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ELITISM DIVERGENCE HARRIS HAWKS OPTIMIZED NANO-ANTENNA IDENTIFICATION FOR 5G WIRELESS COMMUNICATIONS

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Abstract : 5G is a future wireless technology that enhances capacity and provides very low latency, very high data rates, and good quality of service. For every 5G device, the design of a nano-antenna plays a very important role to function effectively and it directs to improve efficient communication, channel capacity, and spectrum efficiency. Different approaches have been developed to enhance the antenna performance. However, a compact size, cost-effective, enhanced bandwidth, gain, and negligible radiation losses based antenna design still faces changing tasks. In order to improve the efficiency of nano-antenna design, a novel technique called Elitism Divergence Multi objective Harris Hawks Optimization (EDHOP) technique is introduced. By applying a proposed optimization technique, populations of Harris hawks (i.e. nano-antenna) are initialized. For each Harris Hawk, the fitness is estimated along with the multi-objective functions such as distance, thickness, width, length, and wavelength of an incident of light, gain. The Elitism selection is applied in a Harris hawks optimization to randomly select the nano-antenna with the best fitness. Following, the global optimum solution is identified from the population based on the position updates. The simulation of the proposed EDHOP technique is conducted using a MATLAB simulator with various performance metrics such as heat loss, thermal loss, SWR, electric field, and radiation efficiency. The simulation results demonstrate that the proposed EDHOP technique improves the performance of nano-antenna design with minimum heat loss, thermal loss, SWR, electric field, and higher efficiency with respect to wavelength respectively.

Keywords: 5G wireless communication, Nano-Antenna Design, Jenson Shannon divergence, Elitism selection, Harris hawks optimization

I. INTRODUCTION

With the development in communication technologies and ever-increasing demand by users for compact communication, a device has imposed a change in the design approach to achieve well-organized antenna structures that are compact and robust. Due to the various communication requirements, plasmonic nano patch antenna on the graphene material design and analysis has become essential.

The graphene nano patch antenna design analysis was developed in [1] to provide better gain by varying the chemical potential and three resonating frequencies and it was suitable for terahertz communication. A compact dual-band and dual-polarized millimeter-wave patch antenna were identified in [2] with decoupling structures for 5G mobile terminal applications. A highly compact quad-band MIMO antenna was designed in [3] with higher gain and provides high data managing capacity for wireless systems.

An eight-element array antenna design was performed in [4] with a single-layer frequency selective surface (FSS) to achieve better gain for 5G applications. A graphene-based hybrid terahertz plasmonic nano-scale antenna was designed in [5] to achieve a maximum gain by varying the conductivity through gate bias voltage. A multiple input multiple output antenna array was modeled in [6] for a 5G mm-wave communication network to improve the radiation efficiency. But the performance of loss analysis was not performed. Single patch nano antenna was presented in [7] which operates at an optical frequency and provides better gain performance. A compact eight-element antenna array for triple-band MIMO operation was performed in [8]. But the designed antenna failed to apply ultra-thin 5G mobile terminals with narrow-frame and wide-screen processes. The antipodal Vivaldi antenna was designed in [9] by means of graphene material for wide-band communication. But the designed antenna used for low-THz applications.

The switched-beam nano antenna was designed in [10] for the THz communication system. However, it failed to implement the physical-layer collaboration between user-side switched-beam graphene antennas and the environment-side hypersurfaces in the THz application.

Contribution of the work

The major contribution of the proposed EDHOP technique is summarized as follows

- A novel EDHOP technique is developed for solving optimal antenna identification with multiple objective functions.
- The elitism divergence multi-objective Harris hawks optimization is applied to find the optimum nano-antenna based on multi-objective functions such as distance, thickness, width, length, the wavelength of the incident light, and gain in the fitness measure for achieving better radiation efficiency and minimizing the heat and thermal loss.
- The Elitism selection strategy is applied for finding the optimal solution based on better fitness. Jenson Shannon divergence is used for position updates to identify the global optimal solution.
- Finally, a simulation test is conducted to validate the performance of the simulation and analytical results with different performance metrics.

Organization of the paper

The structure of article is organized as follows. In section 2, related works are discussed. Section 3 briefly describes the proposed methodology EDHOP technique. Section 4 explains the simulation settings. In section 5, the simulation outcomes and analysis are presented using various metrics. Finally, section 6 concludes the paper.

II. RELATED WORKS

A novel MIMO antenna was presented in [11] operating at the 3500 MHz bands for 5G mobile terminals to improve radiation efficiency. A very wideband8-antenna array was developed in [12] for future 5G NR (New Radio) mobile devices. The designed antenna array achieves desirable efficiency and peak channel capacity. A Simple structure of a tri-band micro strip patch antenna was modeled in [13] for millimeter wave of 5G devices communication.

An expedited optimization-based efficiency of antenna structures design was performed in [14]. A novel 8-antenna array design was performed in [15] for smartphone applications. An mm-wave wideband antenna array was developed in [16] for 5G device-to-device communications. A complementary triangular hybrid plasmonic nano-antenna design and theoretical analysis were performed [17] to improve the efficiency and minimize the error. A novel THz plasmonic nano-antenna array architecture and operation was designed in [18]. A broadband optical nano-antenna was designed [19] which covers a wider range of optical communication wavelengths in nano-photonic applications. A high gain superstrate antenna array was designed in [20] with extremely low cost and possesses high-performance metrics. But the designed antenna structure was not integrated easily into modern 5G transceivers.

