BEES ALGORITHM INSPIRED BY GRENADE EXPLOSION METHOD

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2016

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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Management) (Hons.)

By

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FACULTY OF MANUFACTURING ENGINEERING

2015

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **BEES ALGORITM INSPIRED BY GRENADE EXPLOSION METHOD**

SESI PENGAJIAN: **2015/16 Semester 2**

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Manufacturing Engineering (Management) (Hons.). The member of the supervisory is as follow:

…………………………
(EN. NIK MOHD FARID BIN CHE ZAINAL ABIDIN)

ABSTRAK

Bees Algoritma (BA) diilhamkan daripada tingkah laku mencari sumber makanan lebah madu tulen. Dengan menggunakan Kaedah Letupan Bom (GEM), ia bertujuan untuk meningkatkan kecekapan BA menggunakan asas kelajuan penumpuan. Idea GEM adalah berdasarkan kepada persepsi letupan bom di mana kepingan letupan yang dibuang menghasilkan serpihan objek berhampiran lokasi letupan. Kemusnahan serpihan objek itu menentukan sesuatu nilai. Perbezaan prestasi antara BA Asas dan BA baru yang diperbaharui telah dinilai dengan membandingkan mereka dengan sepuluh fungsi ujian penanda aras yang biasa digunakan. Kedua-dua algoritma juga dinilai pada tetapan parameter yang berbeza untuk menentukan parameter yang lebih sesuai dengan BA yang diperbaharui ini . Hasilnya menunjukkan bahawa algoritma yang diperbaharui lebih baik dan boleh meningkatkan Bees Algoritma asas untuk menyelesaikan masalah pengoptimuman global.

ABSTRACT

Bees Algorithm (BA) is inspired from the genuine food foraging behaviour of honey bees. By using Grenade Explosion Method (GEM), it aims to enhance the basic BA efficiency by convergence speed. The idea of GEM is based on the perception of a grenade explosion where thrown pieces of shrapnel dismantle the objects near the explosion location. Destruction caused by each piece of shrapnel hitting an object is measure. The performance difference between Basic BA and new improved BA were assessed by comparing them with ten well-known benchmark test functions. Both basic and new improved BA also assessed on different parameter settings to determine the suitable parameter that suits the new improved BA. The result suggests that the new improved bees' algorithm can boost the basic bees' algorithm for solving global optimization issues.

DEDICATION

I would like to dedicate this thesis to my parents, Mr Sapani @ Azhar and Mrs Norhayati for nursing me with affection and love. Moreover, they never tired of encouraging me in every single way. Not to forget my beloved family and friends who have always stood along with me throughout my entire life and supporting me.

ACKNOWLEDGEMENT

First and foremost, thanks to the Almighty God for allowing me to finish my study with good health. I wish to express my sincere gratitude to Mr Nik Mohd Farid Bin Che Zainal Abidin for his guidance and advices on this project. Also, thanks to evaluation panels that have corrected my mistakes throughout my study for improvement. Any accomplishment requires work and effort of many people, thus my gratitude also goes to my fellow friends for their support that helps me to finish this project with ease.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ABC - Artificial Bee Colony

ACO - Ant Colony Optimization

AI – Artificial Intelligence

AIA - Artificial Immune Algorithm

BA - Bees Algorithm

BFO - Bacterial Foraging Optimization

D - Dimension

DE - Differential Evolution

EA - Evolutionary Algorithm

EP - Evolutionary Programming

ES - Evolution Strategy

GA - Genetic Algorithm

GEM – Grenade Explosion Method

MCN – Maximum cycle number

nb – Number of best sites

ne – Number of elite sites

ngh – Number of best sites

NP – Population size

nrb – Neighborhood of honey bees

nre – Number of selected elite sites

ns – Number of scout honey bees

PSO - Particle Swarm Optimization

SD – Standard deviation

SFL - Shuffled Frog Leaping

stlim – Stagnation limit

CHAPTER 1

INTRODUCTION

This chapter explains about the background of the study, basic knowledge and information about the concept of the optimization. Then is continues by the problem statement of the study and objective in order to find solutions based from the problem statement. The scope of the study also are emphasises. Next are the significant of the study and organization of the report. Summary of this chapter is concluded at the end of the chapter.

1.1 Background

Optimization is a process of finding the condition that gives maximum and minimum value of function. The optimization is more significant as a resource of minimization and in that respect is a better need to gain sustainability. Besides, optimization algorithm is an explorative and exploitative technique which the purpose is to discover an optimal solution. Swarm intelligence is the behaviour aggregation of decentralized self-organized systems either natural or artificial. The Swarm Intelligence based Algorithm is a search algorithm that is able to locate better solution effectively. Swarm-based Optimization Algorithm (SAO) a moderate of nature procedure that deduces search for the optimal solution. Divergence for both SAO and direct search algorithms for example the Hill Climbing is that for each iteration, SAO uses a population of solutions instead of a single solution. Population resolution in the processes in the iteration and the result acquire is also a population of solutions. SAO includes Ant Colony Optimization, Genetic Algorithm, Particle Swarm Optimization, Bees Algorithm, etc (Rao et al, 2012).

