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USING THE MICROSTRIP PATCH ANTENNA DESIGN OPTIMISATION AND PARTICLE SWARM OPTIMISATION TECHNIQUE

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Abstract: Due to the fact that wireless communication methods are used in satellite, radar, and mobile communication systems, it is essential to do research on innovative distributed beamforming methods using array antennas. The requirements for a high directivity signal with exceptionally rapid beam steering cannot be met by a single antenna. This need is helped by the phased array antenna, which combines a number of small antennas and may create a beam with excellent directivity and extremely rapid electronic beam steering. The radiation pattern of an antenna array is significantly influenced by the weighting method and array design. The selection of the weights has received a lot of attention since it affects the radiation pattern. The array form hasn't been given any thought, despite having a big influence on the radiation pattern. In practice, beam synthesis is often done in one of three ways, depending on the desired radiation pattern. These include sector beam synthesis (Fourier Series, Woodward-Lawson Method), beam generation by null placement (Schelkunoff Array), and narrow beam synthesis (Tchebyscheff, Taylor, Binomial Array). There is no publicly available method for Flat-Top sector beam synthesis, and Schelkunoff Array can only place the nulls in the correct direction with no control over side lobe level. Phased array and traditional narrow beam designs are both hampered by high side lobe levels and grating lobe issues. These beam pattern issues cause a lot of communication interference, which restricts their practical use.

I Introduction:

The 1950s marked the beginning of the conceptualization of microstrip geometries [1]. The earliest known realisation of this type of device was a microstrip patch antenna by Deschamps in 1953, which was integrated with microstrip line [2]. By 1955, Gutton and Bussinot [3] had secured a patent for their microstrip antenna design in France. Labs were where the first microstrip lines and antennas were created. Due to the lack of excellent substrates with low loss tangent, these sorts of antennas in circuit boards using regulated dielectric constants were not commercially available. Academic research on the theory underlying microstrip transmission lines is still ongoing [4]. in the 50s, stripslines were popular over microstrip structures due to the fact that they provide a pure TEM wave, and are easier to design and construct. From the mid to mid-late 1960s Wheeler [5 and Purcel and colleagues studied the various designs to build Microstrip-based transmission lines. Denlinger (8, 8) stated that both rectangular and circular microstrip antennas had the capability to radiate well during 1969. The thickness of the substrate on which the microstrip radiator is placed has an effect on radiation effectiveness. The circular microstrip's radiation properties were also investigated by Denlinger. The current and radiation fields from the resonant modes in circular microstrips were analyzed by Watkins [99]. Howell 10 reported further research into the fundamental microstrip rectangular radiator that is fed by a microstrip gearbox lines at the radiating edge. The early aerospace uses of spacecraft and missiles provided researchers with the incentive to investigate the possibility of using the design of a conformal antenna. Microstrip antenna's tiny size and its ability to be shaped to almost any shape or dimension has increased the interest of researchers. The printed and microstrip antennas are used today in a variety of contexts. Global Positioning System (GPS), Bluetooth automobile applications using Right Hand Circular Polarisation (RHCP) and Satellite Digital Audio Radio Services (SDARS) are just a few examples of the uses. In order to integrate diverse services running on different frequency ranges the multiband printed antennas become essential. Microstrip antennas received a huge amount of interest and became the subject of a large amount of research they received their own issue within IEEE Transactions on antennas as well as Propagation [1111]. A variety of mathematical models that can be used in practical applications including those proposed by Munson, the Transmission Line Model proposed by Munson [12and the Cavity Model produced by Lo et al [13], and so on. These models were developed as a rough representation of the operation of microstrip antennas. While they possess an easy shape the microstrip antenna proved difficult to analyse with techniques that use full waves. The first method of numerically analysis of microstrip antennas was Method of Moments (MoM) established during the 80s [15] [16]17. A resource from the engineering community for Moment Method implementation for microstrip radiators can be found in the Mstrip40 Simulation software. In the 90s, the processing power as well as memory capacity grew which made numerical techniques such as those used in the Finite Difference Time Domain method (FDTD) [18and other methods viable for use in solving actual-world problems.