III. PROPOSAL METHODOLOGY

Extensive development in the 5th generation (5G) technology is a definite appearance of a technological revolution to accomplish the successful demand for high-speed communication as well as innovative wireless applications. 5G is promising as a next-generation technology that provides very low latency, high data rates, and better quality of service. In 5G communication, the design and development of a nano-antenna play a very important role due to high channel capacity as well as higher data speed. The nano-antenna operates at very small wavelengths i.e. nanometers with a compact size. The important issue to overcome is represented by the poor radiation properties of compact antennas, especially due to losses associated with the antenna.

Therefore, for 5G device communication, it is important to design an antenna by maintaining a balance between the simulation and analytical characteristics for minimizing heat loss and thermal loss. The designed antenna differs from the radio frequency antenna which has compact in size, cost-efficient and covers the desired 5G band with better bandwidth, gain, and negligible radiation losses. Based on the motivation, a novel EDHOP is introduced for optimal antenna identification to minimize the loss and improve the efficiency of data communication in the 5G network.

Figure 1 shows the architecture diagram of the proposed EDHOP technique to solve the optimal antenna identification problems by applying an Elitism Divergence Multi-objective Harris hawk’s optimization. To improve the speed of data transmission in 5G network topology, an optimum nano-antenna is identified based on multiple objective functions such as distance, thickness, width, length, and wavelength of an incident of light, gain. The Elitism Divergence Multi-objective Harris hawks optimization is a new swarm intelligence bio-inspired optimization that is inspired by the group behaviors for hunting the prey. This optimization algorithm exist a dominant hierarchy among them. At the top of the hierarchy is a grown-up female bird, followed by a male and then other birds of the pack.

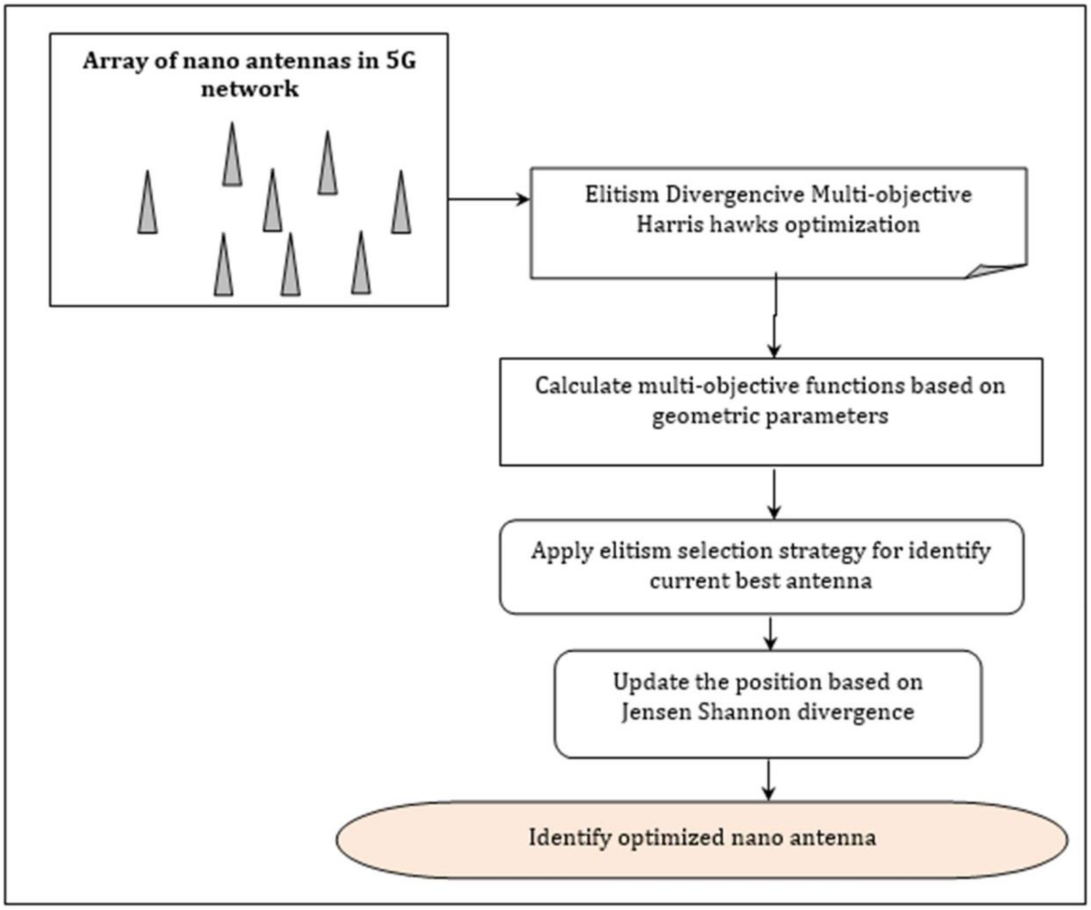

Figure 1. Architecture of the proposed EDHOP technique

This joint hunting creates them able to provide in the cruel desert, where the prey is insufficient. The algorithm is also applied for hunting the bigger prey. The members of the group take turns searching, encircling the prey and attacking the prey. As the prey is identified, other members are informed by the means of visual expressions. Then the hawks fly around the prey. It is continued until the prey is caught by the hawks. By applying this optimization, the Harris hawks represent the antenna, and the prey is denoted as the multi-objective functions of the antenna in the network. The main advantage of Elitism Divergence Multi-objective Harris hawks optimization is to find the optimal location of prey in search space with higher High efficiency. In addition, this optimization is flexible and it is used for different kinds of input.

