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Scope of Heuristics, Meta-Heuristics and Nature Inspired Methodologies For Economic Load Dispatchand Bess Based Ancillary Services

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Abstract: In modern world, the electrical power productions plays a vital role for satisfy the time varying power demands. So, it is very important that the generation on electrical power is transmitted and distributed economically to satisfy the power constraint. In power system the electric power can be generated in various ways, but it is furthermost important to decide, how generated power should be dispatched at most economical way. In order to tackles all these issues, these days lot of heuristics, meta-heuristics and nature inspired algorithm are playing a significant role in modern economy. This proposed research presents a technical review of recently developed heuristics, meta-heuristics and nature inspired algorithm along with its advantages and disadvantages, which can be used as a quick reference for the researchers, who are working in similar area. Further, the similar optimization algorithms can be explored to solve the *Economic Load Dispatch problem of realistic power system considering BESS Based Ancillary Services*

Keywords:*BESS Based Ancillary Services*, Optimization technique, heuristics, meta-heuristics and nature inspired algorithm, Economic Load Dispatch.

1. INTRODUCTION

In the high-tech era of the power system process, the most thought-provoking point of interest is to elect in each period that which of the electrical generating units must run so as to befit a varying demand for electricity & every unit has its peculiar traits. These kind of evaluations and activities falls underneath the Unit Commitment (UC). The production scheduling of electric power generated by generating units for a day-to-day to weekly time sphere in turn to achieve some goal is known as unit commitment problem. The solution found for the UC problem must satisfy the generator constraints (like ramp rate limits & minimum up / minimum down times) and the system constraints (like reserve capacity and transmission constraints and energy requirement) [1].

The Economic Load Dispatch (ELD) allocates power to the committed units, thus minimizing the fuel cost. The two major factors to be considered while dispatching power to generating units are the cost of generation and the quantity of power supplied. The relation between the cost of generation and the power levels is approximated by a quadratic polynomial. To determine the economic distribution of load between the 31 various units in a plant, the quadratic polynomial in terms of the power output is treated as and optimization problem with cost minimization as the objective function, considering equality and inequality constraints [2].

2. LITERATURE REVIEW

In the high-tech era of the power system process, the most thought-provoking point of interest is to elect in each period that which of the electrical generating units must run so as to befit a varying demand for electricity & every unit has its peculiar traits. These kind of evaluations and activities falls underneath the Unit Commitment (UC). The production scheduling of electric power generated by generating units for a day-to-day to weekly time sphere in turn to achieve some goal is known as unit commitment problem. The solution found for the UC problem must satisfy the generator constraints (like ramp rate limits & minimum up / minimum down times) and the system constraints (like reserve capacity and transmission constraints and energy requirement).

Over a given time period the task to find a production level and an optimum schedule, for every generating unit which is bring up by Unit Commitment problem (UCP). It specifies in a scheduling sphere at every point in a time period for which the generating units should be put into use [3]. Because human activities depends a lot on electrical power system, throughout the hours of daylight overall load will usually be more on the system and late afternoon when prominent loads are industrial loads, turning on of lights, and slighter in the late twilight & early dawn while the majority of the population is sleeping. Furthermore, electric power is used in a weekly sequence, during weekdays the load is more than the weekend days. What's the reason that this is considered as a problem in the operation of electric power system? Is it possible to just simplycommit enough units to satisfy the maximum system load necessity and leave them functioning? "Commit" a generating unit signifies "turning it on" i.e. to bring about the unit up to speed,

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harmonize it to the system load & attach it in such a manner that it can supply power to the system. The one of cost-effective problem is with obligating sufficient units and desert them in on situation. Handling too many generating units is rather costly. A huge sum of money can be spared by de- committing the units once they are not in demand [1].

In the electrical power industries from several years optimization methods are being utilized for resolving the unit commitment problem. A large amount of money is saved in fuel costs. Due to the restructuring of industry and advancement in the Optimization technology, there is a change in the role of unit commitment. Therefore the need of algorithm with better solution is increasing day by day. This paper purpose is to help the investigators, researchers and scientists to well known about some of the various hybrid and non-hybrid algorithms which are being used in the unit commitment problem. Algorithm development is necessary due to the unit commitment problem complexity, large size and high economic benefits obtained from improved solution [2]. Some of the Unit Commitment problem methodologies are discussed in the following section.