In 2005, Bees Algorithm was developed as a population-based search algorithm by Professor Pham through his research. In its essential version the algorithm proceeds a kind of neighbourhood search merge with global search, and can be utilized for equally combinatorial optimization and continuous optimization. Bees usually exist in a large number in the form of a swarm. Naturally bees have the nature of foraging, mating and nest selection behaviour in order to live. The objective of the processing information of the

algorithm is to settle and explore better sites through the problem search area. The most quality food source among various solutions is searched by bees by a group decision making process is a good example of a swarm-based decision method.

A honey bee colony can widen the search beyond far distances in various directions over more than 10 kilometres. Scouts are assigned to random sample, the problem area and investigate better sites. The best sites are exploited through the application of a local hunt, in which a minuscule routine of best sites are explored more than the others. Flower patches with abundant measures of nectar or pollen that can be gathered effortlessly ought to be gone by more bees, considering patches with less nectar or pollen ought to get less honey bees. Better sites are ceaselessly exploited, although numerous scouts are conveyed for every emphasis dependably looking for extra better locales.

Other than that, the honey bees that return to the hive, assess the diverse patches relies on upon certain quality limit which measured as a mix of a few constituents for example sugar content (quality).

A bee way of communication is through waggle dance where the dance is performed by scout bees that act as navigator to inform the other rummaging honey bees about nectar site. Likewise, after the information is received, the foraging bees function as the food collector. Basically the information is to show the direction and location of the site with the most honey. This waggle dance move gives exact data about quality; separation and bearing of flower patch (Pham & Castellani, 2009). The exact patch will be given away in the waggle move again when getting back to the hive depends on the food level and more bees will be raised to the resource. According to the fitness, patches can be inspected by more bees or may be abandoned.

1.2 Problem statement

Convergence speed of Bees Algorithm (BA) is varied when using different value of parameter. The parameter could only be set by leading a little number of trails. Therefore, BA is slow in convergence speed (Pham & Castellani, 2009).

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1.3 Objective

The objectives of the study are:

a) To enhance the convergence speed of the new improved Bees Algorithm by incorporate with Grenade Explosion Method.

b) To test the new improved Bees Algorithm with benchmark test function.

c) To determine the suitable parameter that suits the new improved Bees Algorithm.

1.4 Scope

The scopes for this report are:

a) Focuses on the foraging behaviour of bees in nature.

b) Use one of the advance optimization techniques which are the Grenade Explosion Method.

c) The benchmark test functions used for the result comparison are based on the reference research paper.

1.5 Significant of study

Bees Algorithm is very efficient in obtaining optimal solutions along overcoming the problem of local optima. By adjusting the parameter, it is ensuring that to significantly diminish the usage time of the proposed calculations while give the best quality answers for much higher dimensional issues.

1.6 Organization of the report

This report is divided into chapters where each chapter is explained in details:

a) Chapter 1: Introduction

This chapter emphasis on the background of the study which is the optimization. Problems are identified through previous research study that is conducted by the researchers. This is followed by objectives to be achieved throughout the study and scope which narrows down the area of the study.

b) Chapter 2: Literature Review

This chapter covers the basic theories regarding the research topic and the previous studies from journal, book and the internet. The application of the Bees Algorithm is justified in this chapter. Lastly, the method use in the study is elaborated on how the method could help to get an effective alternative for solving the optimization problem.

c) Chapter 3: Methodology

This chapter is cover the details explanation of methodology and obtaining a working procedure for the upcoming project where is been illustrated in a flow chart. The activities are been explained in a following explanation. This chapter is very important to construct and to understand before executing the upcoming project.

d) Chapter 4: Result & Discussion

This chapter covers on the results that have been obtained. Thus, the data and detail explanations are compiled in this chapter to give a better understanding about the study on this new improved algorithm. This chapter also gives detail analysis on every result that is gained.

e) Chapter 5: Conclusion & Recommendation

This chapter is the summary based on the findings and conclusion of the study. Future recommendations are proposed for improvement on the study. The recommendation is also important for further application in manufacturing field.

1.7 Summary

The study on the Bees Algorithm inspired by Grenade Explosion Method is regarding the optimization problem solving. It is an optimization algorithm induced by the natural foraging behaviour of honey bees to find the ideal resolution of optimization. The method use is to take the ideal hunt measurement rather than an irregular choice from the picked calculation.

CHAPTER 2

LITERATURE REVIEW

This chapter provides a basic knowledge and information about the concept of the optimization and its application. Then is continues by the swarm intelligence and its application also the understanding of Bees Algorithm. This chapter explains most on the field of the study and the advantages of the algorithm. Next are the details of the method of Grenade Explosion Method and its advantages.