Contrary to existing optimization, the proposed Optimization includes an Elitism selection strategy to select the current best individuals (i.e. hawks) along with the best fitness values for the next process resulting in minimizing the complexity of the algorithm and it is also used to increase the speeds of convergence of the algorithm. First, the proposed optimization algorithm starts to initialize the population of the 'n' number of Harris hawks (i.e. antenna) 'in the search space.

$A = na_1, na_2, na_3, \dots, na_\mathrm{n}$ (1)

Where, A denotes a population of 'n' number of Harris hawks (i.e. antenna)$na_1, na_2, na_3, \dots, na_\mathrm{n}$. After the population initialization, the fitness of each antenna is evaluated based on multiple objective functions. The objective functions are Distance, Length of a nano antenna, Antenna width, Thickness, the wavelength of the incident light, and Antenna gain. These parameters are explained as given below,

- **Distance**

The distances between the nano-antennas are measured as given below. Let us consider the coordinates of the 'na_1' be '(x_1, y_1)' and 'na_2' be '(x_2, y_2)' as given in figure 2.

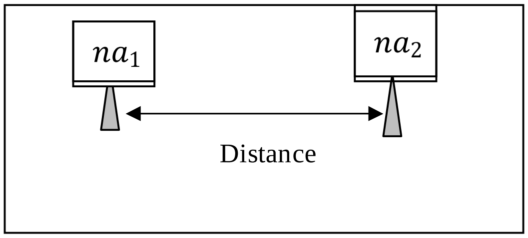

Figure 2. Distance measure between the two nano-antennas

Figure 2illustrates the distance between the nano-antennas 'na_1' and 'na_2' mathematically computed for optimal nano-antenna identification. The absolute distance between the nano-antennas is evaluated by using the Manhattan distance.

$$Dis = |x_1 - x_2| + |y_1 - y_2| \quad (2)$$

From the equation (2), 'Dis' denotes the distance between two nano-antennas, 'na_1' and 'na_2'.

- **Length of nano-antenna**

The length of the nano-antenna is calculated as half of the plasmonic wavelength. The length is mathematically calculated as given below,

$L = 0.5 * \lambda_\mathrm{p}$ (3)

Where, L denotes the length of the antenna, λ_p indicates a plasmonic wavelength.

- **Antenna width**

The width of the antenna is measured through numerical evaluation for maximum radiation efficiency without significantly changing the expected broadside radiation pattern.

$W = 0.8 * \lambda_\mathrm{p}$ (4)

Where, W denotes the width of the antenna, λ_p indicates a plasmonic wavelength.

- **Thickness**

The thickness of the substrate of a patch antenna is required to be between $0.003\lambda_0$and$0.05\lambda_0$, for increased radiation efficiency. Where, λ_0 denotes a free space wavelength which is measured as given below,

$\lambda_0 = \lambda_{\mathrm{p}} * C$ (5)

Where, λ_{p} plasmonic wavelength and C denotes a confinement factor. The value of the confinement factor increases and the efficiency of radiation drops drastically. Therefore, the minimum value of the confinement factor is considered for the design of nano antenna.

- **The wavelength of incident light**

The wavelength of the incident light is measured as the direct relationship between the speed and the inverse linear relationship of frequency. An increase in wavelength will cause a decrease in frequency in order to maintain the speed of light.

$\lambda_{\mathrm{i}} = \frac{\mathrm{c}}{\mathrm{F}}$ (6)

Where, λ_{i} denotes a speed of the light $3*10^8$ m/s, F denotes a frequency.

- **Antenna gain**

The antenna gain is mathematically calculated as given below,

$G = \frac{\mathrm{p}_{\mathrm{mx}}\,(\mathrm{Tna})}{\mathrm{p}_{\mathrm{mx}}\,(\mathrm{Rna})} * G\ (Rna)$ (7)

Where, G, is always less than directivity due to losses associated with the antenna. It can be measured in terms of the reference antenna. p_{mx} denotes a maximum power density of the test nano antenna 'Tna' and the reference nano antenna 'Rna'. The gain is measured in decibels (dB). Based on the above-said parameter estimation, the optimal design of the antenna is identified with the help of the fitness measure. The fitness is estimated based on multi-objective functions,

$F(na) = w_1 * (Dis) + w_2 * (L) + w_3 * (W) + w_4 * (T) + w_5 * (\lambda_{\mathrm{i}}) + w_6 * (G)$ (8)

From (8), 'w_1', 'w_2', 'w_3', 'w_4' and 'w_5', w_6 represents the weighting factor of Distance, length, width, thickness, wavelength, and gain correspondingly. In this way, an optimal nano-antenna is identified after calculating the fitness, there are three different processes namely the Exploration phase, Transition from exploration to exploitation, and Exploitation phase are carried out to find the optimal nano-antenna.

Exploration phase

The first stage of the optimization is the exploration that modeled the Harris hawks' wait, search, and detection of the desired prey. The nature of Harris' hawks, track and detect the prey through their powerful eyes, but rarely is the prey not identified easily.

