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AN ENHANCED COOPERATIVE HARMONY SEARCH ALGORITHM USING CUCKOO SEARCH FOR SOLVING OPTIMIZATION PROBLEMS

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Abstract - **Harmony search algorithm (HS) is a new meta-heuristic algorithm which is inspired by a process involving musical invention. HS is a stochastic optimization system that is like to genetic algorithm (GA) and particle swarm optimization (PSO). It has been widely applied in order to solve many complex optimization problems, including incessant and isolated problems, such as structure design, and function optimization. An improved cooperative harmony search algorithm will be developed in project in which harmonies are split into desired vectors and also GA is used when the harmonies are stagnated for particular number of iterations. The Cooperative Harmony Search will be fused with the Cuckoo Search technique to avoid the stagnation in the solutions while optimizing the functions. Enhanced HS will be applied to function optimization problems to analyze the performance of the proposed system.**

Key Terms: Harmony search, Genetic Algorithm, Function Optimization, cuckoo search.

I. INTRODUCTION

A. optimization

Optimization is a very ancient problem. Optimization is the act of achieving the best possible result under given circumstances to solve many complex optimization problems, such as including function optimization. My work focus on function optimization. The function optimization of all such decisions is either to minimize effort or to maximize benefit. The goal of this work best minimization valve. There is no single method available for solving all optimization problems efficiently. Hence, a number of methods have been developed for solving different types of problems.

B.Methods of optimization

The methods are harmony search, cooperative harmony search algorithm. An enhanced cooperative harmony search algorithm will be developed on harmonies are split into desired vectors. It can be finding on best solution. The major issue of occur in this work harmonies are stagnated for particular number of iterations. This problem solving on use algorithm on genetic algorithm. The genetic algorithm (GA) is a search technique based on the mechanics of natural genetics and survival of the fittest. GA is a smart and different tool for solving complex multimodal optimization problems.

II.ORGANIZATION OF THE PAPER

The rest of this work is organized as follows: Section 3focuses on the literature survey of previous works. In section 4, the system design and the main goals to be achieved using the proposed design are specified. In section 5 implementation of cuckoo algorithm is detailed. The simulation analysis and results are discussed in the Section 6. Finally, conclusion and Future work are stated in the Section 7.

III RELATED WORK

Improved Multi objective Harmony Search Algorithm with Application to Placement and Sizing of Distributed Generation: A Review [1] that has introduced the novel intelligent optimization algorithm for multi objective harmony search (MOHS). To solve the comprehensive multi objective optimization problem.Multi objective optimization is concerned with mathematical optimization problems involving more than one objective to be optimized simultaneously. There are two approaches in solving the multi objective optimization problem. Finding optimal solution by using a weighted sum approach: Finding optimal solution by using a weighted sum approach aims to solve the multi objective problem through using the weighting factors to transform the multiple objectives into one objective. Finding optimal solution based on Pareto-optimal front: Finding optimal solution based on Pareto-optimal front approach aims to optimize all objective functions simultaneously based on non dominated solutions.

A Novel Self-Adaptive Harmony Search Algorithm [2] presented that a novel, self-adaptive search mechanism for optimization problems with continuous variables. This new variant can automatically configure the evolutionary parameters in accordance with problem characteristics, such as the scale and the boundaries, and dynamically select evolutionary strategies in accordance with its search performance. The new variant simplifies the parameter setting and efficiently solves all types of optimization problems with nonstop variables. The results analysis that variant is considerably robust and outperforms the original harmony search (HS), improved harmony search (IHS), and other self-adaptive variants for large-scale optimization problems and constrained problems.

