square root raised cosine pulse. The time-domain performance of the antenna is dependent on the optimisation method.**

I. INTRODUCTION

Impulse radio Ultra Wide Band (IR-UWB) systems use very short pulses to achieve very broad bandwidth for low powered communications. The short pulses can also support UWB Real Time Location System (RTLS) for proximity ranging or localization, with centimetre precision, between pulse-emitting devices. In order to preserve the precision, a RTLS integrated antenna should not add dispersion to the pulses and an improved antenna optimization technique should take account of the time domain (TD) performance. An RTLS system can employ a directional antenna in a handheld sensor to query the locations asset tags antennas the within a room. The higher directivity is used to compensate for the lower efficiencies that can occur with smaller tag antennas mounted on assets.

A tapered-slot antenna is selected for the sensing antenna because of its directivity, ultra wide bandwidth and low-dispersion TD performance [1]. The research focused on a design to achieve optimized pulse fidelity on bore-sight in the receiving mode.

II. UWB TAPERED SLOT ANTENNA OPTIMISED FOR TIME DOMAIN PERFORMANCE

The tapered-slot antenna was fabricated on a 60 mm × 60 mm × 0.7 mm double copper clad FR4 PCB board as shown on Fig. 1. The substrate has a dielectric constant of 4.3 with a tangent delta of 0.025.

This geometry was chosen because the radiated elements are in the same plane, limiting the dispersion due to the potential polarization misalignment unlike an antipodal Vivaldi antenna [3].

The geometry consists of two mirrored 5 points spline shaped slots optimised through a Trust Region Framework (TRF) algorithm from the CST Microwave Studio package [4]. This local optimiser was selected, because of its high efficiency on refining geometries. Furthermore the antenna

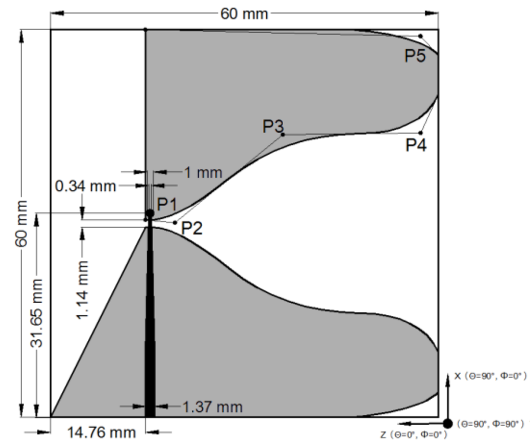

Figure 1. Tapered slot antenna optimised for time domain performance in receiving mode.

was optimized with a Square Root Raised Cosine (SRRC) pulse as excitation signal [2]. This pulse was chosen for its enhanced fit to UWB spectrum, as shown on Fig. 2. The dimensional constraints are defined in millimetres as follows:

- $P_1 (x) = 0 < x < 5$
- $P_{2,3,4,5} (x) = 0 < x < 30$
- $P_2 (z) = 2 < z < 12$
- $P_3 (z) = 12 < z < 40$
- $P_4 (z) = 20 < z < 47$
- $P_5 (z) = 10 < z < 47$

The post-processed weighted cost function using for the optimizer goal is shown on Eq. 1

$$Cost = -0.3 \times \frac{\Gamma}{\alpha} - 0.7 \times FF, \text{ for } \Gamma < \alpha \quad (1)$$

where Γ is the least matched magnitude in the S11, α is the S11 match target (-10 dB) and FF is the fidelity factor at bore-sight when the antenna operate at receiving mode. Fig. 3 shows the measured versus simulated return loss. The antenna achieved a -8.5 dB return loss from 3 GHz up to 11 GHz, and it is seen that good agreement is achieved between measurement and simulation. Fig. 4 indicates a directional radiation pattern with an average gain of 5.6 dBi with a standard deviation of 2.34 and maximum gain of 8.77 dBi at 9.04 GHz at bore-sight.

