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Genetic Algorithms Components and Process to Optimal for RFID Broad Band Transmitter

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Abstract – The scalability in the area of wireless messages has improved great folds in recent years. Micro strip patch transmitters are expected to find many promising relevance's in wireless messages because of their attractive features like low profile, light weight, and inexpensive efficiency. Though, the primary demerits being: narrow operating band size.

Keyword: Genetic Algorithms, Optimal Process for RFID, Broad Band Transmitter

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INTRODUCTION

An MSA in its simplest form consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side. The top and side views of a rectangular MSA [RMSA] are shown in Figure. Though, other shapes, such as the square, circular, triangular, semicircular, sectoral, and annular ring shapes are also used.

Emission from the MSA can occur from the fringing fields flanked by the periphery of the patch and the ground plane. The length L of the rectangular patch for the fundamental TM10 mode excitation is slightly miniature than l /2, where l is the wavelength in the dielectric medium, which in terms of free-space wavelength l o is given as l o /√ee , where ee is the effective dielectric constant of a micro strip line of size W. The value of ee is slightly less than the dielectric constant er of the substrate because the fringing fields from the patch to the ground plane are not confined in the dielectric only, but are also spread in the air.

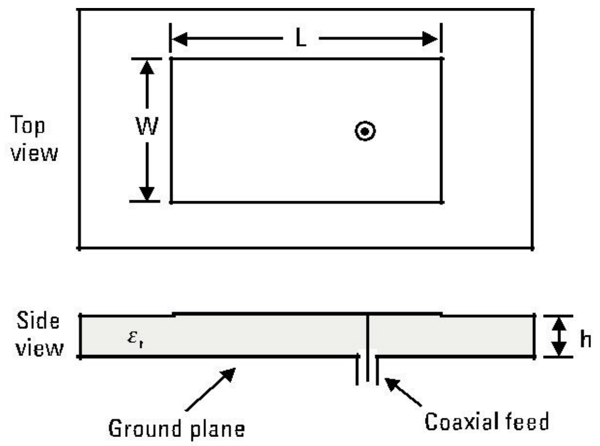

Figure 1: MSA implementation.

To enhance the fringing fields from the patch, which account for the emission, the size *W* of the patch is increased. The fringing fields are also enhanced by decreasing the e_r or by growing the substrate thickness *h*. Therefore, unlike the *microwave integrated circuit* [MIC] relevance's, MSA uses micro strip patches with larger size and substrates with lower e_r and thicker *h*.

REVIEW OF LITERATURE:

The benefits of MSAs make them suitable for numerous relevance's [1-3]. The telemetry and messages transmitters on missiles need to be thin and conformal and are often MSAs. Radar altimeters use miniature arrays of micro strip radiators. Other aircraft-related relevance's include transmitters for telephone and satellite messages. Micro strip arrays have been used for satellite imaging systems. Patch transmitters have been used on message links flanked by ships or buoys and satellites. Smart weapon systems use MSAs because of their thin profile. Pagers, the *global system for mobile message* [GSM], and the *global positioning system* [GPS] are major users of MSAs. Some of the relevance's of MSAs are listed in Table 1.

FEEDING TECHNIQUES:

The MSA can be excited directly either by a coaxial probe or by a micro strip line. It can also be excited indirectly using electromagnetic coupling or aperture coupling and a coplanar waveguide feed, in which case there is no direct metallic contact flanked by the feed line and the patch [4-5]. Feeding technique influences the input impedance and characteristics of the transmitter, and is an significant design Attribute.

Table 1 Typical Relevance's of MSAs

System	Relevance
Aircraft and ship transmitters	Message and navigation, altimeters, blind landing systems
Missiles	Radar, proximity fuses, and telemetry
Satellite messages	Domestic direct broadcast TV, vehicle-based transmitters, message
Mobile radio	Pagers and hand telephones, man pack systems, mobile vehicle
Remote sensing	Large lightweight apertures
Biomedical	Applicators in microwave hyperthermia
Others	Intruder alarms, personal message, and so Forth

The coaxial or probe feed arrangement is shown in Figure. The center conductor of the coaxial connector is soldered to the patch. The primary benefit of this feed is that it can be placed at any desired location inside the patch to match with its input impedance. The demerits are that the hole has to be drilled in the substrate and that the connector protrudes outside the bottom ground plane, so that it is not completely planar. Also, this feeding arrangement makes the implementation asymmetrical.