An Effective Hybrid Firefly Algorithm with Harmony Search for Global Numerical Optimization[3]expressed that the hybrid metaheuristic approach by hybridizing harmony search (HS) and firefly algorithm (FA), namely, HS/FA, to solve function optimization. In HS/FA, the exploration of HS and the exploitation of FA are fully exerted, so HS/FA has a faster convergence speed than HS and FA. top fireflies scheme is introduced to reduce running time, and HS is utilized to mutate between fireflies when updating fireflies. These metaheuristic approaches are solving complicated problems, like permutation flow shop scheduling reliability, high-dimensional function optimization and other engineering problems. Have newly introduced on genetic algorithms (GA). In HS/FA, top fireflies scheme is introduced to reduce running time.

An Improved Harmony Search Based on Teaching-Learning Strategy for Unconstrained Optimization Problems the algorithm expressed as improved global harmony search algorithm, named harmony search based on teaching-learning (HSTL), for high dimension complex optimization problems. The HSTL algorithm for four strategies. Harmony memory consideration, teaching-learning strategy, Local pitches adjusting. Random mutation is employed to maintain the proper balance between convergence and population diversity, and dynamic strategy is adopted to change the parameters. The HSTL algorithm is investigated and compared with three other state-of-the-art HS optimization algorithms. HSTL algorithm is more effective and stable in obtaining high quality solutions and has less FEs, less runtime, and higher success rates under the same conditions.

A survey on applications of the harmony search algorithm “ have introduced on three fold goal. To underline the good behavior of this modern meta-heuristic based on the upsurge of related contributions reported to date.To set a bibliographic basis for future research trends focused on its applicability to other areas.To provide an insightful analysis of future research lines gravitating on this meta-heuristic solver.

Hybrid harmony search and artificial bee colony algorithm for global optimization problems have introduced the artificial bee colony algorithm is a new swarm intelligence technique inspired by intelligent foraging behavior of honey bees. The ABC and its variants are used to improve harmony memory (HM). To compare and analyze the performance of hybrid algorithms, a number of experiments are carried out on a set of well known benchmark global optimization problems. The effects of the parameters about the hybrid algorithms are discussed by a uniform design experiment. The newly introduced on self-adaptive harmony search algorithm. Hybrid Harmony Search with Artificial Colony Bee algorithm (HHSABC) for solving global numerical optimization problems. The Artificial Bee Colony (ABC) algorithm is a new swarm intelligence technique inspired by the intelligent foraging behavior of honey bees. In the ABC algorithm, the colony of artificial bees contains three groups of bees: employed bees, onlookers and scouts.

Engineering Optimization by Cuckoo Search” have introduced a CS algorithm to solve engineering design optimization problems, including the design of springs and welded beam structures. The optimal solutions obtained by CS are far better than the best solutions obtained by an efficient particle swarm optimizer.
For simplicity in describing our new Cuckoo Search use the following three idealized rules:

- Each cuckoo lays one egg at a time, and dumps it in a randomly chosen nest;
- The best nests with high quality of eggs (solutions) will carry over to the next Generation.
- The number of available host nests is fixed, and a host can discover an alien egg with a probability pa ∈ [0, 1]. In this case, the host bird can either throw the egg away or abandon the nest so as to build a completely new nest in a new location.

The performance of CS with GAs and PSO, we know that our new Cuckoo Search in combination with L´evy flights is very efficient and proves to be superior for almost all the test problems. This is partly due to the fact that there are fewer parameters to be fine-tuned in CS than in PSO and genetic algorithms. CS is more generic and robust for many optimization problems, comparing with other metaheuristic algorithms.

Harmony search as a metaheuristic algorithm,” in Music Inspired Harmony Search Algorithm has introduced a review and analyzes the powerful new Harmony Search (HS) algorithm in the context of metaheuristic algorithms. First outline the fundamental steps of Harmony Search, and it works. Then review briefly other popular meta heuristics such as particle swarm optimization so as to find their similarities and differences from HS.Finally, discuss the ways to improve and develop new variants of HS.A heuristic algorithm is a good solution to an optimization problem by ‘trial-and-error’ in a reasonable amount of computing time. Here ‘heuristic’ means to ‘find’ or ‘search’ by trials and errors. Five types of popular metaheuristics algorithms used. Simulated Annealing, Evolutionary Algorithms, Particle Swarm Optimization, Ant Colony Optimization, Firefly Algorithm. Characteristics of

HS and Comparison. There are used two components. Diversification and Intensification.