2.1 Optimization

Nature propelled populace based calculation is an explorative zone which stimulates distinctive natural phenomena to determine an extensive variety of issue. The challenges connected with numerical improvement on huge scale engineering issues have prompted the development of option answers. Conventional techniques like straight programming, dynamic scheduling, etc. frequently caught in a nearby ideal while tackling multimodal issues having expansive number of variables and non-direct target capacity. To beat these issues, a few modern heuristic calculations have been characterized into diverse gatherings relying upon criteria being viewed as for example populace based, iterative based, stochastic, deterministic, etc.

Continent upon the way of wonder mimicked by the calculations, the populace based heuristic calculations have two imperative gatherings which are developmental calculations heuristic calculations and swarm knowledge based calculations (Rao & Patel, 2012). Combinatorial optimization is a mathematical optimization that is related to operations research, algorithm theory and computational complexity theory. It has important applications in several fields including artificial intelligence (AI), machine learning, mathematics and software engineering.

2.2 Swarm intelligence

Swarm intelligence is the behaviour aggregation of decentralized self-organized systems either natural or artificial. Control of various framework variables is required in real world building issues with a specific end goal to advance a given quality consistent, for example, dependability or exactness of a system, or the significance or operation of an item. The improvement is more critical as asset minimization and in that regard is a superior need to pick up sustainability.

Many-sided quality endeavours how apparently basic, singular creatures can act shrewdly as a total unit. The essential thought of multifaceted nature is that a solidary unit can make numerous non-direct associations with its surroundings (Jordan, 1989). A portion of the known developmental calculations are, Genetic Algorithm (GA), Evolution Strategy (ES), Evolutionary Programming (EP), Differential Evolution (DE), Bacterial Foraging Optimization (BFO), Artificial Immune Algorithm (AIA), etc. GA is an extensively utilized calculation for different application. GA deal with the guideline of the Darwinian hypothesis of the continuation of the fittest and the hypothesis of movement of the living creatures (Holland, 1975).

ES depends on the theory that amid the organic movement of the laws of hereditary enrichment have been created for the speedy phylogenetic adjustment (Runarsson and Yao, 2000). ES copies in correlation to the GA, the impacts of hereditary strategies on the phenotype. EP has additionally imitated the wonder of common development at the phenotype level. DE is alike to GA with specific hybrid and choice technique. The BFO is impelled by the social scrounging conduct of Escherichia coli (Passino, 2002). AIA connected in light of the safe arrangement of the individual (Farmer et al, 1986).

A percentage of the conspicuous swarm knowledge based calculations are, Particle Swarm Optimization (PSO) which connected in view of the guideline of searching conduct of the swarm of feathered creature which applied based on the principle of foraging behaviour of the swarm of birds; Shuffled Frog Leaping (SFL) calculation which enlivened from the rule of correspondence among the frogs; Ant Colony Optimization (ACO) which motivated from the standard scrounging conduct of the insect for nourishment (Dorigo et

al, 1991); Artificial Bee Colony (ABC) calculation which propelled from the rule of scavenging conduct of a bumble bee (Karaboga & Basturk, 2008) .

All the developmental and swarm knowledge based calculations are alternate calculations and require normal controlling parameters like populace size, number of eras, elite size, etc. Notwithstanding the standard control parameters, diverse calculation requires its own calculation particular control parameters. Therefore, a change the adjustment of the algorithm specific parameters influences the effectiveness of the algorithm.

The improper adjustment of algorithm-specific parameters either increases the computational effort or yields the local optimal solution (Rao & Patel, 2012).Aggregate foragers in the set of all animals, for example honey bees and ants, interaction with one another in the search for food, prompting an extraordinary presentation of collaboration called swarm. Regardless of the measure of this aggregate survival procedure, the conduct of individual insects is quite simple (Nair et al, 2015).

2.3 Bees Algorithm

Honey Bees Algorithm (BA) is moderately new developmental calculation that may be utilized to discover ideal or close ideal arrangements in huge pursuit region (Pham et al, 2005). BA is particularly valuable for parameter improvement in ceaseless, multi-dimensional, seek territory and multi-objective, complex advancement (Pham et al, 2006). The BA system can create a fantastic arrangement inside shorter estimation time and has a tendency to focalize quickly contrasted with other stochastic routines. The BA has demonstrated both exceptionally successful and speedy in wander arrangement of benchmark improvement issues. Method can generate a high quality solution within shorter calculation time and it tends to converge very fast compared to other stochastic methods. The BA has proven both very effective and quick in diverge set of benchmark optimization problems (Attaran & Ghanbarzadeh, 2011).

Optimization algorithm is exploration and exploitation technique which the purpose is to discover an optimal solution to a problem. Relate to the optimization algorithm, Bees