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Self-Determining Automobile Robot Movement Using Travelling Salesman Problem with Genetic Algorithm Search Technique

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Abstract: Static task scheduling technique is one of the core functions to efficiently utilize the capacity of cooperative control for getting shortest path which can minimize the completion time. A new methodology that is supported on Travelling Salesman Problem (TSP) with Genetic Algorithm (GA) search technique for robots has been proposed. TSP locates an optimum solution for the shortest route to complete the required tasks by configuring GA. We debate the adaption and realisation of the GA search tactics to the task scheduling problem in the cooperative control of multiple resources for getting shortest path with minimize the completion time has been discussed. Simulation results portray that the GA strategy is a practicable methodology for arranging the task scheduling solution.

Keywords: Travelling Salesman Problem (TSP), Genetic algorithm (GA), Robot, Static Task Scheduling, Cooperative control.

1. INTRODUCTION

The static task scheduling problem is described as the procedure of arranging the tasks of an opposition to a network of processors, on the other hand technique can be addressed to minimize the accomplishment time in order to case minimize the distance (or find the shortest route) of the performance. The aim of our study effort is to find out a mechanism that consists of static task scheduling and produce schedules with shorter accomplishment time (or shorter distance) than those timeline generated by the suitable existing static scheduling algorithms. The most of the present static scheduling algorithms only supplement to congruous the processor networks. Till now various attempt has been put for developing scheduling algorithms specifically for inhomogeneous processor networks specific for robot task scheduling. However, using opposite model, where the most existing inhomogeneous scheduling algorithms [1, 2] produce sub-optimal schedules can be used. Hence, there is much more scope for the suitable development of the scheduling algorithms for inhomogeneous (heterogeneous) processor network systems. For that reason we are selecting a single robot but multi-variety task. If a single robot gives the shortest path which can minimize the completion time then we can easily apply this proposed method in multi robot system with multiple tasks [5]. The present work, attempts have been made solve the complete task with eight numbers of task targets by finding out the optimum root of the overall problem using genetic algorithm for travelling salesman problem.

Genetic algorithms are a generally modern optimization technique that can be used for solving problems, in addition to the NP-hard ones. The method does not guarantee an optimal clarification, though it frequently gives high-quality approximations in a realistic quantity of time. This, therefore, would be a superior algorithm to attempt on the travelling salesman problem, is one of the well-known NP-hard problem. Genetic algorithms are freely based on natural evolution in addition to use a “survival of the fittest” approach, where the most excellent solutions survive and are mottled until we get a good quality result [6]. In this article, a genetic algorithm is discussed in details, together with the various methods of encoding, crossover, mutation along with evaluation. This will also take account of the operations utilized for the travelling salesman problem.

The majority of multi-robot systems are inflexible real-time problem that required a real-time task optimizer and scheduler. The real-time task optimizer with scheduler depends significantly on two dominant dispatching mechanisms i.e. time-driven in addition to priority driven. Every task has an initial time for start in time-driven dispatching. Dispatching depends on the priority of a task for priority driven algorithms. This priority assignment can be static or dynamic types [7]. Schedulers are possibly pre-emptive or else non-pre-emptive type in addition to load tasks along with precedence assignments. Several scheduling algorithms are available in various research literatures in addition to bound search is normally utilized for optimal scheduling for time driven scheduling with static priority scheduling techniques such as First-In-First-Out (FIFO), Round-Robin (RR), Earliest-Deadline-First (EDF), Minimum-Laxity-First (MLF) and Least-Slack-Time-First (LST) [10, 11, 12, and 13].

Lamentably, none of the plans gives adequate hold to relative assignment imperatives and time requirements where those are utilized as a part of multi-robot frameworks. Relative limitations are measured in [14] and a parametric booking strategy has been produced for the unique instance of multi-level chains of errands. Sustainable achievements have been gathered for undertakings with relative division requirements [8]. Configuration to-time is an GA approach for taking care of constant issues when numerous strategies that make exchange offs in execution time and arrangement quality are accessible for some errands [9]. In any case, the technique does not consider undertaking interdependencies and in this manner they may not be suitable for a multi-robot framework, despite the fact that they can ensure assignment execution requirements [16].