IV.PRELIMINARIES

A. Find optimization

The find optimization first it can be find on minimum optimal value**.** It can be using on two algorithms. First on harmony search and second on cooperative harmony search algorithm. The System architecture has shown in fig.1

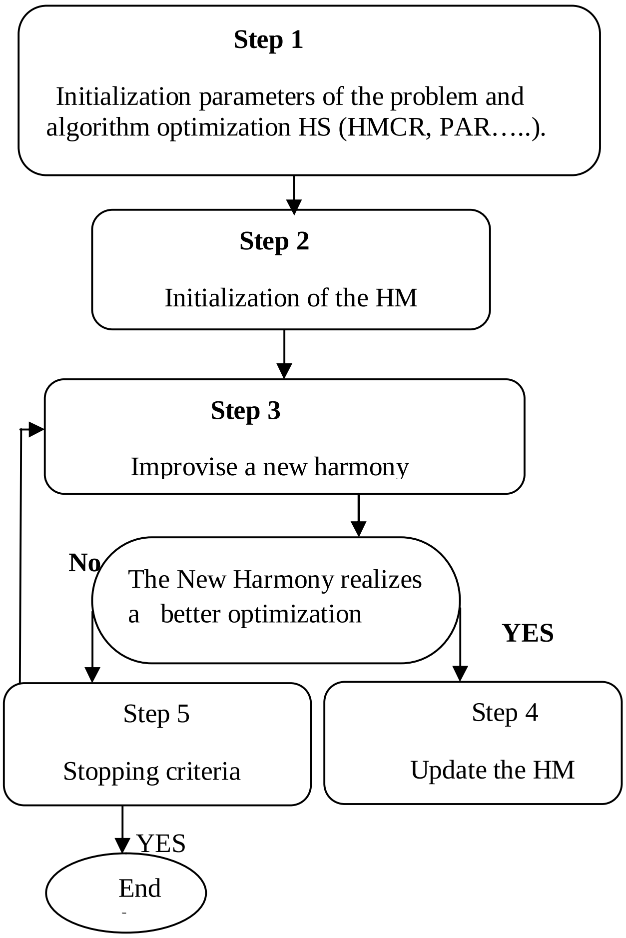

Fig 1 System Architecture

First Initialization parameters of the problem and algorithm optimization HS (HMCR, PAR…..).Second initialization of HM value. Next improvise a new harmony and New Harmony realizes on better optimization. This step means on no stop the criteria and yes means on update the HM.

1. HARMONY SEARCH ALGORITHM

Harmony search (HS) is a meta-heuristic algorithm that mimics the improvisation process of musicians. The important steps involved in HS algorithm are:

A. The problem and algorithm parameters are initialized

Initialize the problem algorithm parameters. The problem parameters like n, Lxi, Uxi should be initialized. In addition, four algorithm parameters should be initialized, including harmony memory size (HMS), harmony memory considering rate (HMCR), pitch adjusting rate (PAR), and the maximum number of improvisation (Tmax), or stopping criterion. The Lxi and Uxi are the lower and upper bound of the ith decision variables and n is the number of decision variables.

B.Harmony memory is initialized

The SHS is similar to GAs. GAs is population based optimization algorithms, but the "population" in SHS is referred to as harmony memory (HM), which is composed of solution vectors.

C.A New Harmony is improvised

The New Harmony is improvised is following to these three rules:
(1) Harmony memory consideration
(2) Pitch adjustment
(3) Randomization.

D.The harmony memory is updated

If the New Harmony vector values are better than the worst harmony vector in the HM in terms of the object function value, the worst harmony in the HM is superseded by the New Harmony vector.

E. Check stopping criterion

If the harmony vector values are satisfied, the iteration is terminated. If the harmony vector values are not satisfied, the Steps 3 and 4 are repeated again and again in best harmony values.