Hence, the hawks wait and search the desert location to identify prey for several hours. In HHO, the Harris' hawks are the candidate solutions and the best candidate solution in each step is considered based on fitness. The position of the Harris hawks in the exploration phase is given by,

$$P_{t+1} = \begin{cases} P_r(t) - m_1 \left|P_r(t) - 2m_2 P(t)\right| & ; z \geq 0 \\ (P_r(t) - P_m(t)) - m_3 (lb + m_4 (ub - lb)) & ; z \leq 0 \end{cases} \quad (9)$$

Where, P_{t+1} updated position of the Harris' hawks, $P(t)$ indicates a current position of the Harris' hawks, $P_r(t)$ denotes the position of the prey, m_1 , m_2 , m_3 , m_4 and z are the random numbers within [0, 1], lb and ub are the lower and upper bounds.$P_m(t)$ denotes an average position of the current population of hawks and it is formulated as given below,

$$P_m(t) = \frac{1}{n}\sum_{i=1}^{n} P_i(t) \quad (10)$$

Where $P_m(t)$ indicates the location of each hawk in iteration t and n denotes the total number of hawks. From (9), $P_r(t)$denotes a randomly selected hawk from the population based on the elitism selection technique. The elitism selection technique is applied for finding the best individuals (i.e. Harris hawks) among the populations for further processing based on the fitness estimation by setting the threshold.

$$Y = \begin{cases} F(na) > Th ; & select \text{ hawks} \\ Otherwise; & Reject\ the \text{ hawks} \end{cases} \quad (11)$$

Where Y denotes an elitism selection outcome, T denotes a threshold, F indicates fitness.

Transition from exploration to exploitation

The proposed optimization algorithm transfers from exploration to exploitation hence the energy of the prey is decreased. The energy 'E' of prey is calculated as given below,

$$E = 2\,E_0 \left(1 - \frac{t}{\max\_T}\right) \quad (12)$$

Where, E_0 denotes a random number within (−1, 1), t indicates an iteration counter, $\max\_T$ denotes a maximum number of iterations.

Exploitation phase

The third stage of the optimization algorithm is the exploitation phase. The exploitation phase is divided into four strategies including the soft besiege, hard besiege, soft besiege with progressive rapid dives, and hard besiege with progressive rapid dives. Let us consider $m \geq 0.5$ and the energy $E \geq 0.5$ hence this is called a soft besiege and the position gets updated as given below,

$$P(t+1) = \Delta P(t) - E\left|K\,P_r(t) - P(t)\right| \quad (13)$$

Where, $P(t+1)$ updated position of Harris' hawks, E denotes the energy of a prey, K denotes the jump strength of the prey,$P_r(t)$ denotes a location of the prey, $\Delta P(t)$ denotes a difference between the current location of prey and the location of Harris' hawks. The distance is identified by using Jensen–Shannon divergence

$$\Delta P(t) = \frac{1}{2}\left|P_r(t) - P(t)\right| \quad (14)$$

$$K = 2(1 - m_5) \quad (15)$$

Where $m_5$represent a random number within [−1, 1]. The second hard besiege strategy is performed with the $m \geq 0.5$and the energy$E < 0.5$. Therefore, the position gets updated as given below,

$P\,(t+1) = P_{\mathrm{r}}(t) - E|\Delta P(t)|$ (16)

Where, $P\,(t+1)$ updated position of Harris' hawks,E denotes the energy of a prey, $\Delta P(t)$ denotes a difference between the current location of prey and the location of Harris' hawks. The third strategy soft besiege with progressive rapid dives is executed with the condition of $m < 0.5$ and the energy$E \geq 0.5$. Therefore, the position of the hawks is obtained as follows,

$P\,(t+1) = P_{\mathrm{r}}(t) - E|K\,P_{\mathrm{r}}(t) - P(t)|$ (17)

The last strategy is |E|< 0.5 and m< 0.5, the prey not had enough energy to run away from the hawks. Hence, the location of the updated using the following equation

$P\,(t+1) = P_{\mathrm{r}}(t) - E|K\,P_{\mathrm{r}}(t) - P_{\mathrm{m}}(t)|$ (18)

Where, $P_{\mathrm{m}}\,(t)$ denotes an average position of the current population of a hawk. Finally, the optimal best location is identified. This process is executed until the termination criteria are satisfied. As a result, an optimal nano-antenna for 5G communication is designed. The flow chart of the EDHOP technique is given below