3. METHODOLOGIES FOR ECONOMIC LOAD DISPATCH

For solving, the Unit Commitment problem various methodologies have been developed in the past years. There are two types of methods for solving Unit Commitment problem, these are given as follows:

1. Non-Hybrid Methods
2. Hybrid Methods

The Non-Hybrid Methodologies which are used in the recent years by the researchers, scientists and inventors are discussed below:

Table-1: Heuristics and Meta-Heuristics Non-Hybrid search algorithm for Economic Load Dispatch

Simulated Annealing Algorithm	Branch and Bound Algorithm	Crow Search Algorithm(CSA)
Particle Swarm Optimization Algorithm	Dynamic Programming Algorithm	Smart Water Drop Algorithm
Fuzzy Logic Algorithm	Lagrangian relaxation method	Seeker optimization algorithm (SOA)
Harmony Search Algorithm	Particle swarm methodology	Differential Evolution Algorithm(DEA)
Genetic Algorithm	Hybrid artificial neural network-differential dynamic programming (ANN-DDP) method	Firefly Algorithm
Fast Heuristic Algorithm	Ant Colony System(ACS) based optimization	Multi-strategy Collaborative Biogeography-Based Optimization (MsEBBO)
Evolutionary Algorithm	Absolute stochastic simulated annealing method	Mixed Integer Quadratic Programming (MIQP)
Pattern Search Algorithm	Stochastic Priority List method	Moderate Random Search PSO(MRPSO)
Binary Fireworks Algorithm	Shuffled Frog-Leaping Algorithm (SFLA)	Grey Wolf Optimization (GWO)
Shuffled Frog Leaping Algorithm	Constrained pattern search algorithm.	Moth-Flame Optimization (MFO) algorithm
Biogeography-Based Optimization	Multi-particle swarm optimization (MPSO)	Hopfield Method
Bee Colony Algorithm	Improved Genetic Algorithm (IGA)	Ant Lion Optimization
Invasive Weed Optimization	Enhanced IWO algorithm (EIWO)	Elephant Herding Optimization
Gravitational Search Algorithm		Monarch butterfly optimization
Binary Gravitational Search Algorithm		Adaptive Cuckoo Search Algorithm
Bat-Inspired Algorithm		Water wave optimization
Imperialistic Competition Algorithm		Autonomous Group Particles Swarm Optimization(AGPSO)
Branch and Bound Technique		Self-Adaptive Bat Algorithm (BA)
Branch and Bound method for Integer Programming		Whale Optimization Algorithm(WOA)

The various NON-HYBRID algorithms used in these methodologies are discussed below:

3.1 SIMULATED ANNEALING ALGORITHM

A feasible solution with higher cost is acknowledged with the temperature reliant probability, but in simulated annealing method other solutions are accredited deterministically. It can escort to the near optimization slowly. Though, acceptance probabilities are associated with both greater and lesser cost for all the solutions. The constraints are handled efficiently for additional units with system reliant probability distribution. However the hill-climbing search is fast it suffers from local optimization and only select better solution. The Absolute Stochastic Method merges the smart properties of genetic algorithm and hill-climbing search. Whereas, genetic algorithm is completely stochastic algorithm, it is a very sluggish process as it wants long generation [4]. The temperature, control parameter, is modified to the cost levels in Adaptive simulated annealing algorithm plan, on which during the annealing process algorithm works. In finding a good solution the time taken is shortened improving the convergence and satisfying all constraints of the algorithm. This method includesreserveconstraints, minimum UP or DOWN time constraints, demand and unit power generation limits, and time reliant start-up costs. During the operation of the algorithm some

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information is gathered from which the parameters of Adaptive schedules are modified. For the Unit Commitment problem stable and acceptable solutions near-optimal are given by the adaptive Simulated Annealing [5].

Advantages:

- It has the capability to strive for near global optimal solutions.
- It is robust in nature.
- This algorithm has good execution time.
- This algorithm has a better convergence.
- Simulated annealing algorithmhas a uniformprobability distribution over global optima.

Disadvantages:

- Due to the non-parallel algorithm arrangement simulated annealing takes longer calculation time than the genetic algorithm.
- The first and most significant problem is that SA uses only one search agent.
- For multi-objective optimization, Simulated Annealing algorithm has been hardly used.

3.2 PARTICLE SWARM OPTIMIZATION ALGORITHM

In year 1995, Kennedy and Eberhart first proposed Particle Swarm Optimization (PSO) technique. Initialization of PSO is done by particles known as population of possible solutions. Each particle flies with a definite velocity in the search area. During exploration, social and cognitive information is attained which influences the particle's flight. The evolutionary process is very easy and has few tuneable parameters. It is effectively applied to solve combinatorial, multimodal, multi-objective and nonlinear problems. Many complex power system problems are provided with quality solutions by this algorithm [6]. Adaptive particle swarm optimization (APSO) is a new parameter free approach. This algorithm overcomes major drawbacks of PSO such as problem reliant penalty functions, choice of optimal swarm size and parameter tuning. An adaptive penalty function approach solves the constrained optimization problem. The APSO is a parameter boundless method. On the basis of their performances, the flight of particles can be adjusted by the algorithm. Therefore no parameter tuning is needed. It is can easily find the most suitable swarm size. For attaining the optimal solution, Tribes move in the search space having diverse sized clusters of particles in it. In turn to locate a local minimum flying experiences are shared among all the particles in a group. Several promising areas are explored by the tribes concurrently and correlate among each other to choose on the global minimum. The algorithm is liberated of the problem to be solved, as it is self-adaptive [7]. Multi Particle Swarm Optimization (MPSO) is a novel strategy which solves the Economic Load Dispatch problem by producing possible particles and renders the search space thin inside the possible solutions. The new strategy generates a few particle swarms, and in each particle swarm location optimum solutions are explored, after that a new particle swarm is devised of location optimum solutions, & in this new particle swarm the global optimal solution is explored. This new generating approach in PSO can efficiently break out from local minima and improves the global searching capability. This strategy applies multi particle swarm to the parallel arithmetic and enhanced the convergence speed [8]. To solve UCP a novel intelligent binary PSO (IBPSO) method is developed. In this technique, mutation point (MP) is attained with an intellectual method. So the real-valued PSO has to be extended to manage discrete area of UC schedule. In the IBPSO technique an individual is a bit sequence which begins its tour from an arbitrary position in the search area & attempts to reach near to global best position and earlier best position of himself [9].

