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A Review on PSO based Micro Strip Patch Antenna for Ku-Band Applications

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Abstract— Because of their little size, microstrip patch antenna or receiving radio wires are generally utilized as a part of the configuration of compact wireless communication equipments. Outlining a patch radio wire with diminished size, for a given band is major territory of exploration nowadays. Improvement calculations are generally investigated by scientists for computing the parameters of a patch antenna or reception apparatus for a given resonance frequency. According to context of this paper, a microstrip patch reception apparatus has been intended for Ku band. The outcomes have been contrasted and the before distributed work.

Keywords—Microstrip Patch Antenna (MPA), Microstrip feed, Patch, Printed Antenna, Particle Swarm Optimization (PSO). .

I. INTRODUCTION

Antenna is one of the critical components in any wireless communication system. The word 'antenna' is derived from Latin word 'antenna.' Since the first demonstration of wireless technology by Heinrich Hertz and its first application in practical radio communication by Guglielmo Marconi, the antenna has been a key building block in the construction of every wireless communication system. IEEE defines an antenna as "a part of a transmitting or receiving system that is designed to radiate or receive electromagnetic waves." Antennae could be broadly classified as wire antennae, aperture antennae, printed antennae, array antennae, reflector antennae and lens antennae.

A. Wire Antenna

This is the basic type of an antenna, widely used on top of the buildings, automobiles, ships and spacecrafts. These antennae are made into different shapes such as a straight wire (dipole), loop and helix.

B. Aperture Antenna

These antennae are in the form of a slot or aperture in a metal plate and commonly used at higher frequencies (3-30 GHz). Typical examples are slotted waveguide antennae and horn antennae. These antennae are very useful for aircraft and spacecraft applications, because they can be conveniently flush mounted on the surface of the aircraft or spacecraft. In practice, these antennae are covered with a dielectric material to protect them from hazardous environmental conditions.

C. Printed Antenna

By definition, a printed antenna is one that is fabricated using standard photolithography technique. The most common version of printed antenna is microstrip antenna, which consists of a metallic patch above a ground plane. The shape and size of patch determine the frequency of operation of the antenna and its performance. These antennae are more popular because of their low cost and ease of fabrication, and easy integration with circuit components. Printed antennae are inexpensive to fabricate using modern printed circuit technology, and are conformal to planar and non-planar surfaces. These antennae can be easily mounted on the surface of aircrafts, spacecrafts, satellites, missiles and even on handheld mobile devices.

D. Array Antenna

In an array antenna, several radiators separated from each other are geometrically arranged to give desired radiation characteristics that are not possible to achieve with a single independent radiating element. The arrangement of array elements is such that radiation from individual elements adds up to give the maximum radiation in a particular direction or directions, and minimum radiation in other directions. In practice, individual radiators are arranged in linear or planar grid depending on the application.

E. Reflector Antenna

These antennae are specifically used in applications requiring communication over long distances, such as outer space exploration and satellite communication. They are built with large diameters in order to achieve the high gain required to transmit or receive signals over very long distances. The reflector antenna usually uses a smaller antenna as the feed.

Lens Antenna

In these antennae, lenses are used to collimate the incident divergent energy to prevent it from spreading in undesired directions. By choosing the appropriate material and setting the geometrical configuration of lenses, they can transform various forms of divergent energy into plane waves. Lens antennae are classified according to the material from which they are constructed or their geometrical shapes.

F. Microstrip Antenna

Microstrip antenna is one of the most popular types of printed antenna. It plays a very significant role in today's world of wireless communication systems. Microstrip antennae are very simple in construction using a conventional microstrip fabrication technique. Microstrip patch antenna consists of a
radiating patch on one side of a dielectric substrate (FR4) that has a ground plane (Cu) on the other side as shown in Figure 1.

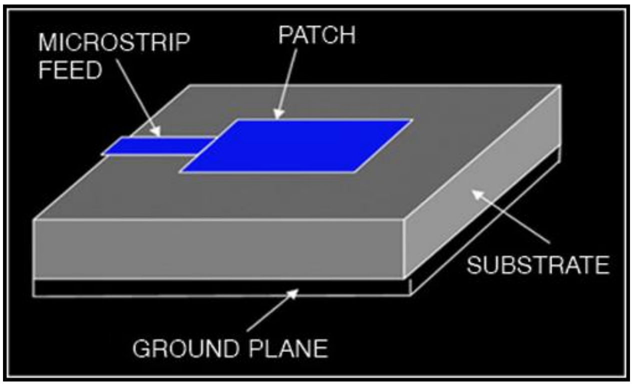

Figure 1: Physical Geometery of Microstrip Antenna.