Static scheduling algorithms are mostly classified as heuristic algorithms, guided random algorithms and hybrid algorithms. Heuristic scheduling algorithms search for close optimal solutions in very less polynomial time. This technique travels from one point to another by utilizing a particular rule set. Such technique though efficient but searches some path in the search space by ignoring others [3]. Heuristic scheduling algorithms are again sub classified into three basic categories such as duplication heuristics, clustering heuristics and list-based heuristics [2, 3, and 4]. Hybrid algorithms are extensively implemented for task scheduling problems [2]. Hybrid scheduling techniques overcome many problems by functioning on a parallel operation on population of points. Therefore it minimizes the probability of convergence obtaining local optimum [3, 5]. On the other hand, a reduced representation of a scheduling problem can go ahead for difficulties in predicting good optimal solutions contained by a reasonable time period. In contrast to the heuristic scheduling techniques that require straight information processors for concluding the next scheduling step, hybrid scheduling techniques manage individually by encoding possible schedules [14, 15]. Hybrid scheduling algorithms can be combined with both heuristic scheduling algorithms and GA for better optimized results. In this article, a scheduling method named travelling salesman problem (TSP) with genetic algorithm search technique is proposed and the scheduling analysis of this method is portrayed. The Section 2 discusses the problem statement the proposed methodology. The Section 3 of the article presents the motivation for our scheduling algorithms whereas the Section 4 discusses the analysis results obtained during performing travelling Salesman Problem (TSP) with Genetic algorithm search methodology.

2. PROBLEM DESCRIPTION

The scheduling problem is addressed in the context of time driven systems as they permit the scheduler to have clear control over when tasks are accelerated. Considering an industrial automatic pick and place system with eight numbers of tasks as pictured in figure 1 (a), the procedure can be imitated into eight numbers of tasks. The robot used in this work is a SCARA type robotic arm which is capable of moving in x-y-z directions. The complete x-y-z coordinate recording is performed using a control unit with data acquisition system connected with a computer. The complete setup is shown in the figure 1 (b). The optimum distance of travel and completion of the tasks is achieved using TSP-GA based approach. Following sections describe the solution of the above problem.

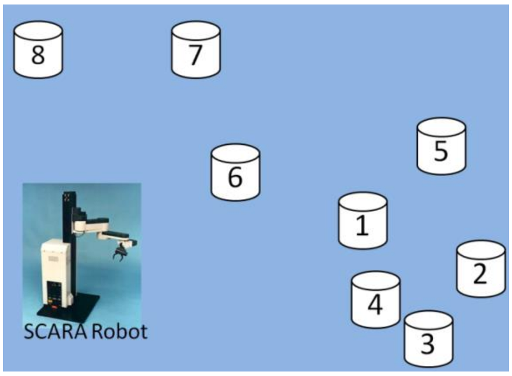

Figure 1 (a). Pick and place sequence and fixture requirements of the robot

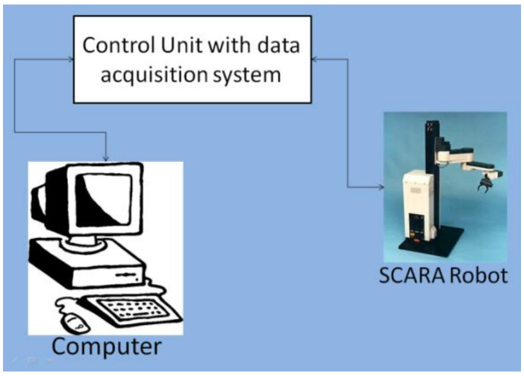

Figure 1 (b). Pick and place sequence and fixture requirements

3. THE PROPOSED METHODOLOGY

In this portion, the new task scheduling algorithm that is reinforced on travelling Salesman Problem (TSP) by means of Genetic algorithmic program search technique used for robot task scheduling is proposed. The discourse process discusses a procedure to produce its incipient population using a heuristic scheduling algorithm. The scheduler generates and locates a solution in the search space around the optimal schedule by utilizing heuristic scheduling algorithm. The exercise of the Hybrid scheduling base algorithm is sketched in figure 2. The robot task locations are enrolled in the table 1.