Advantages:

- The PSO is an intellectual technique which can be applied for engineering applications and scientific study.
- The PSO has no mutation calculation and overlapping.
- It has very fast search speed.
- The calculation in PSO is very simple as compared tothe other emerging algorithms.

Disadvantages:

- It requires parameter tuning and selection of optimal swarm size.
- This technique cannot solve the problems for no coordinate system.
- The modified PSO is considered with valve point loading effects and multi fuel options.
- The generation constraints such as prohibited operating zones and ramp rate limits are considered with network loss.
- It suffers from less exact directive of the speed and the way due to the partial optimism.

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3.3 FUZZY LOGIC ALGORITHM

For solving multi constrained, highly non-linear optimization problems fuzzy logic based techniques are powerful tools in electrical power system. This technique is a mathematical scheme which holds within the concept of ambiguity when describing a theory or a meaning like presence of vagueness or "Fuzziness" in phrase like "more" or "less" as these terms are relative & vague. Thus Variables believed are called as "fuzzy" as contrasting to "crisp". Uncertainty is similar to fuzziness. Ideas like these are applicable to the unit commitment problem. These techniques assure the creation of solution that does not breach unit or system constraints, only if generators accessible in the selection group to encounter the needed load requirement. But generally near optimal solutions are satisfactory in most practical cases, although the global optimality is desirable. It permits a qualitative depiction of the system's features, response and behaviour of a system without the need for precise mathematical formulation. The qualitative analysis of results appears to be attractive using this method [10].

Advantages:

- It can solve multi constrained and highly non-linear optimization problems.
- It provides a powerful global search mechanism.
- In problem solving, it is helpful in decreasing thenecessity for intricate mathematical models.
- It has the capability to control any kind of unit attributes data.

Disadvantages:

- It lacks an effective learning capability.

3.4 HARMONY SEARCH ALGORITHM (HS)

For resolving the UCP an effective in addition of innovative solution based Harmony Search (HS) Algorithm is created. The HS algorithm is modest to use as associated to theadditional Evolutionary techniques and within a reasonable time it reaches to optimal solution. This algorithm is inspired from a natural phenomenon i.e. while an instrumentalist explores aimed at a superior state of harmony, which is natural musical performance process. A number of optimization operators are included in HS algorithm, like size of harmony memory is known as numeral of the solution vector within harmony memory, pitch adjusting rate, memory for harmony it stores the possible vectors and memory for harmony considering rate. In the memory for harmony is a fresh vector is created by choosing the elements of dissimilar vectors arbitrarily. This algorithm can solve the non- linear and complex optimization problems efficiently [11].

Advantages:

- It reaches to the optimal solution within a reasonable time.
- This technique can resolve both large scale and small scale UC problems data efficiently.
- This algorithm is an effectual technique to resolve the non-linear, hard satisfactory and complex optimizationproblems.

Disadvantages:

- As the iteration solution approaches to the optimal solution, it suffers from slow local convergence speed especially.
- For finding an optimal solution the number of iterations rises.

3.5 GENETIC ALGORITHM

An adaptive search technique called Genetic algorithms (GA) motivated from natural evolution centred on the rules of natural choice & persistence of the fittest. The previous techniques do not offer satisfactory or somewhat information about the management of objectives and constraints. An improved technique called Improved Genetic Algorithm; it provides enhancement in price and value of solution for unit commitment problem [12]. A novel advanced Genetic Algorithm GA is developed which handles the constraints very well. The solution is not certified to be optimum owed to the heuristic character of the algorithm. The advanced GA can effectually search near global optimal or global resolution to the UCP[13]. GA reduces the emission cost and operating cost considering the constraints very well. GA involves various steps for solving unit UC problem to develop a high precision solution and good convergence, fitness function, parameter coding, genetic operation like mutation, convergence and crossover criterion are chosen centred on the traits of UC problem [14].

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Advantages:

- Ease of implementation and Computational simplicity.
- Fast calculation speed.
- Powerful search ability to attain global optimum.

Disadvantages:

- Thealgorithmbecomesreallycomplexwhile integrating it with a software program.
- Requires huge effort and computational time.
- Premature convergence problem.

