Trip Frequency Scheduling for Traffic Transportation Management based on Compact Genetic Algorithm

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***Abstract*— This paper presents a method to specify a trip frequency scheduling for Electricity Bus System (EBS) which is one of the most important traffic transfers in many universities. The simulation data is designed to match with the real system of EBS in Naresuan University. In our method, Compact Genetic Algorithm (cGA) is adopted to find the optimal trip frequency which enhances the performance of the traffic transfer. As results indicated, the schedule can be designed by considering of operation cost reduction and passengers service quality.**

***Index Terms*— Trip frequency scheduling, Electricity Bus System, Compact Genetic Algorithms**

I. INTRODUCTION

Nowadays, electricity bus becomes an important traffic transfer in Naresuan University. An increasing proportion in passenger causes the problem of scheduling. In this paper, an appropriate traffic transportation management is performed by using cGA to specify an optimal schedule in which the operation cost is reduced. In addition, the passenger service quality is still maintained.

Several approaches based on traffic transportation management were proposed in [1-3]. In [1], trip frequency scheduling is approximated by a linear program, called linear programming approximation (LPA). Ghassan and Rahim [2] applied the genetic algorithm (GA) to manage formation and dissipation of traffic management strategies. ZHANG et al, [3] used the hybrid genetic algorithm (HGA) to optimize the scheduling of public vehicles based on their actual operational environments. Based on above mentioned literatures, optimization technique is one of the most key techniques to find an optimal schedule.

In [4], compact GA (cGA) was introduced to solve the general optimization problem. cGA [4] represents the population as a probability distribution over the set of solutions and is operationally equivalent to the order-one behavior of the simple GA. As the matter of design, cGA shows an interesting way of getting more information out of a finite set of evaluations [4]. In this paper, cGA is adopted to the trip frequency for Electricity Bus route management in Naresuan University. The fitness function in the proposed technique is based on the concept of reduce operation cost and improve service to the passenger. The objective function adopted in this paper provides a good service at low cost.

The reminder of this paper is organized as follows. In Section II, objective function of traffic management strategies is described. The compact GA is introduced. The fitness function formulated by operation cost and service quality is described in section III. A case study and simulation results are given in Section IV. And finally, conclusions and discussions are given in Section V.

Manuscript received October 9, 2009. This work was supported by the NRCT year 2008.

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II. TRIP FREQUENCY SCHEDULING

An optimal trip frequency schedule can be studied as transportation task planning and management in real practice. The scheduling problem leads to the time distribution of shared resources. The number of required trips is determined on the capacity of Electricity Bus. Therefore, number of required trips (*Nr*) can be determined by

$$Nr = \frac{G}{fC} \tag{1}$$

Where G is the total number of passengers.
f is the number of trips.
C is the capacity of Electricity Bus.

In a trip frequency schedule, time period is defined as k (k = 1,2,…,j). The main objective of this optimization is to reduce the number of trips and improve passenger service quality. Thus, the objective function can be derived as:

$$minimize\ \ Z \ = \sum_{k=1}^{j}\left(Nk_k - Nr_k\right) + \rho\sum_{k=1}^{j}\left(\frac{1}{sa_k}\right) \tag{2}$$

Where N_r is the number of required trips, N_k is the number of trips, S_a is the satisfaction of passenger and ρ is the

ISBN: 978-988-18210-4-1
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

weighting coefficient which depends on the satisfaction of passenger.

III. Compact Genetic algorithm

Compact GA was presented in [4]. In this section, a brief summary of compact GA with the modification is presented. Following steps conclude the compact GA with modification [4] for trip frequency scheduling.

Step 1 Specify all parameters of the trip frequency schedule. The optimal trip frequency schedule is the unknown parameter attempted to be evaluated by cGA. Set of schedule achieved by step 1 and 2 are the initial chromosome.

Step 2 Initialize probability vector (*p*). Number of member in vector *p* is calculated from the number of unknown parameters and number of bits per one unknown. For example, assume that number of unknown parameters is 9 and the number of bits per one unknown is 8. Then, the length of probability vector (*m*) is 9×8 = 72. The initial probability, *p*, for all elements is set to be 0.5.

Step 3 Generate *s* individuals from the vector. Where *s* is defined as the tournament selection of size *s*. In this paper, *s* is selected as 10 and *S* means the unknown controller parameter vector.

```
for i=1 to s do
    S[i] = generate(p)
```

generate means the individual generation procedure that compute the new individual based on the probability vector *p*.

