Synthesis Techniques in Ultra-Wideband Antennas :A Survey

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ABSTRACT*— In this paper, a review concerning the study and development of synthesis technique of ultra wideband antennas able to fit the project requirements of modern communication systems is presented. The synthesis of UWB antennas in frequency and time domain is taken into account.*

KEYWORDS*— Antenna synthesis, ultra wideband (UWB) antennas, Spline curves.*

I. INTRODUCTION

Since time immemorial antennas has been the lifeline of telecommunication systems. It is required to transmit large amount of information using present communication applications. The quality of the transmitted and received signals depends on ability of ultra wideband antennas to transmit or receive very short time pulses. This makes the synthesis and analysis of UWB antennas very challenging. There is no denying that characterization of radiating systems in frequency domain such as efficiency, input impedance, gain, polarization properties and radiation patterns is not the only requisite to achieve good performance of UWB systems as these terms depends strongly on frequency. UWB systems can be conceived with proper translation in the time domain.

In the long term, several UWB antennas based on optimization of geometrical descriptors of reference shapes, so that these techniques allow the description of geometrical characteristics of antenna in a mere and effective way are proposed[1-3]. These concepts lack flexibility in giving different antenna configurations which is required for designing antennas that fulfil tight requirements. Realising the need, antenna geometry with spline curves was proposed [4]. A major determinant of spline representation is the complex curvilinear shapes which are described by a small set of control points.

Section II gives the discussion on antenna synthesis problem. In Section III & IV discussion on the frequency domain & time domain Spline shaped UWB antennas is carried out respectively. Section V concludes the review.

II. ANTENNA SYNTHESIS PROBLEM

The Antenna synthesis issue depends on three fundamental thoughts. The first is the utilization of brilliant portrayal of the antenna geometry that permits the depiction of the antenna with a constrained arrangement of parameters; however that additionally should be exceptionally adaptable in characterizing diverse antenna shapes. The second one is the use of an improvement system ready to shrewdly investigate the arrangement space with a specific end goal to distinguish the best antenna shape. The last one is the meaning of redid cost function considering all the task prerequisites and utilized by the improvement strategy as a record of the integrity of the arrangements.

Genetic Algorithm (GA) and the Particle Swarm Optimizer (PSO) are the popular algorithms used in antenna synthesis problem. Proposed by John Holland in 1975, GA is considered to imitate the concepts of natural selection and evolution. They depend on competing agents to find the best solution. Just as for motion of swarms of bees, flocks of birds and schools of fishes, the concept of social interaction and cooperation is PSO. For antenna synthesis, PSO is demonstrated to be more attractive than GA as it is easier to implement and calibrate.

III. FREQUENCY DOMAIN SYNTHESIS OF UWB ANTENNAS

The behavior of the narrowband systems is consistent over frequency spectrum under consideration as the modulated sinusoidal waveforms in these systems are short time pulses and undergo less distortion. Since the scenario is different in ultra wideband antennas, electrical parameters of antenna require precise optimization in a wide range of frequencies to ensure minimum signal distortions. For this purpose customized synthesis technique is adapted with proper analysis tool for antenna behaviour in time domain. Different shapes of UWB antennas such as triangular [5], circular ring [6], annular ring [7], rectangular structure [8], diamond [9], bow-tie [10], and the combination of elementary building blocks [11] are examined. These techniques remained prevalent for many years. Later more focus was made on achieving ease in describing geometrical characteristics such as feedline extension, ground plane, and substrate dimension.

Antenna synthesis and analysis technique are integrated in [12] where good impedance matching and radiation properties are obtained over the UWB frequency band. The effects of propagation channel on UWB systems are investigated in [13].

IV. TIME DOMAIN SYNTHESIS OF UWB ANTENNAS

Usually the antenna systems that are analyzed around the centre frequency are aimed to reduce the return loss in the desired bandwidth [14]. The focus is on achieving good impedance matching [15] in UWB band. Antenna behavior cannot be described completely if antenna parameters depend on frequency. Therefore, it is critical to analyze the UWB antenna where all the frequencies are simultaneously considered. The time domain definitions of antenna parameters can be found in [16-19]. To minimize the cost function, the system comprising transmitting antenna, receiving antenna and the propagation channel is modelled by time domain FDTD simulator [20]. Other time domain parameters such as system fidelity, similarity factor are considered in [21] to design a UWB antenna system that contains high efficiency, distortion less properties and omnidirectional radiation patterns over the desired frequency range.

V. CONCLUSION

A review on Spline based ultra wideband antennas have been carried out. The need to integrate the synthesis and analysis technique to evaluate antenna performance in frequency and time domain are investigated. The advantages of PSO based optimization are highlighted.

ACKNOWLEDGMENT

The authors would like to thank the reviewers for their invaluable comments and counsels. Moreover, they would like to thank VVCE for their kind and effective cooperation during the experimental validation.

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