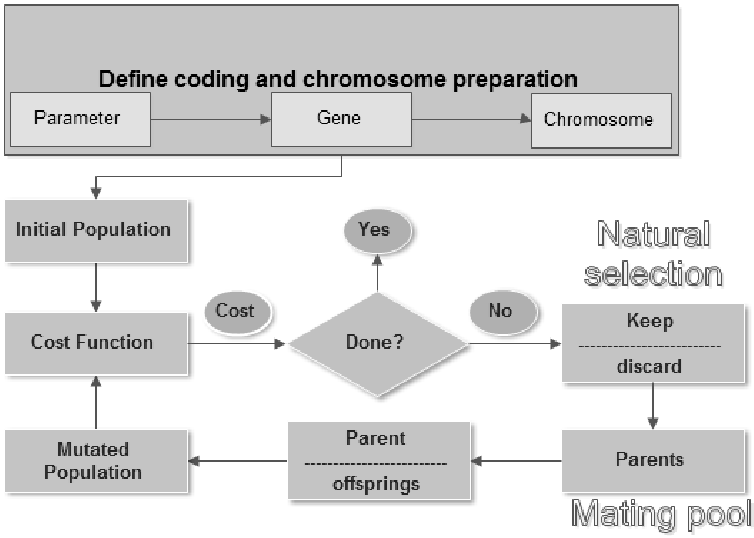

Figure 2. Outline of genetic algorithm for solving TSP

Table 1. Locations for robot task scheduling

Sl. No.	X-AXIS	Y-AXIS	Z-AXIS
1	365.66	-99.22	393.84
2	485.81	-131.82	366.62
3	493.69	-7.97	332.93
4	543.41	103.4	334.55
5	606.42	115.38	397.56
6	468.01	433.25	377.73
7	324.93	300.16	443.2
8	160.62	477.04	455

In the broad sense the genetic algorithm consists of the steps as mentioned in the figure 3.

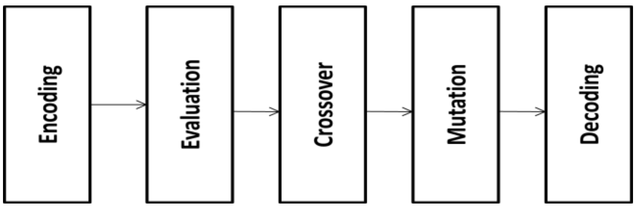

Figure 3. Broad steps of genetic algorithm

3.1 Encoding

The encoding procedure is often the most troublesome aspect of resolving a proposition using genetic algorithms. When attaching them to a precise problem, it is often difficult to find a suitable likeness of the resolution that will be comfortable to use in the crossover procedure. Remembering that we necessarily encode many practicable solutions to produce a population. The traditional procession to describe a resolution is with a string of 0's and 1's.

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3.2 Evaluation

The evaluation mechanism performs a major role in genetic algorithm. Here the evaluation function is used to find the good chromosome. The evaluation function finds the optimal solution to the TSP by setting the genetic algorithm for the shortest route.

3.3 Crossover

Crossover always runs on the chromosomes availability in the mating pool. It works on two chromosomes to generate two off-spring chromosomes where each one generated from both the parents. Crossover randomly elects by substring reference for each parent.

3.4 Mutation

Swap mutation employs on the chromosomes in the mating pool to sustain the variety of the population. It randomly chooses two tasks from a chromosome in addition to swaps them. The swap mutation is referred with probability of about 0.5. The chromosomes in the mating pool are confederated with the chromosomes in the elitism set to produce the fresh population after the swap crossover and swap mutation operators.

4. RESULTS AND DISCUSSIONS

The proposed travelling salesman problem with optimisation using genetic algorithm is modelled using eight numbers of target locations. The figure 4 shows all the task locations in x-y-z directions. Our proposed shortest path algorithm produces two sets of optimum path in every run. Figure 5 shows the optimum path of the task in first run.