2. COOPERATIVE HARMONY SEARCH ALGORITHM

The CHS algorithm may be more easily attentive in a local optimum. As the CHS algorithm is does not an answer to each problem, we must ask ourselves the question of when exactly it is that the CHS algorithm can perform better and which kinds of problems can be solved satisfactorily by the CHS algorithm. The algorithm CHS uses multiple harmony memories, so that every harmony memory can optimize different components of the solution vector.

A. Algorithm of CHS

Initialize the parameters
Divide the n decision variables into m groups
For each HM do
Initialize HM randomly
End for
While termination condition is false do
Calculate PAR and BW by using
Equation (1)

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For each HM do
Generate a new harmony
Evaluate the New Harmony
End for
End while

Formula for PAR and BW:

$$PAR(t) = PAR_{min} + \frac{PAR_{max} - PAR_{min}}{T_{max}} \times t \ldots(1)$$

$$bw(t) = bw_{max} \times \exp\left(\frac{\ln(bw_{min} \therefore bw_{max})}{T_{max}} \times t\right)$$

3.GENETIC ALGORITHM

To successfully apply a GA to solve a problem one needs to determine the following:

1) How to represent possible solutions, or the iteration encoding.
2) What to use as the fitness function which accurately represents the value of the solution.
3) Which genetic operators to employ and
4) The parameter values (population size, probability of applying operators, etc.), which are suitable.
The GA algorithm a following the steps.
Initialization, Fitness Function, Selection, Crossover Mutation, Evaluation, termination.

Initialization

Initially many individual solutions are randomly generated to form initial values.

Fitness function

A fitness function must be devised for each problem to be solved. For many problems, particularly function optimization, and the fitness function should simply measure the value of the function. Fitness function is a designed function that measures the goodness of a solution. It should be designed in the way that will have a higher fitness function value than worse solutions. The fitness function plays a main role in the selection process.

Example on fitness function:
A Simple Fitness Function
Here we want to minimize a simple function of two variables min **f(x) = 100 * (x (1) ^2 - x (2)) ^2 + (1 - x (1)) ^2;**

X

Coding the Fitness Function

We create a MATLAB file named simple_fitness.m with the following code in it:

```
Function y = simple_fitness(x)
y = 100 * (x (1) ^2 - x (2)) ^2 + (1 - x (1)) ^2;
```

The Genetic Algorithm solver assumes the fitness function will take one input x where x is a row vector with as many elements as number of variables in the problem. The fitness function computes the value of the function and returns that scalar value in its one return argument y.

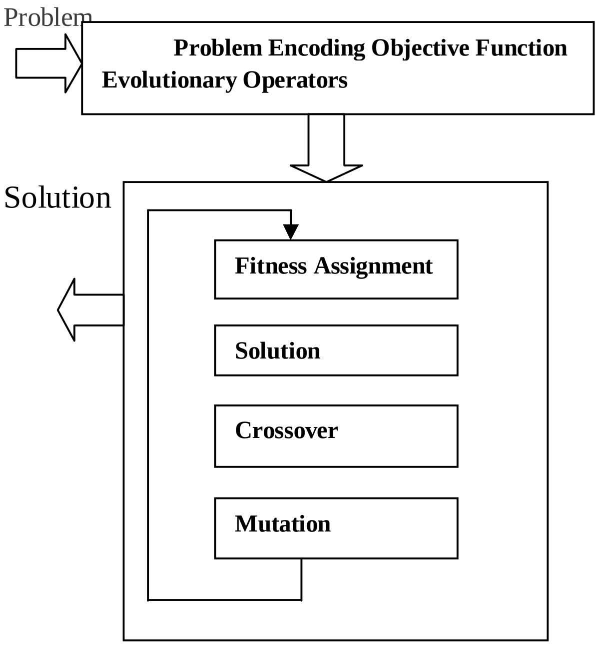


Fig 2 Genetic Algorithm

Selection

Selection is a genetic operator that chooses a chromosome from the current generation's population for inclusion in the next generation's population. Good individuals will probably be selected several times in a generation. Poor ones may not be at all. Before making it into the next generation's population, selected chromosomes may undergo crossover and mutation (depending upon the probability of crossover and mutation) in which case the offspring chromosome(s) are actually the ones that make it into the next generation's population