Genetic algorithms components and process to optimal for RFID broad band transmitter:

A genetic algorithm [GA] is a search and optimal technique inspired by nature's evolutionary processes. A population of candidates iterates through multiple generations of selection, crossover, and mutation until an optimized solution survives, much in the manner of "survival of the fittest". Figure 1 shows the process that a genetic algorithm goes through to find the optimal solution to a trouble.

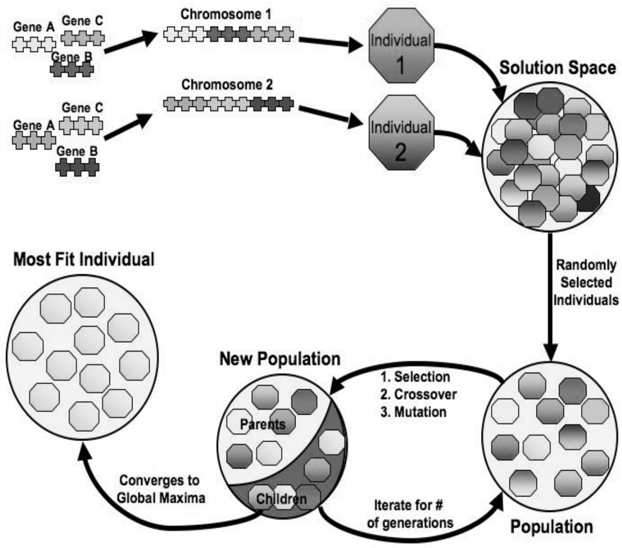

Figure 13: The Genetic Algorithm components and process

➢ *Individuals*

Individuals are candidate solutions to the trouble at hand. An individual is comprised of Attributes or "genes" which combine to make the individual's "chromosome". For instance, a simple RLC circuit would have three genes: one for the resistor value, one for the capacitor value, and one for the inductor value. Genes are often represented with binary mapping. If each gene was 4 bits long, the gene could have 16 possible values.

The circuit would then have *one* chromosome with all of its genetic information. In the circuit case where each chromosome is made up of three genes that are 4 bits long, there are 2^{12} possible individuals. The total number of individuals to a trouble is called the "solution space".

A defined number of randomly-generated individuals establish the initial population of solutions. In order to begin the selection process of the algorithm, a fitness function must be developed that enumerates how "fit" an individual is. For instance, if we are trying to optimize an transmitter's gain and band size, the fitness function would scale and combine the transmitter's gain and VSWR to determine how "fit" the transmitter is. The fitness function produces *one* number that encompasses a combined rating of the individual's genes. These final ratings are then used in the selection process of evolution.

➢ *Selection*

Based on the individual's ratings, there are three common selection approaches to deciding which individuals continue in the process, and which are dropped. They are population decimation, proportional selection, and tournament selection.

➢ *Population Decimation*

The simplest selection scheme is population decimation in which the individuals are ranked according to their fitness ratings, and a cutoff point decimates the weakest individuals. The trouble with this scheme is that traits of the discarded individuals fail to appear in subsequent generations and there is an immediate loss of diversification in the pool of individuals.

➢ *Proportional Selection*

Proportional Selection, also called the Roulette Wheel Selection, selects individuals with a probability that is proportional to their ratings. Thus, a stronger individual has a higher probability of surviving through to the next generation, but there is still a chance for a weak individual to carry through as well, a chance that did not exist in population decimation.

➢ *Tournament Selection*

Finally, Tournament Selection has been found to converge to a solution faster than Proportional Selection does, lending it the most support of the three selection schemes. In Tournament Selection, a sub-population of individuals is randomly chosen to compete on the basis of their fitness. The individuals with the highest fitness win the competition and continue to the next generation, while the other individuals are placed back into the general population and the process is repeated until a desired number of individuals have "won". Tournament solution execution time has *O[n]* time complexity where Proportionate Selection has *O[n^2]* time complexity.