3.6 FAST HEURISTIC ALGORITHM

The Loss of Load Probability (LOLP) constraint is satisfied by the iteration amid the operating reliability estimation and the conventional spinning reserve requirement constrained Unit Commitment using a fast heuristic algorithm considering reliability constrained unit commitment. The algorithm can converge in very less time even for system with large number of units, while the result is attainable and suboptimal. This technique makes UC considering LOLP constraints equivalent among conventional deterministic UC methods in calculation swiftness and it will endorse the use of the probability UC methods. The method comprises two main parts: reliability evaluation and spinning reserve (SR) constrained UC. Then, from UC results LOLP is calculated. Spinning reserve requirement (SRR) is updated when the LOLP gets larger than predetermined utmost LOLP limit. This whole process is repeated again or else the algorithm converges [15].

Advantages:

- The qualities of this method are the robustness & swiftness of the algorithm.
- It finds a solution close to the best one.

Disadvantages:

- A few of the problem's requirements are disregarded or even overpowers in turn to be simple and fast.

3.7 EVOLUTIONARY ALGORITHM

In uncertain environment the multi objectivised unit commitment (UC) problem is resolved by means of multi-objective Evolutionary Algorithm (EA). Uncertainties due to load forecast error and unit outage have to be included in the result using the reliability index, Loss of Load Probability (LOLP) and Expected Unserved Energy (EUE). LOLP index conveys the possibility that the forecasted demand will not covered by generation system & EUE index conveys that during the scheduling sphere the generation system is not providing the expected quantity of energy. The reasons for the success of this algorithm are using population centred algorithm and by means of helper-objective contrary in environment with the prime goal to help sustain population variety & leads exploration away from the local optimum. Added benefit of using helper objective like in one sole run reliability provides a varied group of trade-off cost reliability results [16].

Advantages:

- This algorithm is robust with respect to noisy evaluation functions, non-linear constraints, multi-modalities and discontinuities.
- This algorithm is helpful for those problems, where numerous results are necessary.
- Parallel implementation is easier.

Disadvantages:

- Finding of an optimal solution cannot be assured in a limited quantity of time.
- By using the trial and error method the parameter tuning is done.
- The population methodology might be costly.

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3.8 PATTERN SEARCH ALGORITHM

A Pattern Search (PS) algorithm is used for solving unit commitment to produce an optimal & robust solution. This algorithm is developed to set up relationship amid various factors subjected to the fulfilment of diverse constraints like power demand is equal to power generation and generation limits for developing robust solution. The PS optimization technique is a superior search based method specifically appropriate to resolve a variety of optimization problems which remain external to the extent of typical optimization techniques. The PS algorithm, keep on assessing a string of facts which cannot or can come close to the optimum solution. For a complex UC problem an effectual robust solution is necessary for overall optimization, where uncertainty exists because of number of constraints & by using PS such problem can be dealt easily. With the increase in the unit size intricate constraints are inflicted, by using conventional methods the problems are difficult to address. PS can easily resolve this difficulty as a consequence of logical representation of parameters [17].

Advantages:

- Theconceptofthisalgorithmissimple, computationally effectual and easy to implementation.
- It can be used for a large number of units.
- The proposed algorithm is efficient and faster .
- It can be operated on functions whichareneither differentiable nor continuous.

Disadvantages:

- The PS is highly responsive to the early estimate and it seems to trust on that how near the known initial point is to global solution. It creates the technique feasiblymore vulnerable to get stuck in the local minimum.

3.9 BINARY FIREWORKS ALGORITHM

Binary fireworks algorithm (BFWA) solves the commitment and scheduling problem, for classifying search space it imitates explosion of fireworks in the sky and distance amid linked sparks to calculate global minimum by imitating specific action of fireworks explosion in the sky. Fireworks are generally of two types; good and bad fireworks depend on the explosion & related sparks. A good firework is defined as the firework explosion with fine group and strongly connected sparks & vice versa. The FWA follows the base rule framed such that, the group of sparks emerged from firework explosion symbolizes the search space. Thus, the firework with strongly connected spark group reduces the search space & consequently leading to an optimal solution existence & a bad firework with lightly spaced sparks will result in big search space becoming an incompetent optimal solution [18].

Advantages:

- Fast convergence speed.
- Good optimization accuracy.
- Achieves near optimal solution.

Disadvantages:

- Sometimes when a bad firework occurs the optimal solution becomes inefficient.

3.10 SHUFFLED FROG LEAPING ALGORITHM

The novel evolutionary algorithm which is also called as Shuffled Frog Leaping Algorithm (SFLA) is used to find an answer to Unit commitment (UC) of the thermal units. The SFLA algorithm is integer Coded centred on the performance of the cluster of frogs exploring for the place having a large quantity of foodstuff availability. For controlling precisely the Minimum UP time or DOWN time constraints, scheduling variables are implied as integers. SFLA is a type of Meta- heuristic optimization technique it unites the PSO algorithm social activities and GA algorithm memetic evolution. It is the blend of arbitrary & deterministic approaches. Deterministic method permits the process to make use of the search area effectively escorting its heuristic quest & the arbitrary method confirms sturdiness & elasticity of the search method. It is able of resolving continuous and discrete optimization problems and also able of resolving non-differentiable, multi modal and non- linear optimization problems [19].