2 Literature Survey

A method of numerical calculation was developed to determine the field's phase and magnitude in order to approximate a polar diagram of the chosen aperture plane[12]. Although Dolph's study was unable to discuss the array's directivity, it was mathematically calculated to approximate it when an element's spacing was more than or less than half a wavelength[13]. Except for the ideal isotropic point sources, the evenly lit array's broadside power gain will not be at its maximum. For the existing distribution of usable array components that can create as similar to the intended radiation pattern as possible, an approximation approach is recommended[14]. For engineers and consumers, actual applications of electromagnetics based on different theories and formulations are enumerated and described[15–17].

Aperiodic array theory was developed by using a novel array layout in which the array components were distributed randomly, as well as by discovering a matrix relationship between the array. The grating lobes and various smaller lobes are produced via a steerable uniform linear array. Broad band array was examined while also carefully varying the cosine term of the array factor to manage grating lobes and eliminate side lobe level uneven spacing[19–21]. The most crucial radar communication component is the antenna. A complete illustration of radar communication and related antenna technologies is provided[22].

In the past, linear arrays were analysed primarily; here, the relationship between directivity and beamwidth for uniform planar arrays is examined. The use of the Fourier series in the creation of array patterns was outlined in another recent investigation of array patterns[23]. Thinned arrays, a revolutionary idea in array construction, have been proposed and have proven to be a highly attractive field for scholars. Here, a completely filled planar array's components are removed or turned off by using a probability density function of amplitude taper, and the density of the elements taper from the centre outward. When compared to an array that is completely filled, array thinning, especially for large arrays, offers superior side lobe level control and is more affordable [24]. It is advised to substitute the greatest value for another point while comparing the function values from the vertices of a generic simplex, eventually arriving at the smallest value among the neighbors[25]. A series of finite difference equations that may be used as boundary conditions for perfectly conducting bodies have been used to review Maxwell's equation. This new theory enhances antenna design using various materials and analyses how they behave across various media[26]. Automatically adjusted variable weight of the signal processor using least mean square technique signal processing had indicated that adaptive array would create primary beam towards the received signal direction and putting interference to any other direction[27]. The directivity of the Dolph-Tchebysceff array could not be mentioned.

3 Methodology

It is possible to select a that is wider than length of the patch without the excitation of unfavorable higher order mode if the source of the feed is selected. The development of grating lobes inside antenna arrays limits the usage for extremely large patch widths. In addition, a small patch size can be picked to reduce the demand to use real estate. Crosspolarization's characteristics can also be affected by the size of the patch. If grating lobes and requirements for real estate aren't as important as radiation efficiency, then the patches width must be determined for maximum radiation output. An area of 1 (W /L) 2 [20][21has been found to give satisfying outcomes.

Bandwidth Enhancing Techniques of Microstrip Antennas

In a specific application, the input of an antenna's VSWR the beamwidth, beamwidth, sidelobe angle, gain the polarisation and power handling capability are a handful of the important aspects which must be controlled. Each one of these characteristics can be altered frequently. The pattern of radiation that a microstrip antenna produces is broadside-directed and looks like an omnidirectional dipole. Microstrip antenna's radiation pattern doesn't change significantly in frequency. The range of frequency that elements can be linked to a line is restricted by the impedance of the patch antenna's input and is known to vary significantly in frequency. This means that the primary definition of the bandwidth of microstrip antennas is derived from the impedance bandwidth. A frequency spectrum of the analogous circuit in an resonant microstrip antenna can be utilized in calculating the bandwidth of impedance for the antenna.

The impedance of a patch antenna is dependent on its Q. The dielectric constant r and thickness h, which are substrate factors that affect a microstrip antenna's quality factor, may be changed in order to achieve various impedance bandwidth values and eventually improve the bandwidth. Because the bandwidth grows monotonically with thickness, the dielectric loss also rises. However, employing a substrate that is thicker than necessary for a probe-fed patch antenna causes the probe's length to expand and the patch's impedance locus to become more and more inductive [22], [23], making impedance matching more and more challenging. Reduced r also results in higher field leakage, which may be exploited to expand the antenna's impedance bandwidth. This method is only effective for h 0.02 however.