II. MICROSTRIP PATCH ANTENNA

Microstrip patch radio wire has various great circumstances like minimal effort, conservative size, clear structure and comparability with joined equipment. It has enormous applications in military, radar frameworks or structures versatile interchanges, Global Positioning System (GPS), remote identifying et cetera. Considering the degree of this paper review on various techniques for diminutiveness by pin and opening stacking on microstrip receiving wire are displayed. A microstrip radio wire combined with a singular shorting post at true blue position and size is found to give reducing by and large locale with reverence to a common patch receiving wire. Also, the negligible indirect entranced patch receiving wires can be proficient by space stacking on patch. The pile of the spaces or openings in the radiating patch can bring about meandering of the empowered patch surface current Paths besides, achieve bringing down of the full repeat of the gathering mechanical assembly, Which identifies with a diminished radio wire size for such a gathering device, stood out from a routine circularly hypnotized microstrip radio wire at the same working repeat.

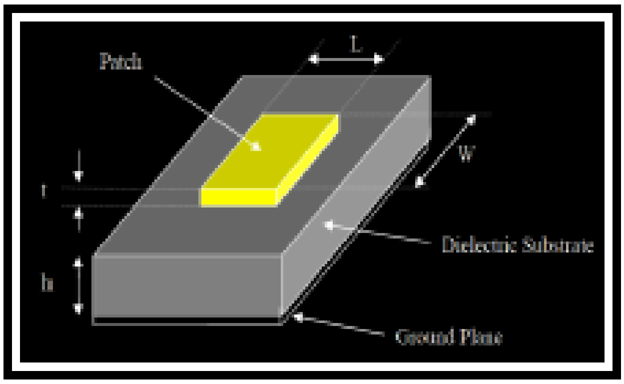

Figure 2: Structure of Microstrip Patch Antenna.

A Microstrip patch reception apparatus comprises of a transmitting patch on one side of a dielectric substrate which has a ground plane on the other side and outline of MSA appeared in Figure 2. The transmitting patch and the food lines are generally photograph scratched on the dielectric substrate. The EM waves bordering off the top patch into the substrate and are emanated out into the air after reflecting off the ground plane. For better reception apparatus execution, a thick dielectric substrate having a low dielectric steady is alluring since this gives better proficiency, bigger data transfer capacity and better radiation.

III. PARTICLE SWARM OPTIMIZATION

Particle Swarm Optimization was firstly introduced by Dr. Russell C. Eberhart and Dr.James Kennedy in 1995. As described by Eberhart and Kennedy, the PSO algorithm is an adaptive algorithm based on a social-psychological metaphor; a population of individuals (referred to as particles) adapts by returning stochastically toward previously successful regions. Particle Swarm has two primary operators: Velocity update and Position update. During each generation, each particle is accelerated toward the particles previous best position and the global best position. At each iteration, a new velocity value for each particle is calculated based on its current velocity, the distance from its previous best position, and the distance from the global best position. The new velocity value is then used to calculate the next position of the particle in the search space. The particle swarm algorithm is used here in terms of social cognitive behavior. It is widely used for problem solving method in engineering. In PSO, each potential solution is assigned a randomized velocity, are "flown" through the problem space. Each particle adjusts its flying according to its own flying experience and its companions' flying experience. The ith particle is represented as Xi = (xi1, xi2 …xid). Each particle is treated as a point in a D-dimensional space.