Advantages:

- It has faster convergence speed.
- The algorithm is able of resolving continuous&discrete optimization problems [19].
- It is able of resolving non-differentiable, multi modal & non-linear optimization difficulties [19].

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Disadvantages:

- Non-uniform initial population.
- Slow convergent rate.
- Limitations in local searching ability.
- Premature convergence.
- Easy trapping into local extremum.

3.11BIOGEOGRAPHY BASED OPTIMIZATION (BBO)

This Biogeography Based Optimization algorithm can be applied for solving the Unit Commitment problem in the electric power system. A study based on topographical dispersal in biological creatures is called biogeography. BBO have qualities in general with additional biology centred optimization techniques, like Particle Swarm Optimization & Genetic Algorithms. The problems which PSO and GA can solve will also be solved easily by BBO. This technique can easily solve non convex & non smooth problem generally using two phases: 1) Mutation 2) Migration. The migration of species from one isle to another is depicted by BBO using mathematical models, how the species ascend & turn out to be non-existent. An isle in BBO is explained as any locale that secluded geographically from other locale. Well fit locale for the species represents the High Locale Suitability Index (HSI) although locale with low HSI said to not so well fit. Every locale comprises of characteristics which chooses the HSI for the locale. These characteristics are called Suitability Index Variable (SIV) considered as independent variable which plots the value of the HSI of the locale. A huge amount of the species has high (HSI) locale whereas lesser amount of the species has low (HSI) locale. In BBO, HSI of the locale may be raised by the migration process although due to mutation process the species in the locale will tend to go extinct if the HSI does not ascend and swapped by new species [20].The BBO with new migration operator is tested over 20 test problems and results are compared with that of original BBO and Blended BBO and results shows that proposed operator is competitive to the present one. This paper proposes that modified migration operator for better diversified search in promising area of search space. The proposed modified BBO (MBBO) uses the information from selected candidate solution to find global optima more accurately with high convergence rate. To verify the performance of MBBO 20 test problems with different characteristics are employed and its comparison with original BBO are conducted in terms of efficiency, reliability and accuracy, the comparison results shows that MBBO outperforms the all considered algorithms.The results also showed that chaotic mutation operators are not able to improve the performance of BBO. Another finding of this paper was that the combination of the chaotic selection and emigration operator is better than other combinations investigated. This was due to the superior exploration of the CBBO with these two operators combine. For future studies, it would be interesting to employ CBBO for solving real-world engineering problems.

Advantages:

- Doesn’t take unnecessary computational time.
- Good in exploiting the solutions.
- Unlike the other optimization techniques solutions don’t perish in the end of every generation.
- It has better convergence possessions and can escape the convergence which is premature.
- All the non-linear and linear constraints are measured.

Disadvantages:

- Exploitation of the solutions by BBO is poor.
- During every generation no facility is given forchoosing the finest members.
- While founding the qualities, a locale does not consider its resulting fitness, which may result in the generationof several infeasible results.

3.12GBEST ARTIFICIAL BEE COLONY ALGORITHM

The Scheduling of units is an optimization task known as UC for the generation corporations attaining utmost benefit with least operation price exclusive of any impulse of filling consumer's need owed to the deregulation of the power industries. Hence, Gbest Artificial Bee Colony (Gbest ABC) algorithm is operated for solving Profit Based Unit Commitment (PBUC). The Gbest ABC method emphases on a group of honeybees & their food search behaviour. There are generally categorised into three clusters of bees i.e. Onlookers, scouts and employed bees. In the ABC algorithm bees hover to search food in the multi-dimensional search area. Reliant on previous experience, a number of bees hunt for food supply whereas other bees lacking experience search arbitrarily. The onlooker bees get food statistics from the employed bees. The best food locations from those explored by the employed bees are selected by the onlookers & after that they further search food resource nearby the elected food resource. Having no possibility of

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progress in the food resource, the scout bees hover & locate fresh food resource arbitrarily lacking earlier experience [21].

Advantages:

- Flexibility, sturdiness & simplicity.
- Unlike other search methods uses less controlparameters.
- Other optimization algorithms can be easily hybridized with it.
- It has the capability of handling objective cost having stochastic character.
- Using logical & basic mathematical operations it can be easily implemented.

Disadvantages:

- In ABC, for local minima the convergence performance is slow.
- Premature convergence to local minima due to poor exploitation.

3.13INVASIVE WEED OPTIMIZATION (IWO)

IWO is a novel method to effectually resolve unit commitment (UC) and generation cost solution. The load demand is dispersed amid all the generating units using an existing technique IWO .This technique exploits the yield of UC attained by means of the Lagrangian Relaxation technique& it evaluates the essential generation through the plants leaving the OFF & considering the ON generator units, hence providing a more accurate & faster response. This technique comes under the meta-heuristic technique it imitates the inhabiting behaviour of weeds. The technique of cultivating of weed plants is used to banquet out above a space. Initially, in open periphery ground the arbitrarily spread out seeds arepermitted to grow. Like the growth of plants, estimation of their fitness functions is done & arranged in the order of fitness declining. At the top, only the best fit plant is positioned. Newseeds of the plants get implanted reliant upon the fitness values. The evaluation between fitness of seed & the parental weed is evaluated collectively. A normalized standard deviation assessment decides the location at a space where the plant new seeds are to be dispersed. In the record, weeds having smallest fitness are eliminated. In comparison to other evolutionary algorithms this method of congregating to the optimum resultgetting relatively accurate best fit parent-seed mixture [22].

