CHAPTER 1

INTRODUCTION

In this era, for mankind the quest for better and better solution for a difficulty has never been completed. Human beings habitually make efforts to seek the best of everything in life. There is habitually a search in all aspects of life, Search for food, money, power, knowledge, solutions, etc. The best of all these does not go without a cost. It examines the entire possibilities, which in turn results in effort and time. If many options are available there is a chance to pick the best of them.

Many numbers of algorithms and techniques are available in the field of computer science, which helps the mankind to research deep into the solution space and find the best of them. Some search method is engaged for a problem to have a flawless solution. Thus evolved the various search techniques and algorithms in the past. Some of the traditional search techniques include greedy search, simulated annealing, exhaustive search, hill climbing method, heuristic method, etc. Each of the methods is apt for different kinds of problems. In a very complex search, the traditional methods are too slow in finding the best solution. As the solution space increases very fast for certain problems, it is very difficult to find the solution using traditional methods. In such situations, a randomized procedure proves effective and Genetic Algorithms offers a solution.

1.1 GENETIC ALGORITHMS

On the notions of genetics and natural evolution, Genetic Algorithms (GA) (Holland 1992) are the stochastic search algorithms.
“Survival of the fittest”, the Darwin’s theory is applied in the search space to direct towards the search process from the randomized initialization to a more prospective direction in the search space, which is very large. In the process of searching a solution in the search space, a number of genetic operators are applied to help the process of investigation.

Genetic Algorithms could be considered as an optimization strategy where points in the problem space, are analogous to organisms involved in the process of natural selection. Each point in this problem space comprised by a bit vector is comparable to a chromosome with each bit position analogous to a gene and each bit value is analogous to an allele.

In the traditional GA, the representation of bit string if of fixed length (Herrera et al 1998). A particular feature of an individual is represented by a bit position in a string, and the value stored in the position represents how the feature is present in the string of a search space. Usually, the string is evaluated as a collection of structural features of a solution that have little or no interactions (Angeline 1996). This similarity may be applied directly to the genes in biological organisms. Each gene represents an entity which is dissimilar from other genes.

Encoding is a foremost part in framing a bit string (Lobo & Goldberg 2004). Generally binary encoding, real value encoding, permutation encoding, tree encoding are used. Gray encoding (Zeger et al 1990), a non binary encoding is applied in GA. There is a one to one correspondence between the set of encodings and all possible outcomes in the problem. This type of encoding is referred to as a real encoding. This gray value encoding is implemented in Genetic Algorithm, which makes the process simpler and makes the performance faster compared to other randomized search procedures.
Compared to other randomized search algorithms like Monte Carlo algorithms (Karp & Luby 1983), GA are very special, because in parent chromosomes they have memory and no offspring’s are generated independently from the parents. GA is the most robust search method (Chakraborty & Chaudhuri 2003) in which it requires a little information to search in a very large or in a weak search space more effectively. Unlike traditional search methods, genetic search perform through a population of points in contrast to the single point of focus of most search algorithms (Lin et al 1994), (He & Tan 2012). Thus an implicit parallel method is implemented in Genetic Algorithm, which makes the performance faster compared to other randomized search procedures.

Though the GA is widely used in many domains, the need for a high performance Genetic Algorithm is necessary. Usually, the performance of the Genetic Algorithm is measured either by the speed of the search or by the dependency of the search (Tarek et al 2006). Dependency denotes the chance of getting good results even if the problem is too complex (Back 1996). The achievement of GA depends on the alternative of the right set of parameters for a specific optimization problem.

Even though the Genetic Algorithm is used for solving the optimization problems, it is not directly implemented to solve the constraint optimization problems. Several strategies have been implemented to solve constraint optimization problems. By examining the Genetic Algorithm, significant process has been made in various aspects of GA in an attempt to improve further its performance in all types of problems and search spaces. Whatever be the type of problem, the performance improvement methods may in the pattern of designing a new genetic operator, modification of the procedure or by a hybrid algorithm, etc.
This study is such a supplement to publications wherein, performance enhancement of GA is attempted through the following methodologies:

1. Implementation of encoding technique to improve the performance.


1.2 OBJECTIVES

In Genetic Algorithm, the performance is resolute by its ability to convergence to an optimal solution in a short period of time. Some types of GA have addressed the performance matters in their distinct perspectives. This research looks at the performance improvement of the Genetic Algorithm in the following methods.