4 Experiments & Results

This section explains in detail how the suggested approach's performance was assessed. Numerical findings in this part using an array of lens antennas confirm the performance of the suggested beam forming system, which was detailed in the previous chapter. Analysis of the experiments is done using MATLAB R 2014a. The settings from the previous chapter's simulation setup and setup are taken into consideration. Similar to the preceding chapter, specified values and notations were employed (ETSI, 2017). This chapter compares the performance of the proposed GCBCO algorithm to that of IGPSO and GSO.

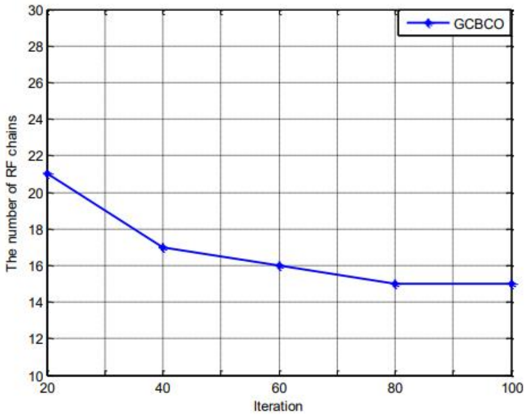

Figure 4.1 Convergence Curve of GCBCO Algorithm

The convergence of the proposed GCBCO algorithm for combined antenna selection and beam shaping design is shown in Figure 4.6. It also demonstrates that the convergence of this approach is optimum when 230 base stations are employed, since the suggested work reduces array gain losses and the beam squint effect, which improves convergence.

Table 4.2 : Spectrum Efficiency vs. SNR

SNR(dB)	Spectrum Efficiency(bits/seconds/Hz)		
	GSO	IGPSO	GCBCO
-40	0.0132	0.0315	0.0174
-35	0.0411	0.0963	0.4923
-30	0.1183	0.2776	1.1098
-25	0.3384	0.7112	1.7274
-20	0.8023	1.5304	2.5756
-15	1.5973	2.7345	3.8013
-10	2.7828	4.1942	5.3753
-5	4.2040	5.7782	6.9667
0	5.7682	7.4122	8.8207

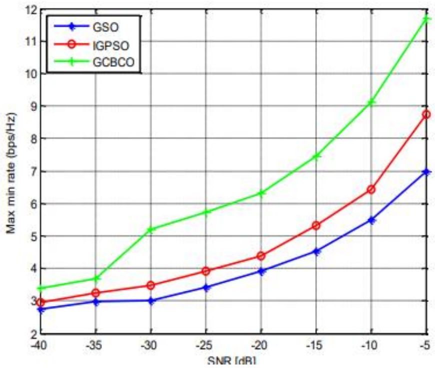

Fig 4.2 Max-Min Rate vs. SN

5 CONCLUSION:

To increase the spectrum efficiency of a MISO mmWave system, the combined transmit antenna selection and digital beam forming design with low-resolution are suggested in this chapter.

Singular Value Decomposition (SVD) is first used to optimise the whole precoding matrix. With beam squint, array impulse response fluctuates across frequency more noticeably than without it. For excessive route delays with SINR and MVDR, the Group Crossover Bee Colony Optimisation (GCBCO) strategy is offered in addition to the Joint Antenna Selection (JAS) and beam shaping technique. In the GCBCO technique, crossover operation is implemented to create a new route in the antenna array system if the solution is not reached after the maximum number of repetitions. According to experimental findings, the suggested design, which incorporates an array of lens antennas, is capable of outperforming benchmark systems in terms of spectrum efficiency and maximum and minimum rates while reducing BER. The iterative optimisation of the users' power consumption during beam shaping may be a significant advancement of this study.

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