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MULTI-OBJECTIVE HYBRID WHALE OPTIMIZATION ALGORITHM WITH PATTERN SEARCH FOR SOLVING LOAD DISPATCH PROBLEMS

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ABSTRACT: In this paper multi objective hybrid whale optimization algorithm with pattern search for solving load dispatch problems is implemented. To extract the optimum efficiency globally, hybrid whale optimization algorithm with pattern technique is utilized. By using the theory of Humpback Whales the hybrid whale optimization algorithm is processed. Sequential pattern is utilized while processing the hybrid whale optimization algorithm. This is integrated based on the final values. The hybrid whale optimization algorithm is mainly utilized in the test systems. From results it can observe that the cost, Reliability and transmission loss gives effective outcome. By using hybrid whale optimization algorithm load dispatch problems can be solved.

KEY WORDS: Hybrid Whale Optimization Algorithm (HWOA), Load Dispatch Problems, Mutation and Sequential patterns.

I.INTRODUCTION

In our daily life electrical generation plays very important role and its importance is not neglected by anyone. [1]. To reduce the expenses of fuel is the main intent of power industry. Based on the cost of fuel thermal generation unit runs. Fossil fuel generation will reduce the cost of fuel. This will optimize the time, scarcity and expenses in effective way [2]. This will meet the demands of consumer very effectively.

In the power system planning and operation, Economic dispatch (ED) problem plays very important role. While optimizing the power system mainly non convex, multi constrained and non linear problems are obtained. Therefore huge capital investment is done on thermal generating units which are limited to fossil-fuel reservoirs [3]. There will be running charges on the thermal generating units. Because of high expenses Economic dispatch (ED) problem will be obtained.

Generation of electric power based on load is done by power generating units. By determining the generated power from units, Economic dispatch (ED) will manage the power system operation. Because of this there will be reducing in the fuel cost which will meet the demands of load based on power constraints. Thermal, nuclear, wind, solar, wave tidal and geothermal is the power generators which generate the power in electric form [4].

In this intelligent networks are used which is known as smart grid which will generate, transmit and distribute the power in very effective way. This will generates the power according to the demands of consumer. This entire system is controlled by the Economic Dispatch (ED). Electric power is generated by the use of Renewable energy sources.

There are smart appliances and smart meters in the smart grid which will communicate the consumer with high speed. High efficiency, reliability and security are obtained by the use of smart electric power generation [5]. There are different methods introduced to solve the load dispatch problems.

By using the methods of Classical optimization, generation of optimal power is done from power stations. This will limit and minimize the cost of fuel based on the constraints [6]. The other methods are given as Newton method, lambda iteration, gradient method and quadratic programming (QP). Load dispatch problems solutions are found by using the different algorithms [7].

Global optimum solution is found by using the different meta-heuristic optimization methods. Different meta-heuristic optimization methods like Cuckoo Search Algorithm (CSA), Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Bat Algorithm (BA), Whale Optimization (WO) algorithm, Gray Wolf Optimization (GWO) [8]. These methods will solve the load dispatch problems. By using this hybrid whale optimization algorithm effectiveness is improved compared to whale optimization algorithm. Based on the constraints high accuracy is obtained.

II. WHALE OPTIMIZATION ALGORITHM

By hunting the behavior of humpback whales, whale optimization algorithm is inspired. By using the bubble-net hunting strategy, humpback whales will perform the operation [9]. When it is close to the water surface the school of fish is hunted. 12m below the prey is derived and make bubbles around the fish. They use the spiral shape to

perform the entire operation. To catch the prey then will swim up to the surface.

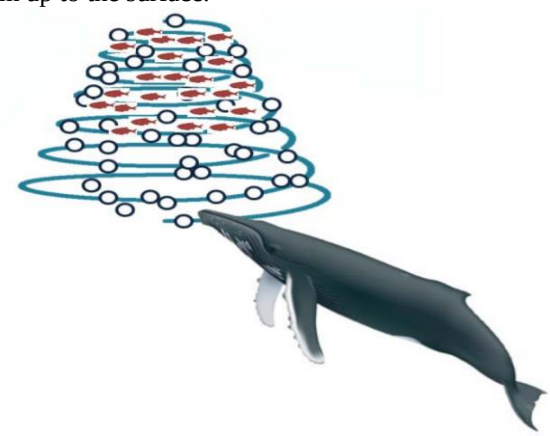

Fig. 1: BUBBLE-NET HUNTING STRATEGY OF HUMPBACK WHALE

The below shows the steps which are used to hunt the prey they are bubble-net attacking, encircling the prey and searching for prey.