1. Including Genetic Algorithms, any parameter optimization technique requires some method to represent a parameter (bit string). Gray Encoding is one such parameter method in which the steadiness of the algorithm is maintained. This also assists to sustain the diversity in population, which avoids the premature convergence, which means getting attached in some localized optima.
2. Even though there is no premature convergence while implementing GA with Gray code, the convergence velocity is high. In order to improve the convergence velocity, a MCPGA is designed where simultaneous execution takes place.

3. Selecting an individual is difficult in the multi-objective optimization problems. Generally, the initial population are defined at random for GA. While considering the entire population, some irrelevant population might have a chance to enter into the population which reduces the convergence velocity. If the best individuals are identified at the beginning of the GA, the selection pressure is reduced and the convergence can be improved. Thus the Population Reduction method is proposed for fine tuning the initial population.

4. Also it was analysed that the GA is not suitable for solving the constraint optimization problems, this research furthermore focuses in conceiving an efficient method that can explain troubles with various user preferences at the gene level. This makes to solve the constraint optimization problems much easier.

1.3 PHASES OF RESEARCH

The various stages of this study work are schematically shown in Figure 1.1, which depicts the entire workflow right from the literature survey to the untested investigation of the proposed design.
CONTRIBUTION OF THE THESIS

The research contributions of the thesis consist of the following components:

- A detailed literature survey of the performance enhancement techniques
- A design of the Genetic Algorithm with gray encoding and performance analysis with different parameters of GA.
A design of Genetic Algorithm called Multi Clustered Parallel Genetic Algorithm and performance analysis with different parameters of GA.

A design of new method called Population Reduction (PR).

Design of the biologically inspired genetic operators namely Gene Inactivation for solving problems with user specific constraints.

Analysis of each tuning method with different parameter settings.

Comparison of each tuning method Vs Genetic Algorithm with optimal parameters.

A detailed survey of the existing methods is done and the positive and contradictory facts are recognised from the existing procedures. This research also starts with a thorough survey of Genetic Algorithms, the various operators and techniques used by various Genetic Algorithms. It was discerned that coordinating of bit string, diversity and the selection pressure are the factor which takes a foremost function in improving the performance of the Genetic Algorithm.

### 1.5 ORGANIZATION OF THE THESIS

The organization of the thesis is as follows:

Chapter 2 provides the brief introduction about the Genetic Algorithms, the various parameters involved in Genetic Algorithms and its working principles and design considerations. The performance issues of Genetic Algorithms have been explained. The different methodologies to performance improvement of GA identified by researchers are discussed.
Chapter 3 proposes a tuning method at the bit structure. Gray encoding mechanism is proposed and its representation, working principles and various parameters are analysed by applying it with 0/1 knapsack problem and the performance is compared with SGA.

Chapter 4 proposes an algorithm called Multi Clustered Parallel Genetic Algorithm, its methodology, pseudo code, working principles and the impact of various parameters on the algorithm has been made and analysed. The optimal parameters of the algorithm are identified and it is compared with Standard Genetic Algorithm.

Chapter 5 proposes another tuning method in identifying the best individuals called Population Reduction method (PR). The genetic parameters are applied to identify the optimal parameter and applied with PR for comparing it with SGA.

Chapter 6 deals with another tuning method called Gene Inactivation to improve the performance of the GA by inactivating the genes in the individual based on user identified preferences.

Chapter 7 concludes the research as well as the thesis with the proposed tuning methods implemented with various genetic operators and the performance comparison of Genetic Algorithm for different scenarios. It also suggests some guidelines on further research in this direction.