➢ *Crossover*

Once the selected individuals have been established, a process of "crossover" flanked by the individuals occurs to create new individuals. The existing individuals are called the "parents", and the new individuals are called "children". Crossover is applied with probability *p_cross* where values of .6-.8 have been found to work best in most situations [samii 15]. For Parents 1 and 2 and their associated Children 1 and 2, a random number p is selected flanked by 0 and 1. If $p > p\_cross$, a random location in the parents' chromosomes is selected; that portion of genetic information is copied to the non-associated child, such that both Children now have genetic information from both Parents 1 and 2. If $p < p\_cross$, the entire chromosome of Parent 1 is copied to Child 1 and likewise for Parent 2 and Child 2. The object of crossover is to produce better combinations of genes, and thus create more fit individuals.

➢ *Mutation*

In addition to selection and crossover, a small percentage of individuals undergo mutation. Like crossover, mutation occurs with relation to some probability *p_mutation* which is normally quite low, .01-.1. With this probability, an element of an individual's chromosome is randomly selected and changed. In binary coding, this simply means changing a "0" to a "1" or a "1" to a "0". Mutation is another means of growing the diversity of a population and examining parts of the solution space that may otherwise have been ignored.

➢ *Generation*

Once the initial population of individuals has undergone selection, crossover, and mutation, the resulting population constitutes a new "generation" and the process is repeated. The algorithm should run enough generations such that the solution converges to a global maximum. Typically, on the order of 100 generations are enough to find a solution for most troubles.

➢ *Benefits and Demerits of Genetic Algorithms*

A genetic algorithm searches an entire population and does not depend on an initial set of conditions. In effect, a GA search converges to the global maximum, where other common search techniques such as Conjugate Gradient, Newton, and Simplex techniques, converge to local maxima. Additionally, a GA search simply uses a cost function to assess an individual's rating, and does not rely on local information such as derivatives, allowing it to work despite discontinuities in a solution space. Another GA benefit is its simplicity; a GA search is quite easy to understand and formulate for a designer. With these benefits, a GA search optimizer is ideal for solution spaces having:

- discontinuities
- constrained Attributes
- large number of dimensions
- many potential local maxima

The one major demerits to genetic algorithms is their slow convergence time. Typically, GA optimizers must evaluate *every* individual in a population over ~100 generations to converge to global maxima. In transmitter design, this demerit poses a trouble because the "evaluation" of an individual requires it to be simulated; and highly-accurate EM solvers such as HFSS take quite a long time to simulate.

Though, *Numerical Electromagnetic Code* [NEC], is an electromagnetic simulator based on the Technique-of-Moments technique, that offers fast, accurate, and reliable simulated results for wire structures and uses simple text input and output files. A typical simulation in NEC of less than 100 wire segments takes less than 20 seconds [6] where each version of the simple bowtie design in HFSS took to approximately 7 minutes to simulate. In GA optimal, where populations are typically around 100 individuals, and 30-50 generations are iterated, thousands of simulations must be run. Fast simulation time is necessary to make GA optimal worthwhile.

➢ *Transmitter Design: Good Candidate for GA Optimal?*

Transmitter design *is* a good candidate for GA optimal. Transmitters have many dependent Attributes that create nonlinear design troubles. These Attributes are either continuous, discrete, or both, and always include constraints. In this sort of solution space, finding global maxima is key. And in electromagnetic-design troubles, "convergence rate is often not nearly as significant as getting a solution" [7-8].

CONCLUSION:

The standard process of transmitter design relies on the manipulation of simple transmitters by using traditional and intuitive techniques. Though, this technique of design is very limiting to the range of resulting transmitters. The solution space for transmitters is vast-for example, a simple RFID bowtie transmitter with a double-squiggle has the attributes like: height length, base length, wire thickness, location of microchip, size of squiggles, and type of substance.

Even with a limited set of Attributes as shown above, the solution space is still huge. In my design process, I was limited to a local set of possible solutions, because I relied heavily on what I knew about transmitters and the results of specific designs. Though, GA optimizers are "non-bias" to a solution space, and thus survey the entire solution space instead of localizing on an area of interest. GA-optimizers therefore have the potential to introduce novel, non-intuitive concepts in transmitter design. Below are several examples of GA-implemented transmitter designs.

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