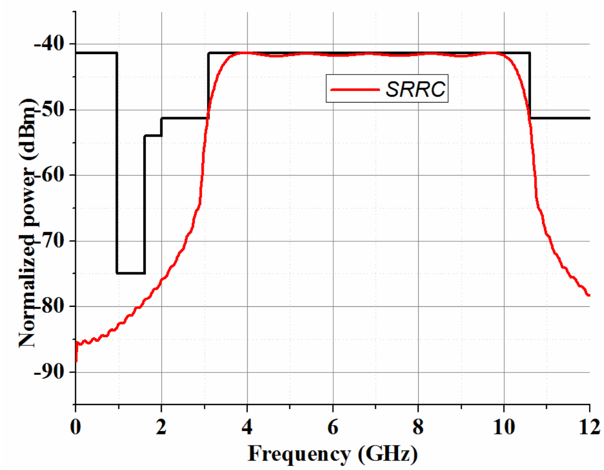

Figure 2 Energy distribution magnitude of the SRRC signal

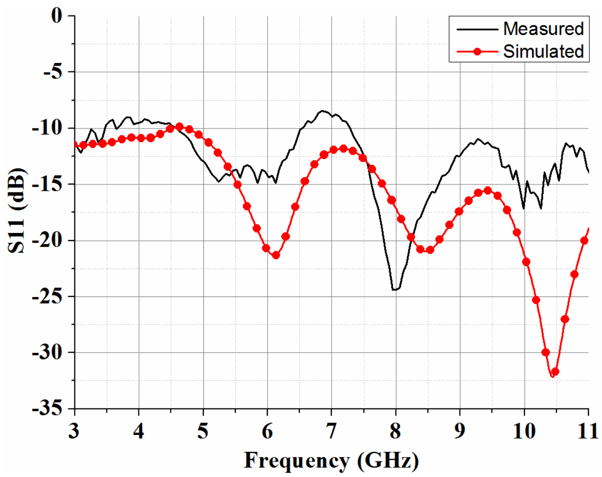

Figure 3 Measured and simulated return loss

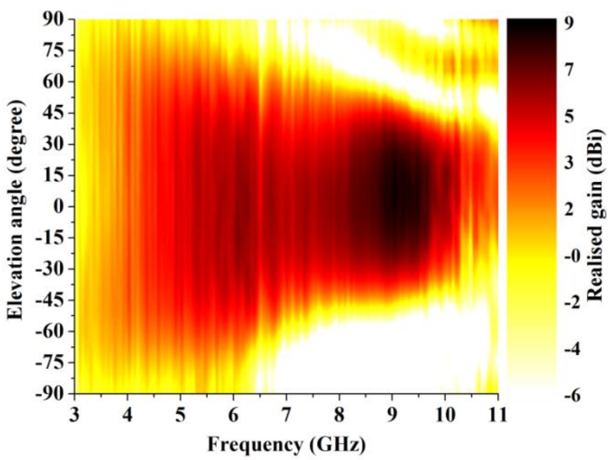

Figure 4 Measured gain

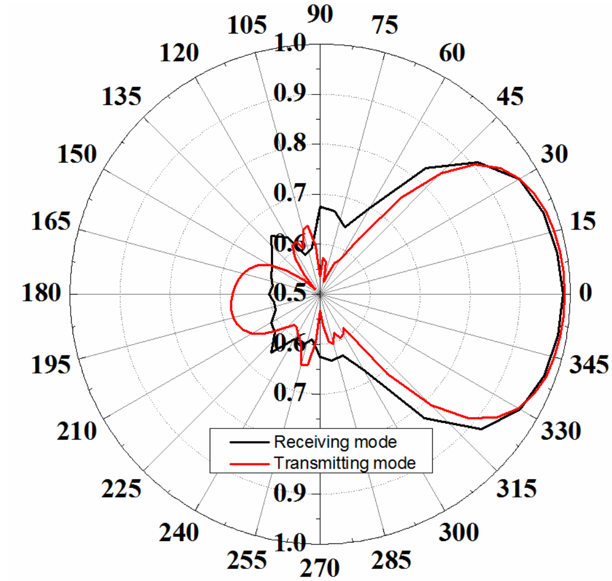

Figure 5 Simulated Fidelity Factor for receiving and transmitting mode

Fig. 5 illustrates that the tapered slot time domain antenna outperforms the initial antenna [1], with simulated fidelity factor of 98.5 % in receiving mode and 98.9% in transmitting mode. This represents an improvement of 1.7% and 2.4% respectively compare to the initial antenna. At bore-sight the measured FF was equal to 97.3% and 96.1% at receiving and transmitting mode.

III. Conclusions

A UWB tapered slot antenna was optimised for best TD performances at bore-sight. The frequency and dispersive characteristics have been simulated and measured using a Square Root Raised Cosine pulse and it has been proven that this antenna achieved superior TD performances. Finally this antenna can find applications in a scanning base station for RTLS system, in radio imaging and as a reference antenna for high quality TD performance measurement.

References

[1] P. Cerny, J. Nevrly, M. Mazanek "Optimization of tapered slot Vivaldi antenna for UWB application", in *Inter. Conf. Electromag. And Comms.*, pp. 1-4, June 2008.

[2] A. Dumoulin, M. John, M. J. Ammann and P. McEvoy "Optimized Monopole and Dipole Antennas for UWB Asset Tag Location Systems", *IEEE Trans. Antennas Propag.*, In press.

[3] M. John, M. J. Ammann and P. McEvoy, "UWB Vivaldi Antenna Based on a Spline Geometry with Frequency Band-Notch", *IEEE Inter. Symp. Antenna and Propag*., pp. 1-4, September 2008.

[4] Computer Simulation Technology website: www.cst.com