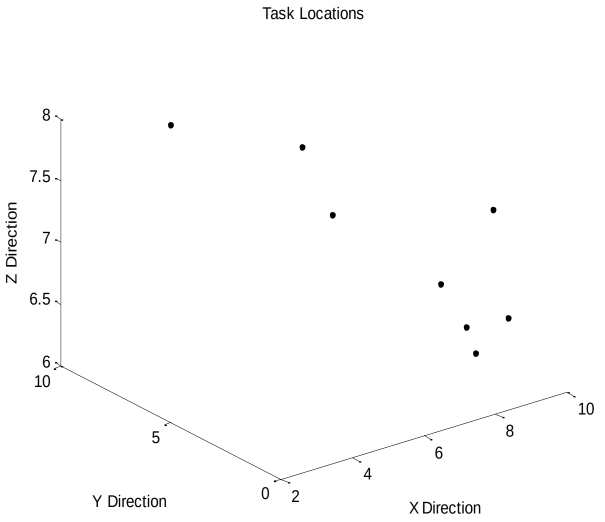

Figure 4. Task locations in x-y-z directions.

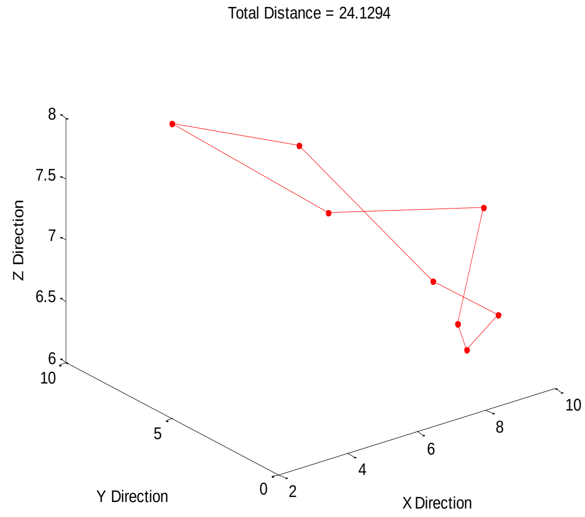

Figure 5. Optimum path of the task locations in first run.

Similar process was again repeated with the same task locations as shown in the figure 4. The optimum task locations obtained in the second run of the algorithm is shown in the figure 6.

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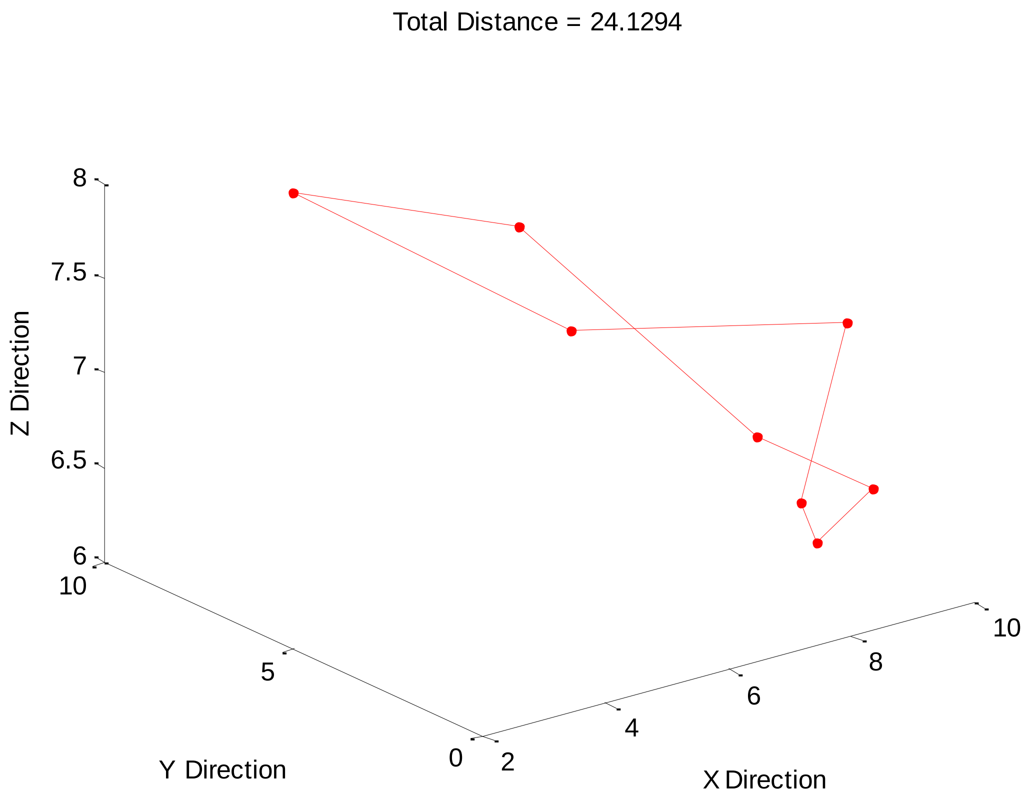