V.ALGORITHM IMPLEMENTATION

In this section, the proposed work on the measure on optimal (best) values on using an enhanced cooperative harmony search algorithm, but harmonies are stagnated for particular number of iterations. This types of problem avoid using on algorithm genetic algorithm. Genetic algorithm on avoid minimum number of iterations. These types of problem avoid using another algorithm on cuckoo search algorithm.

A. Implementation Of Cuckoo Search Algorithm

The cuckoo search algorithm on proposed method. Cuckoo search (CS) is an optimization technique. The cuckoo search on avoid stagnation to provide best solution.

The rules for CS are described as follows:

- Each cuckoo lays one egg at a time, and dumps it in a randomly chosen nest
- The best nests with high quality of eggs will carry over to the next generation
- The number of available host nests is fixed, and a host can discover a foreign egg with a probability $p_a \in [0, 1]$. In this case, the host bird can either throw the egg away or abandon the nest so as to build a completely new nest in a new location.

B.PSEUDO CODE FOR CS

Generate an initial population of n host nests;

while (t<Max Generation) or (stop criterion)

Get a cuckoo randomly (say, i) and replace its solution by

performing Levy flights;

Evaluate its fitness F_i

Choose a nest among n (say, j) randomly;

if ($F_i < F_j$)

Replace j by the new solution;

end if

A fraction (p_a) of the worse nests is abandoned and

new ones are built;

Keep the best solutions/nests;

Rank the solutions/nests and find the current best;

Pass the current best to the next generation;

end while

B. The system models

The system models are followed by,

1) Benchmark Functions Implementation

2) Implementation of Basic Harmony Search Algorithm

3) Implementation of Cooperative HS

4) Implementation of Enhanced HS with CS

5) Experimental Analysis with benchmark functions.

1) Benchmark Functions Implementation

Benchmark function means standard functions to test the algorithm in all the aspects. Ten benchmark functions have been chosen to test the performance of the Cooperative harmony search Algorithm, and standard harmony search algorithm, and GHS algorithms are tested for the sake of comparison.

- Griewank function

$$f(x) = \sum_{i=1}^{d} \frac{x_i^2}{4000} - \prod_{i=1}^{d} \cos\left(\frac{x_i}{\sqrt{i}}\right) + 1$$

(1)

N=15000 ; ∈ [-600, 600]

- Rosenbrock's function

$$f(x) = \sum_{i=1}^{n=1} (\cos\,(x_i^2 - x_{i+1})^2 + (1 - x_i)^2 \quad (2)$$

Where n = 15000, ∈ [−2.048, 2.048]30. Rosenbrock's function is a naturally non separable function, the global optimum being$X* = (1, 1, . . . , 1)$ which is located in a narrow valley; it is very hard for algorithms to find the correct direction and reach to the global minimum.

- Quadric function

$$f(x) = \sum_{i=1}^{n} \left(\sum_{j=1}^{i} x_j\right)^2 \qquad (3)$$

N=100: and dimension x=30

- Ackley function

N=100; dimension x=30.

- Rastrigin function

$$f(x) = \sum_{i=1}^{n}(x_i^2 - 10\cos(2\pi x_i) + 10) \quad \textbf{(5)}$$

N=100: dimension x=30.

