Design of Energy Conscious Antenna System for WLAN Frequency Band

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***Abstract* – The electronically steerable parasitic array radiator (ESPAR) antenna system is configured with one feed radiating element and N-parasitic radiating elements. The radiation pattern is electronically controlled by means of the variable devices loading the parasitic elements. These imply the achievement of low power antenna system with low fabrication cost. The ESPAR antenna can be designed to cover the frequency bands of the wireless local area network (WLAN), which are 2.4GHz and 5.8GHz. The modification can be achieved by loading the antenna elements with lumped circuits and a matching network system. This will be done by using the genetic algorithm optimisation technique.**

***Keywords* – ESPAR antenna, Lumped circuits, Genetic Algorithm**

I. Introduction

The ESPAR antenna is an adaptive antenna with aerial beam-forming (ABF), which is cost effective. Adaptive antenna, which automatically control its radiation pattern by an optimisation algorithm tuned to radio signal's environment. The use of digital beam-forming and microwave beam-forming adaptive antenna, [2] [9] is most limited to military application, due to high cost. An ABF adaptive antenna has its signal processing in the antenna or space stage. ABF requires only one set of high-frequency amplifier, one frequency converter, some receiver circuits.

Wireless local area network (WLAN) is an important application of the wireless communication; it uses ISM frequency bands [4]. WLAN use frequency bands 2.412-2.482 GHz for IEEE 802.11b/g and 5.15-5.825 GHz for IEEE 802.11a. A dual-band ESPAR antenna for WLAN is proposed with monopole radiating elements, which are loaded with lumped circuits. The latter are designed with the aid of genetic algorithm [6] and simplified real frequency technique [8].

The paper is organised as follows. In Section II the main principles of the ESPAR system are detailing on the loading of on monopole elements. Next, Section III describes the research goals. Then the prior art related to the goals of this work are presented in section IV. Section V presents the research methodology. Lastly, conclusions are given in Section VI.

II. System's Fundamentals

A. Introduction

The practical configuration of ESPAR antenna is shown in **fig**.1a. This antenna type is proposed as the result of the need for low-costly adaptive antennas for a user terminal [2].

B. Configuration

These are the different components needed to construct the antenna: The active element with a ¼ wavelength height located at the centre of the ground plane; the N-parasitic elements located around the active element at equal intervals; variable reactance elements which are loaded at the bottom of the parasitic elements, between them and the ground plane with ¼ wavelength skirt [2].

C. Design and Analysis

There are two parameters in the design process: **Structural Parameter**: concern about the mechanical properties of the antenna, such as the number of the parasitic elements, N; the length of the active antenna l_o; the length of the parasitic elements l_n (n=1, 2..N): **Control Parameter**: this is the reactance X_n (n = 1, 2…N) which is responsible for the controllability of the radiation pattern of the antenna [1].

D. Beam Control

The antenna's adaptive control system consists of the two building blocks [23]: **Criterion** as a guideline in the adaption process; **Optimisation** algorithm which helps in adjusting the reactance based on the criterion.

III. Research Goal

The model to be presented at the end of the study should be a dual band ESPAR antenna which is the energy conscious antennas, which is loaded with lumped circuits.

IV. Related Work

Mutual coupling induces currents on the parasitic elements with the current flowing on the active element. The current is induced according to the following formula (1):

$$\mathbf{i}=\frac{v_s}{(2Z_s)}\mathbf{w} \qquad (1)$$

v_s represent the transmitted voltage signal source phase and amplitude from the feeding RF port of the central radiating element. Z_s is the source impedance and **w** represents the equivalent weight vector [3]. The bandwidth of the ESPAR antenna can be enhanced by loading the monopole element with lumped circuits and a matching network for a smooth voltage standing wave ratio (VSWR) [5]. A technique that can be used to synthesise the lumped components to the monopole antenna is the genetic algorithm (GA); this technique is a global numerical–optimization method. The algorithm evaluates the cost function of the possible solutions, where the cost function (CF) is found by evaluating function *f,* at the given parameters $p_1,\ldots p_N$. The cost function can then be represented as follows [6]: $CF = f(p_1,\ldots,p_N)$. (2)
The flow chat of the GA algorithm is as follows [5] as described in **fig.2:**

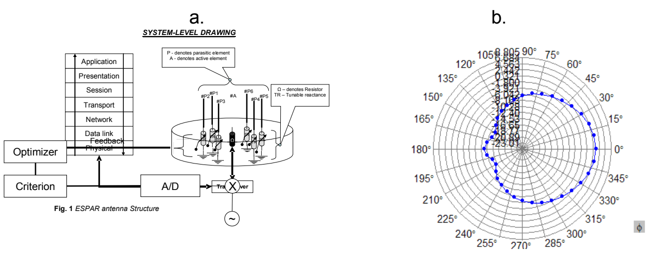

Fig.1 practical configuration for ESPAR antenna and a simulation results of an ESPAR antenna

There is an ESPAR antenna that has achieved the dual-band coverage. This antenna consists of one RF fed element and six parasitic elements for each band. A low pass filter is used to avoid fluctuations; this filter is located between the parasitic element and the variable reactance [7].

V. Research Methodology

A. Investigation

There are different schemes that have been identified in literature that achieve dual-band in monopole antennas. The ESPAR antenna loading with lumped circuit and matching network using genetic algorithm will investigate as compared to other existing techniques.

B. Modelling

The antenna model proposed will be energy conscious with practicality not limited to dual frequency band, but more frequency bands. It should be ease to configure.

C. Simulation Design

Simulations for the single band ESPAR antenna has been conducted results can be observed in fig.1b, using WIPL-D Microwave a powerful and easy-to-use software package for fast and accurate simulation and design of microwave circuits, devices and antennas.

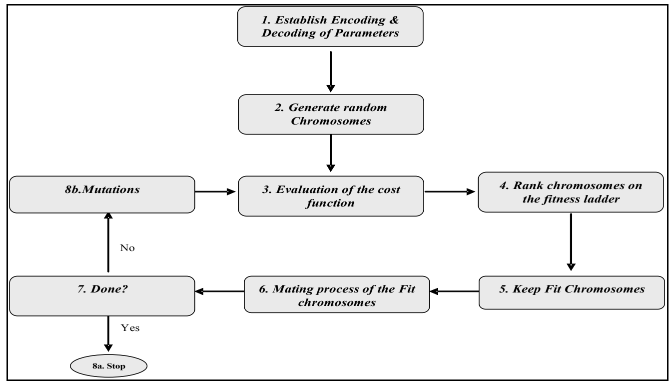

Fig.2 The GA operation principles.

VI. CONCLUSION

This paper presented the basic configuration of ESPAR antenna system that has been proposed for modification. This modification is intended to be achieved with the concepts presented and other possible techniques that can be integrated with the proposed lumped load technique. The final antenna system to be proposed should operate at the WLAN frequency bands and be ease to configure for other frequency bands.

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