Figure 6. Optimum path of the task locations in second run.

The best solution during each run is shown in the figure 7 and figure 8. It can be observed from the figure 7 that the minimum distance of 24.1294 is reached at 20 iterations in the first run. In the similar sense, figure 8 shows that the minimum distance about 24.1294 is reached at 6 iterations.

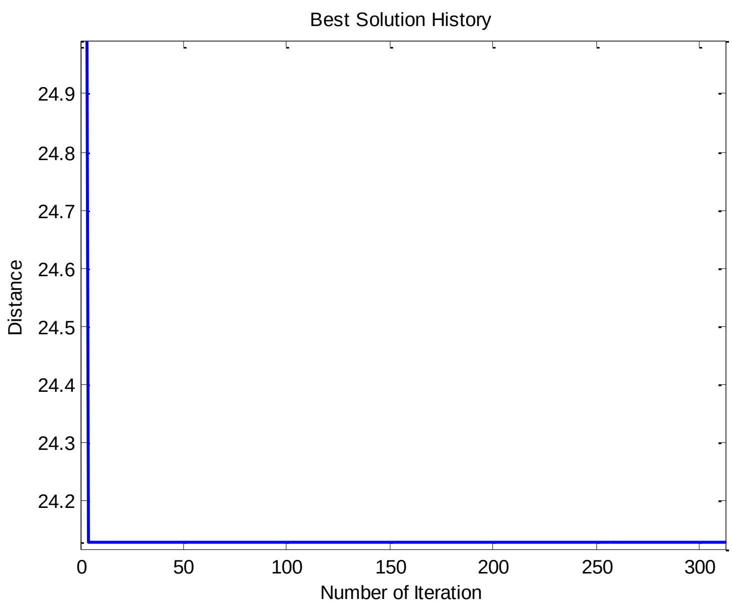

Figure 7. Distance history obtained from TSP-GA in first run.

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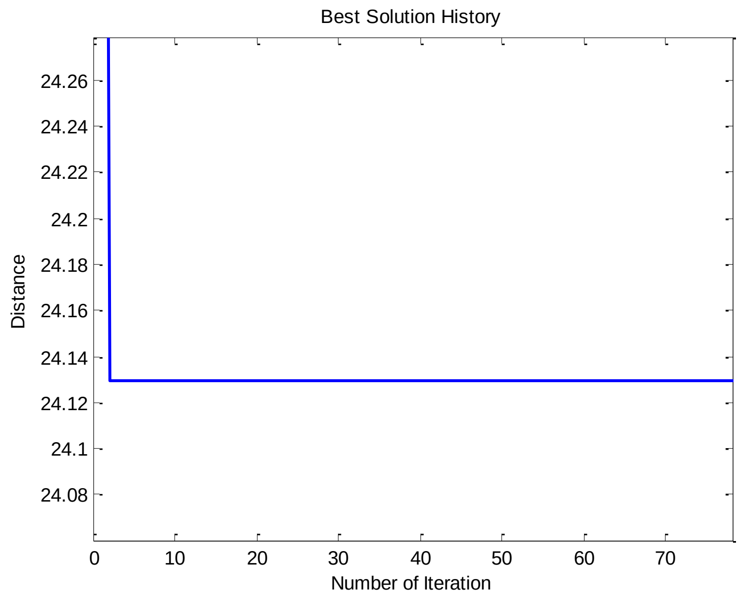

Figure 8. Distance history obtained from TSP-GA in second run.