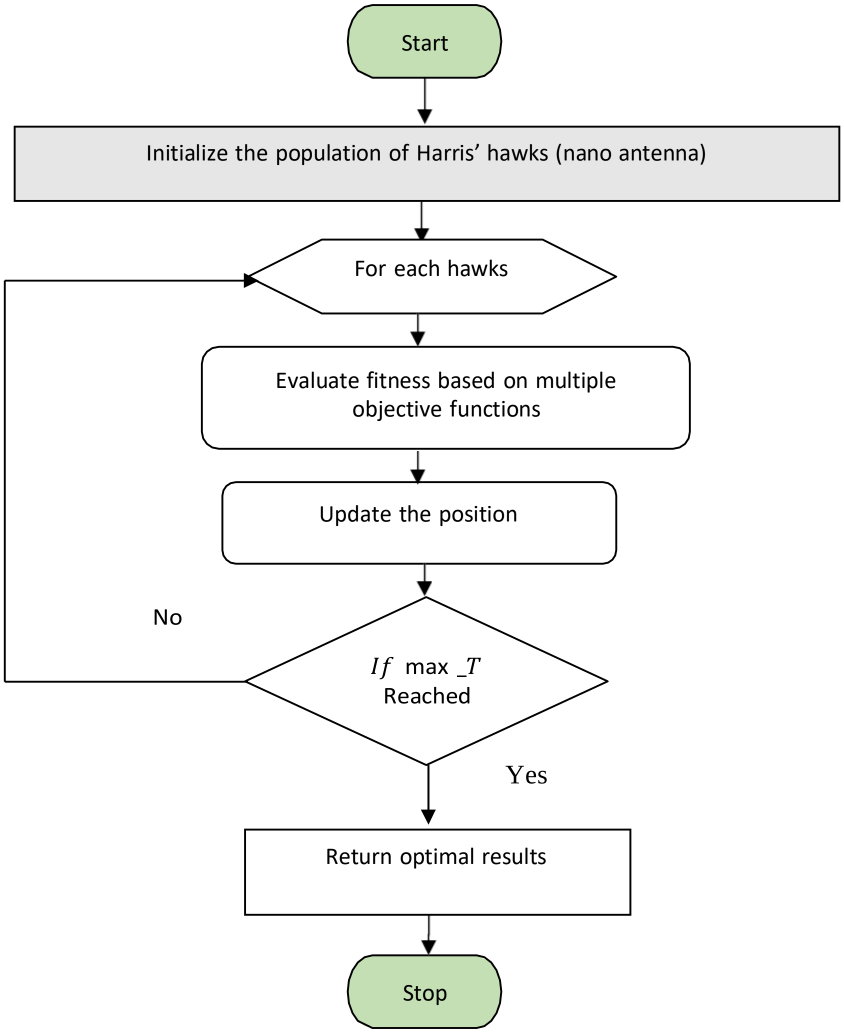

Figure 3. Flowchart of an Elitism Divergence Multi-objective Harris hawks optimization

Figure 3 illustrates the flowchart of the elitism Divergence Multi-objective Harris hawks optimization to find the best optimal antenna for improving the data transmission rate in a 5G network. The algorithmic process of EDHOP is given below,

```
// Algorithm 1 Elitism Divergence Multi-objective Harris hawks optimization
Input: Number of nano-antennas '$na_1, na_2, na_3, \dots, na_n$'
Output: Find optimal nano-antennas
Begin
Step 1:  Initialize the current population of nano-antennas '$na_1, na_2, na_3, \dots, na_n$
Step 2:  Calculate multiple objective functions
Step 3:  Compute the fitness '$F(na)$' based on multiple objective functions
Step 4:While (t < Max _iter) do
Step 5:        for each hawk
Step 6:   Update the energy using (12)
Step 7:        If $(E > 1)$ then
Step 8:            Updates the position $P\ (t+1)$ using (9)
Step 9:End if
Step 10:       If $(E < 1)$ then
Step 11:        if $(m \geq 0.5$ and $E \geq 0.5)$ then
Step 12:        Updates the position $P\ (t+1)$ using (13)
Step 13:            else if$(m \geq 0.5$ and $E < 0.5)$then
Step 14:            Updates the position$P\ (t+1)$ using (16)
Step 15:            else if$(m < 0.5$ and $E \geq 0.5)$then
Step 16:                Updates the position$P\ (t+1)$ using (17)
Step 17:            else if$(m < 0.5$ and $E < 0.5)$then
Step 18:                Updates the position$P\ (t+1)$ using (18)
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Step 19:        end if
Step 20:    end if
Step 21:      end for
Step 22: t= t+1
Step 23:   end while
Step 24: Return ( best optimal solution)
End
```

Algorithm 1 describes the process of Elitism Divergence Multi-objective Harris hawks optimization based on optimal nano antenna identification. By applying the optimization technique, the population of nano-antenna is initialized randomly in search space. For each nano-antenna, the multi-objective functions are measured. Based on the multi-objective functions, the fitness is computed. Followed by, the positions of the Harris hawks are updated based on the different conditions and find the global best position. The entire process is repeated until the maximum iteration gets reached. Finally, the optimal nano-antenna is obtained for improving the efficiency.

IV. SIMULATION SETTINGS

In this section, the simulation of EDHOP is implemented in the MATLAB simulator. The plasmonic resonance of a nano-optical antenna requires an understanding of the parameters and material properties. The number of parameters is employed for learning the functional plasmonic devices with the brute force parameter simulation. A modeling-based automated design optimization framework is an important one for nano-optical transducer design. The EDHOP is designed by joining the commercial electromagnetic analysis tool termed the Ansoft HFSS with the MATLAB optimization toolbox. Two optimization tools are combined on a MATLAB-based scripting interface to repeatedly search for optimal geometric parameters of dipole and bowtie antenna called sequential quadratic programming (SQP) and Harris Hawks Optimization.

The Anfost HFSS software is used to identify the parameters like s-parameters, resonant frequency, and fields. The nano-antenna features like directivity, field enhancement, far-field radiation pattern, and polarization are achieved the same as RF and microwave antennae. The shape, size, and antenna material are important due to surface plasmonic effects. The metal is selected with high conductivity and dielectric material. The mesh size for Finite Element Method analysis is taken as 0.2-time wavelength. The maximum element size is chosen because half minimum skin depth improved the accuracy. The optimization increased thefield intensity '$|E(x = 0, y = 0, z = 0)|$' depending on bound limitations of [20, 450] and [200 2000] for geometric length and wavelength respectively. Convergence is achieved in less than 20 iterations and 10 generations for sequential quadratic programming (SQP) and the Harris Hawks Optimization framework.