Advantages:

- It has a faster and accurate response.
- This method could be stretched for any duration and no. of generating units for load scheduling.

Disadvantages:

- The convergence of results and the speed of execution are reduced due to reason that IWO technique obtains the outputs of UC from various other techniques.

3.14GRAVITATIONAL SEARCH ALGORITHM (GSA)

For the wind-hydro-thermal synchronization problem, GSA is utilized for resolving & for dealing with the equality constraints pseudo code centred process is advised for increasing optimization process of the problem. Penalty function methods are not used in this module for dealing with the equality constraints other than. The major drawback of penalty function technique is reduction in the search area & if is a greatly constrained problem, it can employ good deal of time to search the possible solutions. This algorithm follows the law of gravity. Objects are deemed as agents in GSA & their masses helps in the evaluation of their functioning. Fitness function is clearly proportionate to the masses of the agents. The masses draw each other owing to gravitational push of attraction enacting on them through everyiteration &all the agents experiences a global transfer toward the agents with heftier masses. An efficient agent has heavier mass. GSA is engaged to inspect the impact of various circumstances. This suggested method is pretty effectual for attaining result due to the influence of dissimilar groups [23].

Advantages:

- Ease of implementation.

4. HYBRID METHODOLOGIES FOR ECONOMIC LOAD DISPATCH PROBLEM

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The following hybrid methodologies are implemented by various researchers, scientists & inventors in the recent years and can be considered as useful methodologies for are discussed below:

Table-2: Heuristics and Meta-Heuristics Hybrid search algorithm for Economic Load Dispatch

Particle Swarm-Based-Simulated Annealing Optimization Approach	Simple genetic algorithm-Tabu search and simulated annealing
Quantum-Inspired Binary PSO	Hybrid Particle Swarm-Based-Simulated Annealing Optimization (PSO-B-SA)
Improved Priority List and Enhanced Particle Swarm Optimizatic	Improved Priority List and Enhanced Particle Swarm Optimization (IPL-EPSO)
hybrid of Genetic Algorithm And Differential Evolution (hGADE)	Differential Evolution (DE) & Biogeography-Based Optimization (BBO)
Quadratic Programming & unit de-commitment (QPUD)	Differential Harmony Search Algorithm
Particle Swarm Optimization And Grey Wolf Optimizer Algorithm (PSO-GWO)	Tabu Search (TS) and Quadratic Programming (QP)
Improved Firefly & Particle Swarm Optimization Hybrid Algorithm	EP and Sequential Quadratic Programming (SQP)
Gbest Artificial Bee Colony Algorithm (GABC) & Teaching Learning Based Optimization	Self-Organizing Hierarchical Particle Swarm Optimization (SOH-PSO)
Genetic Algorithm and Tabu search	Aggregation-Based PSO (ICA-PSO)

5. RESEARCH FINDINGS

The surveyed literature reveals that there are numerous optimization techniques available to contendthe complexities of economic scheduling and dispatch problems. Some of these methods are already discussed in table 2.1,2.2 and 2.3. Every algorithm has advantages and limitations as implemented to different problems. According to no lunch theorem there is always a need to develop new optimization algorithm. Some of the observations of existing methods are explored as *conventional approaches* for optimization and*Memetic approaches* for optimization and enlisted as:

5.1 Non-Hybrid and Conventional Approaches for Optimization

- In *Genetic Algorithm* the problem exists in finding the global minima but is capable to give results in less time.
- *Evolutionary programming* is not suitable to solve multi-objective problems the performance reduces and computational time increases with increase in multiple objectives.
- *Simulated Annealing*easily converges near local optimawith less computational time but takes much time to reach the near-global minima.
- *Hopfield Method* can only be applied to the systems with linear constraints.
- *Particle Swarm Optimization* has very high search speed but it requires high tuning and selection of the parameters. The algorithm converges to local optima in less time and is used for local searching.
- *Pattern search algorithm* stuck in the local minima but can be operated with high efficiency and fast speed.
- *Differential Evolution Algorithm*results in global optimal solution with minimum convergence time and is superior in term of exploration, exploitation and convergence but have complex structure.
- *Harmony search algorithm* solves non-linear and complex optimization problems within a reasonable time but suffers from slow local convergence speed and requires large number of iterations for optimal solution..
- *Gravitational search algorithm* is easy to implement and has low computational time but it easily stuck into local optima rate of convergence slows down in the later search phase.
- *Bat-inspired algorithm*is easy to implement and requires less execution efforts and search better solutions at high convergence rateand due to local optima this algorithm confronts improper convergence.
- *Artificial bee colony algorithm* is flexible and uses less control parameters and easily hybridized with other algorithms but has slow convergence speed for the local minima and sometimes premature convergence occurs due to poor exploitation.
- *Ant Lion Optimization* proved high convergence rate and less computational time for multi-modal problems but sometimes fall in premature convergence.
- *Whale Optimization Algorithm* is much determined in comparison with other algorithms but sometime

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do not perform better.