1) Encircling the prey:
Location of small fish is searched by the humpback whales to encircle them. Therefore Whale Optimization Algorithm is assumed as best solution to detect the current position of prey [10]. Based on the best search agent, location is updated. The below equations shows the behavior:

$$D = |CP\ g^{*}\ (t) - P\ g\ (t)| \quad (1)$$

$$Pg\ (t + 1) = Pg^{*}\ (t) - AD \quad (2)$$

Here best solution vector is represented as Pg^{*} absolute value is represented as |.|. Coefficient vectors are represented as C and A.

Number of current iteration is represented as t. Best position of prey is updated. Therefore A and C are defined as shown below:

$$A = 2a.r - a \quad (3)$$

$$C = 2.r \quad (4)$$

Here by using the interval [0, 1] vector r is chosen randomly. Based on 2 to 0 the iteration is linearly decreased.

2) Bubble-net attacking (exploitation stage):
Spiral updating position and shrinking encircling mechanism are the two attitudes used in the Bubble-net attacking.

• Shrinking encircling mechanism
Value of a is reduced based on the behavior by using the mechanism of shrinking encircling.

• Spiral updating position
By using spiral shape the humpback whales will be moved. Therefore position is updated. The definition of spiral equation is defined as the location between whale and prey that mimic the spiral shape:

$$Pg\ (t + 1) = D.e^{bt}.\ \cos(2\pi l) + Pg^{*}\ (t) \quad (5)$$

Here distance between school of fish and ith whale is represented as $D' = |CPg^{*}\ (t) - Pg\ (t)|$. Shape of logarithmic spiral constant is represented as b. By using the interval [−1, 1], 1 is selected randomly.

By using the mechanism of shrinking encircling for humpback whale position is updated. Because of this 50% of probability is determined. The below shows the equations of mechanism of shrinking.

$$Pg\ (t + 1) = Pg^{*}(t) - AD \text{ if } p < 0.5 \quad (6)$$

$$D.e'\ bl.\cos(2\pi l) + Pg^{*}\ (t) \text{ if } p \geq 0.5 \quad (7)$$

Where the number of probability is represented as p and the interval range is between [0, 1].

3) Search of prey (exploring stage):
Searching is done randomly by the humpback whales based on the vector |A| exploration. Range of vector |A| is between 1 or less than -1. Global search is performed randomly by the whales when $|A| \geq 1$ and best position is updated by the whales when $|A| < 1$.

$$D = |CPgrand\ (t) - P\ g\ (t)| \quad (8)$$

$$Pg\ (t + 1) = Pgrand(t) - AD \quad (9)$$

In this Random search agent chosen by random position is represented as Pgrand.

III. HYBRID WHALE OPTIMIZATION ALGORITHM WITH PATTERN SEARCH

Hybrid Whales Optimization Algorithm is introduced in this paper. This will resolve the problem of load dispatch. The below shows the step wise discussion of implementation.

Step 1: Initially, allocation is done randomly to initialize the population generation. In the same way number of whales is chosen in this step to calculate the population size.

Step 2: Next, generation of search agents are estimated by using the step 1. For this objective function feasible solutions are obtained. Similarly, best solution is identified in this process.

Step 3: Humpback whales will recognize and encircle the small fishes. Positions are updated by the humpback whales to optimize the number of iterations. By using the below equations process is manifested.

$$D = |C.X^{*}(t) - X(t)| \quad (10)$$

$$X\ (t+1) = X^{*}(t) - A.D \quad (11)$$

Here present iteration is represented by the 't' and coefficients of vectors are represented by A. Both vectors A and C are searched by the agents which are responsible by the quest and this is defined as shown below:

$$A=2a.r - a \quad (12)$$

C = 2. R (13)

Step 4: In this step, operation of bubble net attacking is performed. While performing the operation of hunting probability of whales are assumed. The manifest process of the mathematical model is given in below:

$X(t+1)= X^*(t) - A.D$ if P<0.5 (14)

$X(t+1)= D^{e^{bl}}.\cos(2\pi l) + X^*(t)$ $if\ p > 0.5$ (15)

Here distance among the best solution is represented as DK=| X*(t) – X(t)|. Representation of shape and state of logarithmic spiral is given as b. [-1, 1] is the range of random number '1' of multiplication element. Arbitrary number in [0,1] is represented as 'p'.