V. PERFORMANCE RESULTS AND DISCUSSIONS

In this section, the performance of EDHOP obtained from the simulation is analyzed with the wavelength of 200, 400…2000 nm. The heat loss with respect to wavelength is shown in table 1.

Table 1. Tabulation for Heat Loss versus Wavelength

Wavelength (nm)	**Heat Loss (W) *10^-18**	
	Simulation	**Analytical**
400	13.5	12.6
420	14.2	13.8
440	15.4	14.8
460	14.6	14.1
480	15.5	14.7
500	16.7	15.6
520	10	9
540	8	6
560	6	4
580	4	3
600	3	2

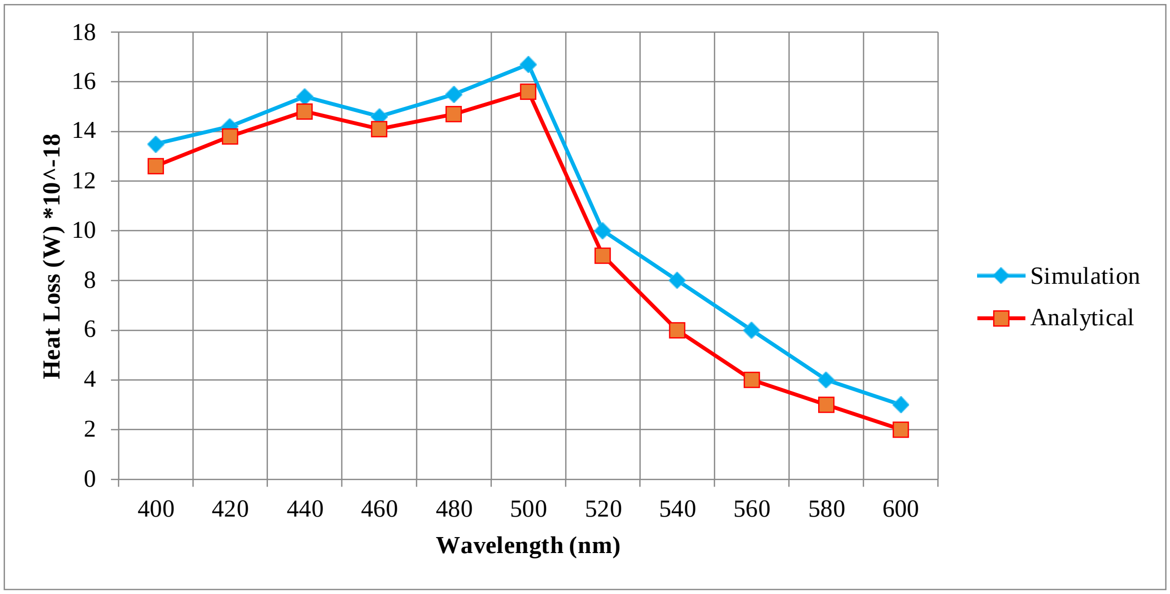

Figure 4. Graphical illustration of heat loss

Table 1 and figure 4illustrate the performance analysis of heat loss versus wavelength in nm. As shown in figure 4, the wavelength is taken as input in the 'x' direction and the results of heat loss are obtained 'on the y' axis. At higher wavelengths, the heat losses are minimal. The optimal antenna performance is computed depending on the multiple objective functions. The heat loss is estimated based on enhancement or expansion to various parabola radii, dielectric constants, field radiation patterns, and polarization due to wave front. It is clear that the emission patterns are not linear due to finite element non-uniformity on the curvature part of the parabolic configuration. As the radius is small, the radiation pattern also small. Hence it minimizes heat loss.

Table 2. Tabulation for thermal loss versus wavelength

Radius (nm)	**Thermal Loss (W)**	
	Simulation	**Analytical**
200	97	101
400	159	165
600	265	280
800	306	325
1000	492	520
1200	475	490
1400	369	400

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1600	295	310
1800	167	182
2000	132	151