5.2 Hybrid/Memetic Approaches for Optimization

- *Firefly-PSO algorithm*gives a better solution efficiently and precisely with fast convergence rate.
- *GA-TS-SA algorithm* focuses on fuel cost minimizing while retaining the power output of the generation within their safe limits. But when the number of constraints are typically large scale system it takes more time to converge.
- *PSO-SA algorithm* can easily escape from the local minima and have better computational speed with high convergence speed.
- *DE-BBO algorithm* improves the searching ability of differential evolution by incorporating BBO and gives better performance than individual algorithms.
- *DE-HS algorithm*has better searching ability and gives better performance than individual algorithms
- *EP-SQP algorithm* used base level search and lead to global search region and SQP is used to conduct local search in that region to find the optimal solution..
- *GA-DE algorithm* has the advantage of having good convergence speed with no premature convergence and high computational time.
- *PSO-GSA algorithm* has increased computational efficiency which make the control parameters more robust. It has convergence toward superior quality near optimal result without stucking in local optima.

From survey of literature regarding latest search algorithm, economic load dispatch and renewable energy scheduling,it has been perceived that noticeable efforts have been made to solve the ELD problem considering simple, dynamic, multi area and multi-objective ELD problem using different optimization algorithms, but no significant efforts has been made in field of Economic load dispatch problem considering the impact of plug-in electric vehicles and renewable energy sources.Further, the optimized solution for economic load dispatch problem has not been investigated with reference to other important constraints such as ramp rate, valve point effect and prohibited operating zone etc., which seriously affect the optimality of the results. Therefore to overcome the above mentioned drawbacks, research proposal here is to implement hybrid solution approaches to explore economic dispatch problem with due consideration of plug-in electric vehicles/ BESS and renewable energy sourcesto provide global optimal solution.

Also, it is clear from the literature, appreciable efforts are made to solve the single and multi area economic dispatchproblem using various meta-heuristics optimization techniques, but no significant efforts are made to find out the global optimization search algorithm by combining local and global search capability of algorithm to improve exploration and exploitation. Further, No free lunch theorem has logically suggested that none of the optimization algorithm is able for solving all types of optimization problems efficiently. In other words, there is always scope of improvements to upgrade current techniques to better solve maximum optimization problems efficiently.

In recent research studies pertaining to optimization algorithm, it has been reported that swarm intelligence optimization have some drawbacks which must need to be solved[201]. Another important concernin swarm intelligent algorithm is regarding exploration, which is inopportune measure without theoretical guidance. In practical application, it creates serious problem. This motivated our attempts to propose yet another memetic algorithm for solution of single and multi-area economic load dispatch problem with due consideration of renewable energy and plug-in electric vehicles.Further, the single and multi area economic load dispatch problem has not been investigated with respect to impact of hybrid and plug-in electric vehicles and renewable energy sources, which seriously affects the load demand pattern and optimality of the results. The work is therefore justified in persisting the proposed study.The research proposal therefore *presents"Memetic Meta-Heuristic Optimization for Economic Load Dispatch in BESS Based Ancillary Services".*

6. CONCLUSION

Fast established computer technology, which change the engineers in electrical power sector are involved by machine learning and Artificial intelligence. Emergent computer software permit additional aureate scheme for power system optimization. Further, sophisticated process approaches results in greater consistency. In the proposed research, the authors has presented the scope of Artificial Intelligence and Machine Learning algorithm for the solution of Economic Load Dispatch in BESS Based Ancillary Services. Further, the advantages and disadvantages of various

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heuristics, meta-heuristics, evolutionary and nature inspired algorithms are explored in more depth, which can be used as quick reference by other scientists working in similar domain.

REFERENCES

[1] Allen. J. Wood, Bruce F. Wollenberg "Power Generation, Operation and Control", John Wiley & Sons, Technology & Engineering, 7 Nov, 2012.

[2] Benjamin F. Hobbs, Rothkopf, M.H., O'Neill, R.P., Hung-po Chao "The Next Generation of Electric Power Unit Commitment Models", 2001.

[3] Amit Bhardwaj, Vikram Kumar Kamboj, Vijay Kumar Shukla, Bhupinder Singh And PreetiKhurana "Unit Commitment in Electrical Power System- A Literature Review", Proc. of Power Engineering and Optimization Conference (PEDCO) Melaka, Malaysia, 6-7 June 2012.

[4] A.Y. Saber, T Senjyu, T Miyagi, N Urasaki, T. "Absolute Stochastic Simulated Annealing Approach To Unit Commitment Problem", IEEE 13th International conference on Intelligent System Application to Power System, Virginia, 6-10 Nov. 2005.