Step 5: In this step A is utilized which is a vector for searching prey randomly. 1 and -1 are the values of A. Locations are updated depend on the search agents. The below equation shows the arbitrarily chosen search agent equations:

$D= |C.Xran - X(t)|$ (16)

$X(t+1)=X_{ran}$-A.D (17)

From latest population arbitrary whale is picked and it is represented as Xran. To get better prey from whales A|>1 condition is used.

Step 6: To optimize the process mutation is used. Mutation is obtained by enhancing the global searching capability. In this step cost is calculated and checked. Hence the cost reduced very effectively. For next iteration, data is updated.

Step 7: In this step prohibited operation zones, generation limits and checking of power balance constraints is prohibited in this zone. Power balancing constraints are violated when the mechanism of equality is handled. Depend upon the zones of generation limits, operation is violated.

Step 8: Allocation is done in this step to satisfy the criteria. If it is satisfied then entire operation is stopped and next operation of iteration is performed.

Step 9: All the obtained data is set in sequential pattern and the final results are printed.

The main intent of hybrid whale optimization algorithm is to improve the trade-off of WOA's exploration-exploitation. The combination of differential equations mutation and components of WOA is nothing but a hybrid operator. This hybrid whale optimization algorithm will search for pray, encircling prey and spiral updating position. In hybrid whale optimization algorithm mainly there are two parts exploration part and exploitation one. In this λ is obtained as

$\lambda = 1 - \frac{1}{t_{max}}$ (18)

Here current generation is represented as t and maximum number of generations is represented as tmax. To control hybrid whale optimization algorithm λ is applied based on the ability of the exploration and the exploitation. To explore initial generation exploitation time increases.

IV. RESULTS

The below table (1) shows the comparison results of whale optimization algorithm and hybrid whale optimization algorithm. The parameters used in this are transmission loss, cost and reliability.

Table. 1: COMPARISON OF PARAMETERS

S.No	Parameter	Whale Optimization Algorithm	Hybrid Whale Optimization
1	Transmission loss	less	High
2	Cost	High	less
3	Reliability	Less	High

The below figure (2) shows the comparison of transmission loss and cost for whale optimization algorithm and hybrid whale optimization algorithm.

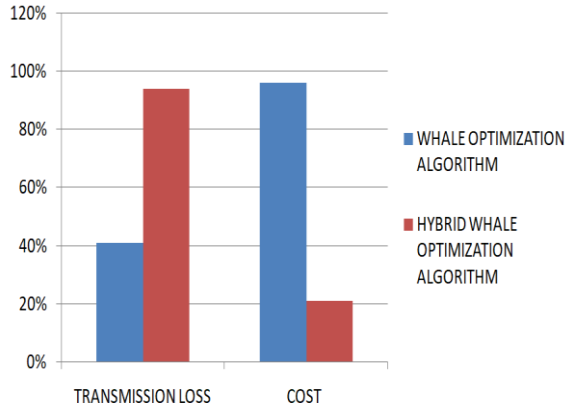

Fig. 2: COMPARISON OF TRANSMISSION LOSS AND COST

The below figure (3) shows the comparison of reliability for whale optimization algorithm and hybrid whale optimization algorithm.

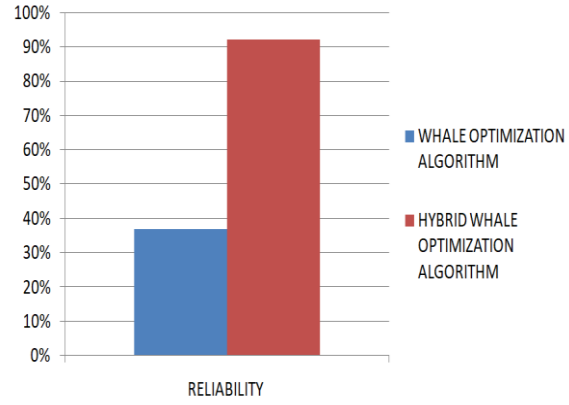

Fig. 3: COMPARISON OF RELIABILITY

V. CONCLUSION

Hence in this paper Hybrid Whales Optimization Algorithm (HWOA) was implemented successfully. Dispatching load problems are solved by Hybrid Whales Optimization Algorithm (HWOA). Performance of Hybrid Whales Optimization Algorithm (HWOA) compared with Whales Optimization Algorithm (WOA) is given in detail manner.

Hence in this paper from results it can observe that the transmission loss will be high for hybrid whale optimization algorithm and reliability also will be high.

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