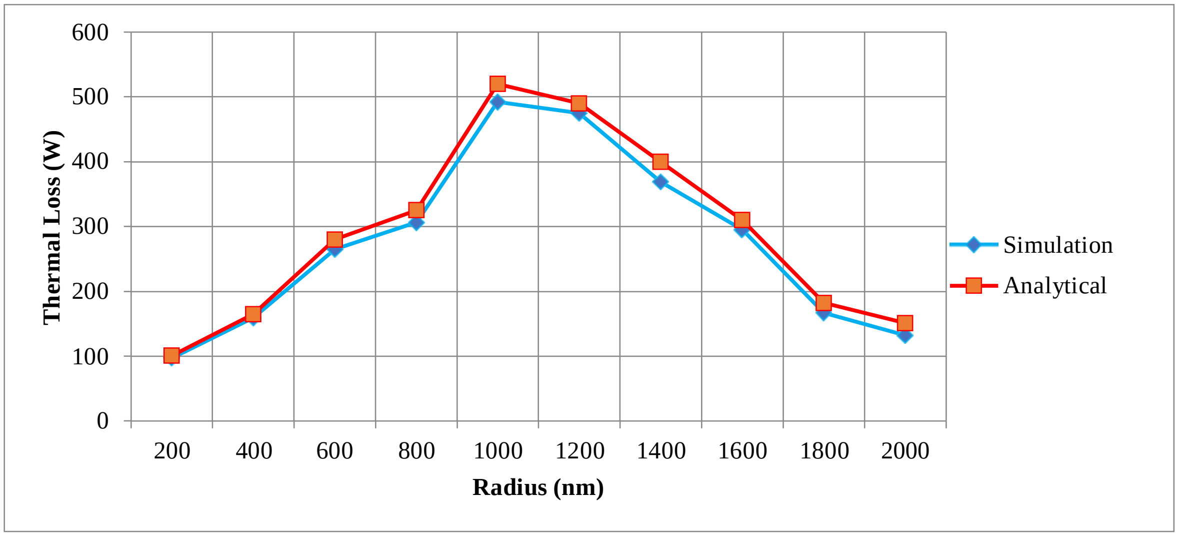

Figure 5. graphical illustration of thermal loss

Table 2 and figure 5 illustrate the simulation and analytical results of thermal loss versus radius in nm. The simulation result is achieved with help of the parametric sweep function for different parabola radii as illustrated in figure 5. When the radius is lesser than 1000 nm, the thermal losses are increased and the scattered field contributes to the gain. When the radius is higher than 1000 nm, the thermal losses get reduced. Therefore, the thermal loss is inversely proportional to the radius when the radius is higher than 1000nm.

Table 3. Tabulation for Standing Wave Ratio versus wavelength

Wavelength (nm)	**Standing Wave Ratio(dB)**	
	Simulation	**Analytical**
200	-8	-11
400	1	5
600	-4	-7
800	-6	-10
1000	-12	-15

1200	-25	-29
1400	-20	-22
1600	-10	-12
1800	-6	-8
2000	-3	-5

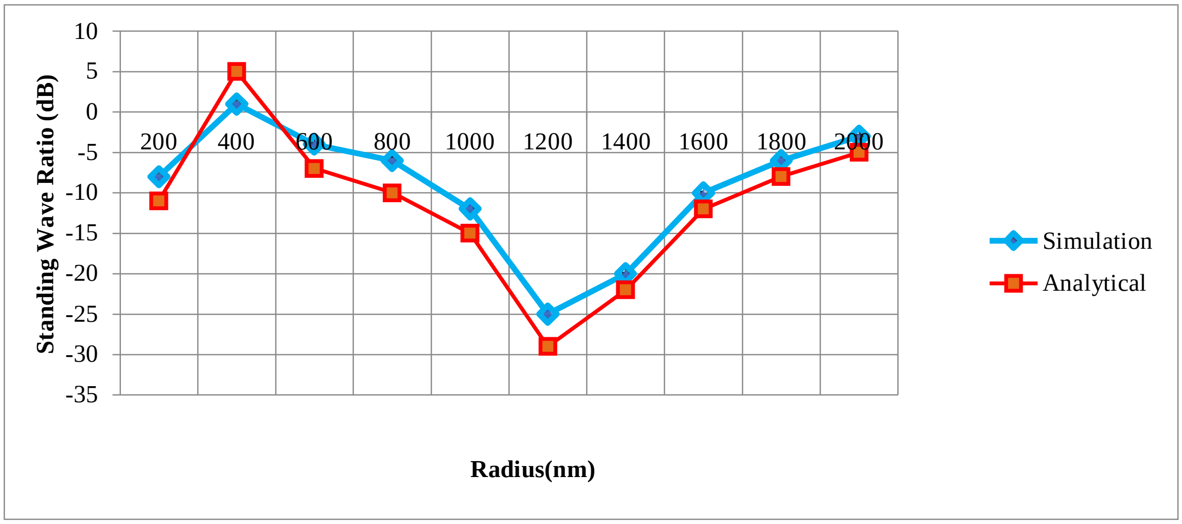

Figure 6. Graphical illustration of standing wave ratio

Table 3 and figure 6depict the graphical illustration of the standing wave ratio with respect to the radius in nm. As shown in the figure, the standing wave ratio results are obtaining the vertical direction of the graph whereas the input of radius in nm is given to the horizontal axis. The impedance matching between the antenna and source or waveguide is performed through the standing wave ratio (SWR) parameter. SWR is described as the fraction of the peak amplitude of the standing wave to the minimum amplitude of the standing wave. SWR depended on the dielectric permittivity relationship of the antenna and waveguide. The central radius gets changed by varying the opening angle. When the θ=5°, the bandwidth of the antenna is described using RF antenna theory and the wavelength region corresponding to SWR obtains below -6dB level and is positioned from 800 nm to 1200 nm range.

Table 4. Tabulation for Electric Field versus wave length

Radius (nm)	**Electric Field(a.u)**	
	Simulation	**Analytical**
200	0.04	0.06
400	0.12	0.14
600	0.2	0.22

800	0.21	0.26
1000	0.2	0.23
1200	0.17	0.19
1400	0.14	0.17
1600	0.11	0.14
1800	0.1	0.11
2000	0.09	0.1