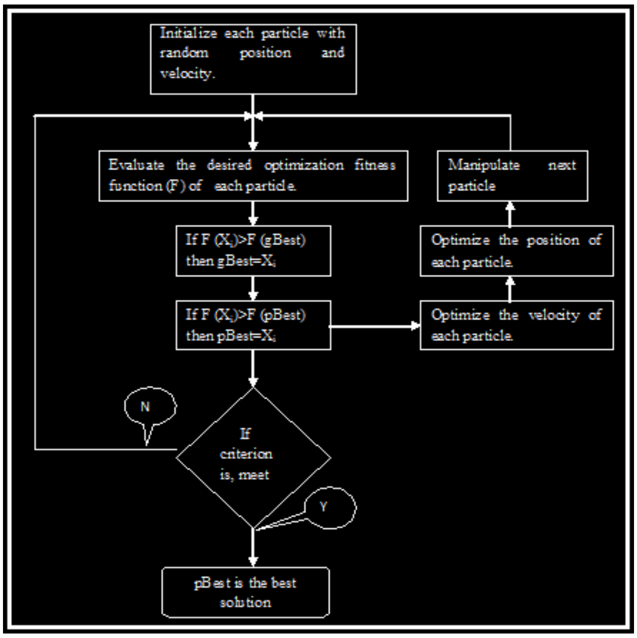

Figure 3: Flow diagram of PSO.

The best previous position (the best fitness value is called pBest) of any particle is recorded and represented as Pi = (pi1, pi2…..pid).Anther "best" value (called gBest) is recorded by all the particles in the population. This location is represented as Pg = (pg1, pg2…..pgd). A t each time step, the rate of the position changing velocity (accelerating) for particle i is represented as Vi = (vi1, vi2…..vid). Each particle moves toward its pBest and

gBest locations. The performance of each particle is measured according to a fitness function, which is related to the problem to be solved [3]. The flow diagram of PSO is shown in Figure 3.The PSO proves itself to be far more efficient than the previously discussed techniques in many aspects. Particle Swarm Optimization is an evolutionary optimization technique developed by Eberhart et. The merits of PSO lie in its simplicity to implement as well as its convergence can be controlled via few parameters. Several works have already been done in order to explore the flexibility of FIR filter design provided by PSO. The comparison of GA and PSO has been already made [2]. Several modifications of the already existing PSO technique have been made so that its efficiency can be increased. PSO is used with the differential evolution to obtain a hybrid optimization algorithm.

The inertial weights and acceleration coefficients are the parameters of PSO whereas scaling factor and the recombination probability are the parameters of DE. With the use of this method; the optimization algorithm becomes insensitive to the parameters of PSO as well as DE. In, the hybrid differential evolution approach (HDE), which is derived from both differential evolution and PSO is used. The inertial weight concept and the neighbor topology of PSO are used with the concept of the DE, which avoids the trapping of the solution in local minima as well as it speeds up the convergence process. In DEPSO, new offspring is created by the mutation of global best, which is taken as one of the parent and Gaussian distribution is used. PSO based on velocity differential mutation is used for avoiding the local minima. In this paper velocity is mutated rather than the particle's position. PSO uses the concept of mutation to increase the convergence speed and the global search ability. Quantum-behaved Particle Swarm Optimization (QPSO) which was proposed by Sun, is a novel algorithm based on the PSO and quantum model. In this concept each particle has a quantum behavior. In quantum mechanics, a particle, instead of having position and velocity, has a wave function. By using this concept, one cannot find the positions and velocities of the particles of search space exactly so the algorithm gets modified accordingly. Discrete Particle Swarm Optimization method along with the concept of Quantum evolution can be used for combinatorial optimization problem. In this method slight modification in the velocity update is done so that it can update adaptively and can avoid local minima. A new Quantum based PSO which uses hyper-chaotic discrete system equation, as hc-QPSO is also used. The main concept in confining all the particles in identical particle system is to remove the seasonal fluctuation, which helps in better updating of the particle's position. Averaging out the search length is used to avoid the local minima and a 2- dimensional hyper chaotic sequence theory is used. QPSO is used for the design of FIR filters .This algorithm reduces the computational time, converges to the global optima and proves to be more efficient than the other evolutionary techniques like GA and PSO. The new concept of Quantum infused PSO is also utilized for the design of digital filters .The global best is selected by comparing the global best obtained from the conventional PSO and the offspring obtained from the QPSO. By merging the two techniques of PSO and QPSO, the best of both the methods can be extracted so as to obtain better results. PSO is used for the design of FIR digital filters by using LMS and Minimax strategies for different populations and number of iterations. PSO is not only being used for filter design but also for various other optimization purposes like in electrical systems, antenna etc. PSO with little amount of modification as constrained PSO (CPSO) is used for the designing of a nonlinear MIMO system identification, where two types of kernels one linear and another Gaussian is used. For parameter optimization, CPSO is used to obtain optimal free parameters. PSO is also used for the design of two folded reflected array antenna for 77 GHz, by optimizing maximum power in the direction of main beam as well as obtaining proper antenna diagram from the reflector configuration. Beam forming system which uses adaptive array antennas is very useful in mobile communication. K.A. Papadopoulos proposes PSO and GA approaches for the optimization of multiple constraints like beam direction, suppression of side lobes and null placement and control. Basically this is a multi-objective problem but all the objectives have been converted to a single one with the help of weighting factors, whose proper selection poses an important task.