- Booth function

$$f(x) = (x_1 + 2x_2 - 7)^2 + (2x_1 + x_2 - 5)^2 \quad \textbf{(6)}$$

- Sphere function

$$f(x) = \sum_{i=1}^{n} x_i^2$$

- Schaffer function

$$f(x) = 0.5 + \frac{\sin^2\left(\sqrt{x_1^2 + x_2^2}\right) - 0.5}{\left(1 + 0.001(x_1^2 + x_2^2)\right)^2}$$

- Hartman3 function

$$f(x) = -\sum_{i=1}^{4} c_i \exp\left[-\sum_{j=1}^{3} a_{ij}(x_j - p_{ij})^2\right]$$

2) Implementation of Basic Harmony Search Algorithm

Improvised according to these three rules: (1) harmony memory consideration; (2) pitch adjustment; (3) randomization. The probabilities of harmony consideration and pitch adjustment are dependent on HMCR and PAR.

3) Implementation of Cooperative HS

The CHS algorithm may be more easily trapped in a local optimum. As the CHS algorithm is not an answer to every problem, we must ask ourselves the question of when exactly it is that the CHS algorithm can perform better and which kinds of problems can be solved satisfactorily by the CHS algorithm. The algorithm CHS uses multiple harmony memories, so that each harmony memory can optimize different components of the solution vector.

4) Implementation of Enhanced HS with GA

An enhanced cooperative harmony search algorithm will be developed in which harmonies are split into desired vectors and also GA is used when the harmonies are stagnated for particular number of iterations.

VI.SIMULATION RESULTS AND ANALYSIS

In this section, the mat lab 2013(a) software as used. The bench mark function on input. Pitch values (intervals) on -600 to 600.number of iteration on N=100.dimension of x=30, x values on (x_1, x_2 ....x_{30}).the five bench mark function as used as followed

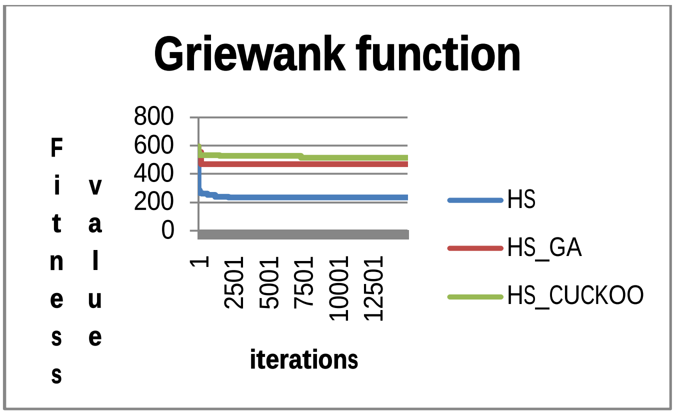
A.Griewank benchmark function
B.Rast function
C.Rosen function
D.Ackley function
E.Quadric function
F.Booth function
G.Sphere function
H.Schaffer function
I.Hartman3 function

1) Cooperative harmony search and cuckoo search:

CHS algorithm is able to find a better solution. Value an (-600,600).number of iteration it can be 15000.griewank function a zeros. Dimension it can be 30.spliting value on (3 3 3 3 3 3 3 3 3 3 3)

Griewank HS results,HS_GA results&HS_CUCKOO

That below graph on Griewank function harmony search, genetic algorithm and cuckoo search algorithm comparison.no.of iteration on 15000. result. Series 1 on harmony search result. series 2 is harmony and genetic algorithm, series 3 on harmony and cuckoo search algorithm.



Griewank function

The best value on griewank from 516.92.It can be using on more number of bench mark function.

VI I. Conclusion and Future work

In this work, the CHS was then applied to function optimization problems. The results of the experiment show that CHS is capable of finding better solutions when compared to HS and a number of other algorithms, especially in high-dimensional problems. An enhanced cooperative harmony search algorithm will be developed in which harmonies are split into desired vectors and also GA is used when the harmonies are stagnated for particular number of iterations. Genetic algorithm used as stagnation again and again. So this problem overcomes on cuckoo search algorithm. This algorithm finding on best solution and to avoid stagnation.Future work aims at extending their work to some other optimization technique will be applied to enhance the performance it can be calculated.

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