It can be studied from figures 7 and 8 that the travelling salesman problem with genetic algorithm based minimum distance finding technique produces accurate shortest path to perform the robot tasks. The distance matrix obtained during each running of the algorithm is shown in the figure 9 and figure 10. The shortest path obtained during each time running of the algorithm are listed in the table 2.

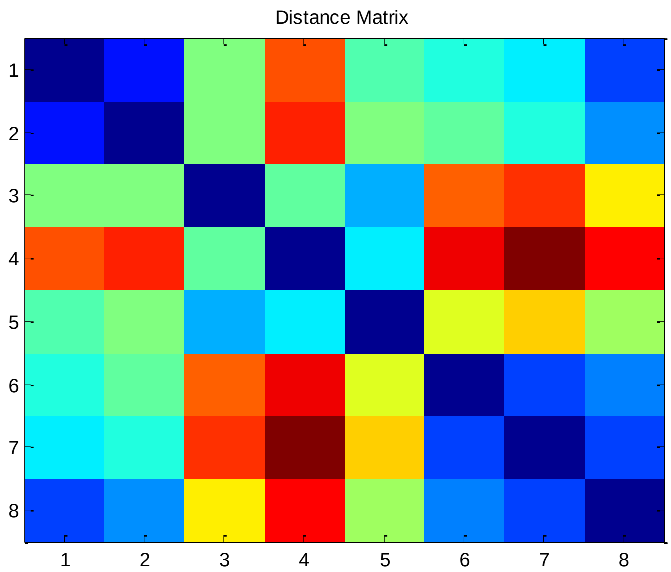

Figure 9. Plot of the distance matrix in first run.

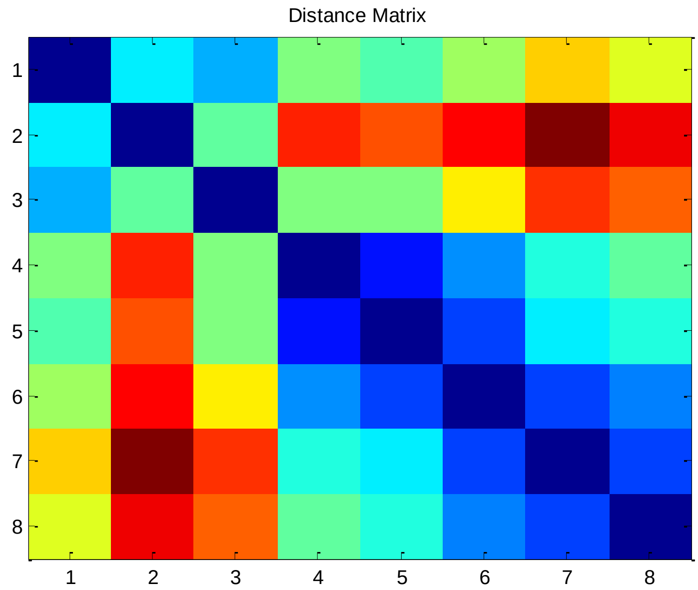

Figure 10. Plot of the distance matrix in second run.

Table 2. List of location index during each running of the TSP-GA algorithm

Sl. No.	Index of each locations	Distance	Number of Iterations	Program Running
1.	[4 5 6 8 7 1 2 3]	24.1294	20	First Run
2.	[7 8 6 5 4 3 2 1]	24.1294	6	Second Run

It is observed from the table 2 that the minimum distance obtained during each time is same and the algorithm provides best root of the robot tasks to perform the complete task.

5. CONCLUSION

A novel hybrid scheduling algorithm invoked the genetic algorithm for task scheduling has been analyzed. It is observed that the GA algorithm optimizes the task scheduling in TSP. First, the GA algorithm discusses a list-based scheduling heuristics to produce a near optimal schedule sequence. The GA uses the list-based scheduling technique to produce its first population sequence. After all, the GA algorithm helps to evolve this population to find the correct optimal (or near-optimum) schedule sequence. The GA algorithm engages a set of genetic operators that are specifically selected for the task scheduling problem. These operators search the search space efficiently. Hence, the time required by the GA algorithm to find an optimum or near optimum schedule is minimized. The accomplishment of the GA algorithm is compared to two of the utmost list-based scheduling algorithms for TSP.

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