Step 4 Use (2) to compute the fitness value of each *S*. Keep *S* that has the maximum fitness value as the *winner*, and *S* that has the minimum fitness value as the *loser*.

```
winner, loser = compete(S[1], S[2]…., S[s])
```

compete means the comparison procedure.

Step 5 Update the probability vector *p* from the *winner* and *loser*. Following pseudo code is used to described the updating algorithm.

```
for i=1 to m do
  if winner[i] ≠ loser[i]
    if winner[i] = 1 then p[i] = p[i] + (1/n)
  else p[i] = p[i] – (1/n)
    if p[i] > 1 means probability = 1
    if p[i] < 0 means probability = 0
```

where *n* is the population size, *m* is the chromosome length.

Step 6 Check the convergence by

```
for i=1 to m do
    if p[i] > 0 and p[i]<1 then return to step 2
```

If the solution is converged, *p* is the optimal solution. More details of compact genetic algorithm can be seen in [4]. Fig. 1. shows the flow chat of the compact genetic algorithm.

This fitness function is proposed to minimize the difference between the number of required trips and the number of trips and maximize the the satisfaction of passenger. Then, the task of the trip frequency schedule is just to solve the fitness function of the process to zero.

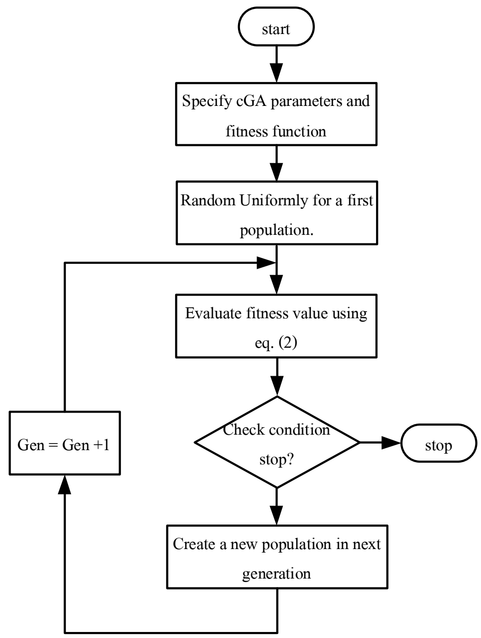

Fig. 1. Flow chat of compact genetic algorithm.

IV. Case study and simulation results

To verify the effectiveness of the proposed algorithm, some simulations were performed. Performance of optimal schedule is verified by the index of operation cost reduction and service improvement to the passenger. Population size is selected as 20, tournament selection size (*s*) is 10, number of bits per unknown is 8 and the upper and lower bound of input is 0 and 10. The optimal trip frequency scheduling are obtained in 933th generation. The fitness value of the optimal schedule that is acquired equals 4.907. Convergence of solution is shown in Figure 2.

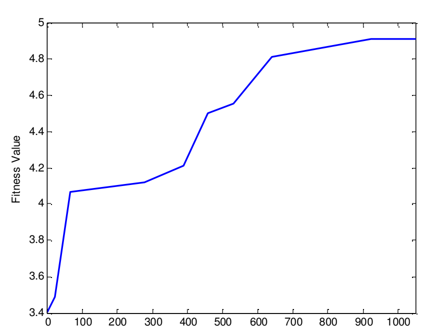

Fig. 2. Fitness value versus Iteration (generation) in compact Genetic Algorithm.

ISBN: 978-988-18210-4-1
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

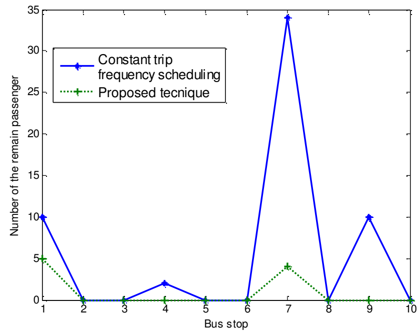

Fig. 3. Number of the remain passenger versus each bus stop.

Figure 3 shows results of number of remain passengers when using various methods. As seen in this paper, the proposed technique gains more effectiveness than the conventional techniques.

V. Case Study and Simulation Results

In this paper, an optimal trip frequency scheduling of Electricity Bus is proposed. cGA is applied to evaluate the optimal schedule. The effectiveness of the proposed technique is proven by the satisfaction of the passenger and operation cost of the Electricity Bus. The simulation results demonstrate the feasibility and intelligence of the proposed approach.

Acknowledgement

This research work was funded by NRCT (2008).

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ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)