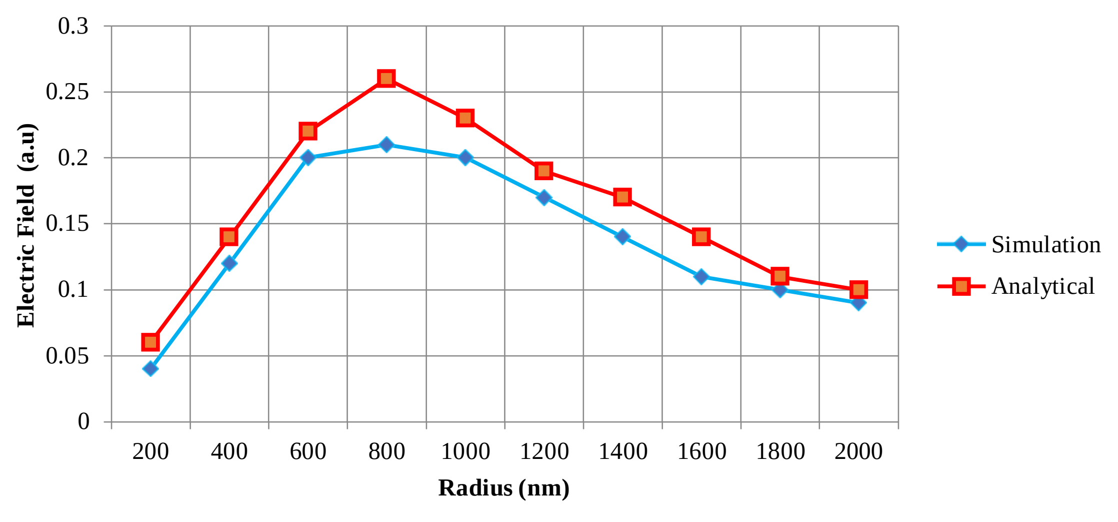

Figure 7. Graphical illustration of electric field

Figure 7illustrates the measurement analysis of the electric field versus radius in nm. The electric field ‘*E*’ is a deep dip in the electric field spectrum. It is a significant parameter to observe that value of the radius corresponding to the minimum value of the electric field (E) is equal to the length ‘*L*’ of the slot antenna. The total electric field is significantly decreased near the wavelength equal to length.

Table 5 Tabulation for radiation efficiency versus wave length

Radius (nm)	**Radiation efficiency** (%)	
	Simulation	**Analytical**
200	85	83
400	86	84
600	88	85

800	92	89
1000	93	90
1200	95	91
1400	96	92
1600	92	89
1800	90	88
2000	93	90

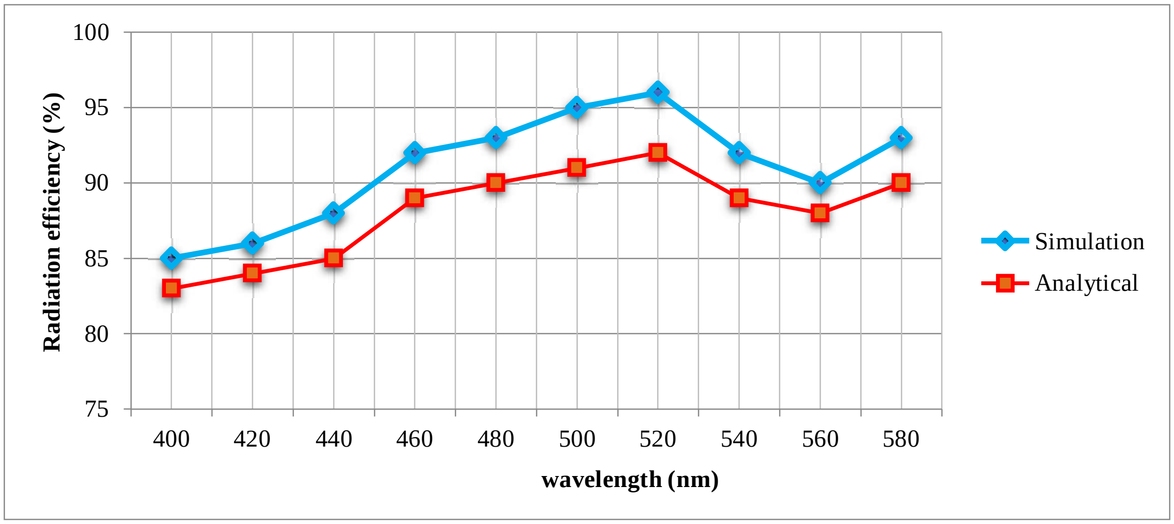

Figure 7. Graphical illustration of radiation efficiency

Table 5 and figure 7 depict the graphical illustration of radiation efficiency for ten various numbers of input taken in the ranges from 200 to 2000 nm. As shown in figure 7, the number of input wave lengths is taken as input in the ‘x ′ directions and performance analysis of radiation efficiency is observed at the ‘y’ directions. The wavelength-dependent radiation efficiency at different radii is obtained as shown in figure 7. The effect of the major radiation efficiency is attained at a radius of 520nm. The higher efficiency is attained by identifying the optimal nano-antenna with help of Elitism divergence multi-objective Harris hawks optimization.

VI. CONCLUSION

A highly compact nano-antenna with an enhanced gain is identified by using the EDHOP technique for 5G mobile communication. The analysis and mathematical modeling of the nano patch antenna are discussed using Elitism divergence multi-objective Harris hawks optimization models. The proposed optimization technique finds the optimal nano-antenna based on fitness estimation. As a result, the best optimal nano-antenna is identified based on position updates. Hence, the overall efficiency gets improved with minimum loss. Simulations were conducted in MATLAB with different performance metrics. The overall simulation analytical results demonstrate the effectiveness of our proposed EDHOP technique in terms of achieving higher radiation efficiency, and standing wave ratio with minimum heat loss and thermal loss.

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