[5] G. Dudek, "Adaptive Simulated Annealing Schedule to the Unit Commitment Problem", Electric Power Systems Research, vol. 80, issue 4, pp. 465-472, 2010.

[6] Kennedy J., Eberhart, R. "Particle Swarm Optimization", IEEE International Conference on Neural Networks, Vol. 4, 1995.

[7] V. S. Pappala and I. Erlich, "A New Approach For Solving The Unit Commitment Problem By Adaptive Particle Swarm Optimization" Proc. of . IEEE PES General Meeting, Pittsburgh, PA, Jul. 20–24, pp: 1–6, 2008.

[8] Wei Xiong, Mao-Jun Li, Yuan-Lin Cheng, "An Improved Particle Swarm Optimization Algorithm for Unit Commitment", Proc. of International Conference on Intelligent Computation Technology and Automation, vol. 01, pp: 21-25, Washington DC, USA, 2008.

[9] Y.Pirhayati, K.Mazlumi, "An Intelligent Binary Particle Swarm Optimization for Unit Commitment Problem", IEEE International Conference on Power and Energy, 2010.

[10] D. P. Kadam, P.M. Sonwane, V.P. Dhote and B.E. Kushare, "Fuzzy Logic Algorithm for Unit Commitment Problem", Proc. of the International Conference on Control, Automation, Communication and Energy Conservation, pp: 1-4, Perundurai, Tamilnadu, June 4-6, 2009.

[11] S. Najafi, Y. Pourjamal, "A New Heuristic Algorithm for Unit Commitment Problem" Energy Procedia, vol. 14, pp: 2005–2011, 2012.

[12] S. Jalilzadeh and Y. Pirhayati, "An Improved Genetic Algorithm for Unit Commitment Problem with Lowest Cost" in IEEE International Conference on Intelligent Computing and Intelligent Systems, pp: 571-575, 2009.

[13]Kezhen Liu, Jilai Yu, Hong-Chun Shu, Yong Chen, "A New Advanced Genetic Algorithm For Optimal Unit Commitment Of Power System", Proc. of Power and Energy Engineering Conference, APPEEC 2009 Asia-Pacific, pp: 1-4, 27-31 March 2009.

[14] S.Shobana and R.Janani "Optimization of Unit Commitment Problem and Constrained Emission Using Genetic Algorithm" International Journal of Emerging Technology and Advanced Engineering, vol-3, pp: 367-371, May 2013.

[15] Ming Yang, Feng-Lu Cheng, Xue-Shan Han, Bin Yang, Xiang-Xing Meng, "A Fast Heuristic Algorithm for Maximum LOLP Constrained Unit Commitment", Proc. of IEEE International Conference on Power System Technology (POWERCON), pp: 1 – 6, 2012.

[16] Anupam Trivedi, Deepak Sharma and Dipti Srinivasan, "Multi-objectivization of Short-Term Unit Commitment under Uncertainty using Evolutionary Algorithm", In the proceedings of IEEE Congress on Evolutionary Computation (CEC), Brisbane, Australia, pp: 271-278, June 10-15, 2012.

[17] Prof. Vikrant Sharma, Navpreet Singh Tung, ArshBatish and Harmandeep Singh, "Single Area Unit Commitment Optimization using Pattern Search" Proc. of International Journal of Advanced Research in Comp. Science and Software Engineering, vol. 3, pp: 896-903, Oct 2013.

[18] Lokesh Kumar Panwar, Srikanth Reddy K, Rajesh Kumar, "Binary Fireworks Algorithm Based Thermal Unit Commitment", International Journal of Swarm Intelligence Research, vol. 6, issue 2, pp. 87-101, April-June 2016.

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

[19] J. Mary Anita, I.JacobRaglend, "Solution Of Unit Commitment Problem Using Shuffled Frog Leaping Algorithm", Proc. of International Conference On Computing, Electronics And Electrical Technologies (ICCEET), pp: 93 – 98, 2012.

[20] Mary Anita, J.; Jacob Raglend, I., "Solution of emission constrained Unit Commitment problem using Shuffled Frog Leaping Algorithm" Proc. of International Conference on Circuits, Power and Computing Technologies (ICCPCT), pp: 93-98, 20-21 March 2013.

[21] B. Saravanan, E. R.Vasudevan, and D.P. Kothari, "A Solution to Unit Commitment Problem Using Invasive Weed Optimization Algorithm", Proc. of International Conference on Power, Energy and Control, pp: 386-393, Feb. 2013.

[22] Anup Shukla and S. N. Singh, "Cluster Based Wind-Hydro-Thermal Unit Commitment Using GSA Algorithm", 14 IEEE Power & Energy Society General Meeting, Washington DC, USA, pp: 1–5, July 2014.

[23] Peng Li, Zeyuan Zhou, Xiaopeng Lin, Xavier Yang, XingyanNiu, "Dynamic Optimal Operation Scheduling Of Microgrid Using Binary Gravitational Search Algorithm" , Proc. of International Conference On Power System Technology (POWERCON), Chengdu, pp: 3175 – 3180, 20-22 Oct. 2014.