IV. LITERATURE REVIEW

The idea of microstrip receiving wire with directing patch on a ground plane isolated by dielectric substrate was undeveloped until the transformation in electronic circuit scaling down and expansive scale mix in 1970. After that numerous scientist have portrayed the radiation starting from the earliest stage by a dielectric substrate for various arrangements. The early work of Munson on miniaturized scale strip reception apparatuses for use as a position of safety flush mounted receiving wires on rockets and rockets demonstrated this was a down to earth idea for use in numerous radio wire framework issues. Different scientific investigation models were created for this radio wire and its applications were stretched out to numerous different fields. The small scale strip reception apparatuses are the present day receiving wire designer's decision. In this area, the microstrip radio wire writing study is talked about. A twofold L-opening microstrip patch receiving wire [1] exhibit with CPW nourish innovation has been proposed for microwave access and remote neighborhood applications. This paper results in smaller receiving wire with great omnidirectional radiation qualities for proposed working frequencies. In its most essential frame, a microstrip patch [1] reception apparatus comprises of a transmitting patch on one side of a dielectric substrate which has a ground plane on the other side as appeared in Figure 2. Directing material for example, copper is utilized to make patch. The transmitting patch and the food lines are typically photograph scratched on the dielectric substrate. There are various substrates that can be utilized for configuration of microstrip patch reception apparatuses. Patch could be design in any possible shape. A microstrip antenna is characterized by its length, width (W), height (h) and dielectric constant. Length (L) of patch controls the resonant frequency (f) of operation as seen from Equation (1). In cell phones, compact patch antennas are required. In this strategies high permittivity (ϵ_r), material has been used as substrate as its results in shrinkage of patch antenna.

$$f = \frac{c}{(2L\sqrt{\epsilon_r})} \qquad (1)$$

Equations (2) demonstrate that a diminishing in the estimation of permittivity results in expansion in reception apparatus transmission capacity. The effectiveness of patch increments with reduction in permittivity. Additionally stature of substrate controls the data transfer capacity and expansion in stature of substrate builds data transfer capacity as appeared from mathematical statement 2 [8].

$$R \propto \frac{(\epsilon_r - 1)}{{\epsilon_r}^2}\frac{\mathrm{W}}{\mathrm{L}}\mathrm{h} \qquad (2)$$

In this way for better radio wire execution, a thick dielectric substrate having a low dielectric consistent is alluring. In any case, such an arrangement prompts a bigger receiving wire size. To outline a minimal Microstrip patch receiving wire, higher dielectric constants must be utilized, yet it results in lower productivity and smaller data transfer capacity. Along these lines there must be a trade off Fig.1. Layout of a Micro strip Patch Antenna between receiving wire measurements and reception apparatus execution. A patch reception apparatus can be sustained utilizing different procedures, for example, line encourage, opening coupled food, coaxial test food and closeness coupled food [6, 10]. The design and estimation of the parameters of a microstrip patch antenna is generally a complex task. Usually in patch antenna designs, a trial and error method is used. Optimization algorithms are widely used by researchers to find the optimum value of antenna parameters [2-5, 11-14]. In this paper, particle swarm optimization (PSO) has been used to obtain the optimum antenna parameters. The performance of the proposed patch antenna has been evaluated in terms of return loss and voltage standing wave ratio.

V. CONCLUSION

Because of their minimized size, microstrip patch antenna or radio wires have been increasing wide significance in convenient correspondence frameworks. For a given resounding recurrence, the computation of ideal estimation of patch parameters is a repetitive errand. Streamlining calculations can be utilized to take care of such outline issues. The outline of microstrip patch antenna or receiving wire utilizing PSO has been proposed for Ku band wireless communication systems or remote correspondence frameworks. The execution of the proposed plan has been assessed and looked at with the current work.

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