Optimization of Waiting and Journey Time in Group Elevator System Using Genetic Algorithm

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Abstract— Efficient elevator group control is an important issue for vertical transportation in high-rise buildings. From the engineering design perspective, regulation of average waiting time and journey time while considering energy consumption is an optimization problem. Alternatively to the conventional algorithms for scheduling and dispatching cars to hall calls, intelligent systems based methods have drawn much attention in the last years. This study aims to improve the elevator group control system's performance by applying genetic algorithm based optimization algorithms considering two systems. Firstly, average passenger waiting time is optimized in the conventional elevator systems in which a hall call is submitted by indicating the travel direction. Secondly, a recent development in elevator industry is considered and it is assumed that instead of direction indicators there are destination button panels at floors that allow passengers to specify their destinations. In this case optimization of average waiting time, journey time and car trip time is investigated. Two proposed algorithms have been applied considering preload conditions in a building with 20 floors and 4 cars. The simulation results have been compared with a previous study and conventional duplex algorithm.

Keywords—elevator; elevator group control; genetic algorithm; artificial intelligence; optimization.

I. INTRODUCTION

High-rise buildings and vertical transportation need the installation of an efficient elevator group control system that provides transportation of many passengers in short time. During the last years, with the increase of number of these type of buildings, the need for effective control of these systems have brought new challenges from point of view of the optimization and control [1]. As the problem is a nonlinear and complex system, in the last decade studies about elevator group control has focused on applying artificial intelligence (AI) to improve the efficiency of these systems. In first studies, Artificial Neural networks (ANN) as a nonlinear mapping approach has been applied for the control of an elevator [2]. In a similar study, ANN has been applied as a single controller for the elevator group control systems [3-4]. Recently, in [5] using ANN a simulator for group elevator has been developed and analyzed. Similarly, other AI methods have been applied in later studies. Applications of AI systems such as expert system, fuzzy logic, and reinforcement learning for development of intelligent elevator scheduling, have been compared in the control of these complex systems [11]. As the problem of group elevator control and scheduling is a nonlinear convex optimization problem, in later studies heuristic optimization algorithms have been preferred.

Heuristic optimization and search algorithms have been used to find optimal solution in elevator problem. In [6], Genetic Algorithm (GA) has been used to optimize elevator car allocation under different traffic conditions [6]. In [7] GA and Tabu search for the optimization of car allocation problem have been investigated, and it was stated that GA is computationally suitable for optimization of group elevator system. In other study a GA based optimization algorithm has been applied using car dynamics in problem formulation [8]. Since the input and output variables of elevator problem can be represented as binary values, GA based optimization can be applied easily for problem coding and optimizing this problem. For example, in [9] Ghareib applied a simple algorithm to optimize waiting time considering preload conditions of cars [9]. Time based optimization subjects in control of group elevator are as follows.

- Waiting time (WT) is the time until the car arrives at the floor after a passenger requests a hall call.
- Car trip time (CTT) is the time that a car serves until the last passenger assigned to that car is transported.
- Travel time is the time starting from passenger's entrance until leaving the car at the destination floor
- Journey time (JT) includes passenger travel time and waiting time.

This study suggests improved GA-based optimization algorithms to optimize WT, JT and CTT considering two systems. In the first system conventional elevator system in which passengers can only select the trip direction is considered. Secondly, a recent development in elevator industry is considered and it is assumed that instead of direction indicators, there are destination button panels at floors that allow passengers to select destination floors. In a previous study, proposed algorithms for these systems were named as

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GA1 and GA2, respectively [9]. In this study we name our proposed algorithms as GA3 and GA4 for two systems. For the purpose of comparison the same scenario in [9] is adopted. This scenario considers a group elevator system including 4 elevators serving in 20-floors building. On this scenario, considering first system, our proposed algorithm GA3 is compared with GA1 and conventional duplex algorithm in WT optimization. Considering second system, GA4 is compared with GA2 in WT optimization. Moreover in this study proposed algorithm GA4 is also applied for CTT and JT optimization.

The study has been organized as follows; section II evaluates GA as an optimization method. Section III presents problem encoding approach in GA for elevator dispatching problem. In section IV proposed algorithms are explained and formulated. In chapter V the referred scenario including 4 elevators serving in 20-floors is presented and comparative simulation results are given. The last section discusses the performance of the proposed algorithms.

II. Genetic Algorithm

The problem of finding optimal solution for group elevator can be optimized using heuristic optimization algorithm. As a compatible algorithm with binary variables GA is suitable for coding dispatching cars to hall calls. The proposed approaches use GA to improve WT and JT of passenger that are measures for service quality and CTT that is a measure for energy consumption.

GA is a stochastic search algorithms based on biological evolution. If a problem as a binary string with chromosome and gens, GA can be easily to find optimal solution. Figure 1 presents abstract of GA flowchart. The main steps of applying GA to any problem have been presented as follows.

Step 1: Code the problem as a binary chromosome
Step 2: Choose the size of a chromosome population N
Step 3.Select genetic operators as crossover probability pc and the mutation probability pm.
Step 4: Define a fitness function.
Step 5: Randomly generate an initial population of N
Step 6: Calculate the fitness of each individual chromosome:
Step 7: Select a pair of chromosomes to generate next generation.
Step 8: Create a pair of offspring chromosomes
Step 9: Place the created offspring chromosomes in the new population.
Step 10: Replace the initial (parent) chromosome population with the new (offspring) population.
Step 11: Go to Step 6, and repeat the process

The above algorithm repeats the optimization process until the termination criterion is satisfied or selected iteration has completed. In proposed problem, two GA are used to optimize TWT and TJT that tends to reduce power consumption. To apply GA to any optimization problem, the first step is coding the problem, and defining chromosome and gens values. Although, in current study, the problem coding step is similar to previous study [6], the coding process has been presented in detail in section III.

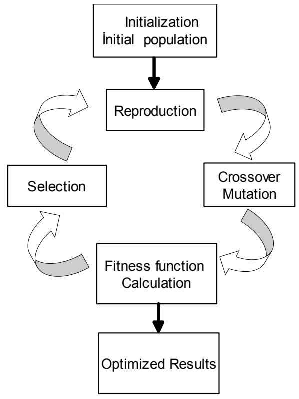

Fig. 1. Abstract of GA steps.

III. Problem Coding

In order to code the elevator dispatching problem into binary string, a potential solution consisting of N bit strings where each string has length of 2x(NF-1) is defined. NF is the number of floors and N is the number of cars. Each part in binary string (2x(NF-1) bits) represents dispatch condition of a car. Particularly, first (NF-1) bits represent the up hall calls which can be from 1st floor to (NF-1)th floor and the second (NF-1) bits represent down hall calls which can be from NFth floor to 2nd floor. In figure 2 structure of a potential solution is shown for a scenario with 20 floors and 4 cars. For a particular car, first part of the string holds the up HCs whereas second part holds down HCs. If the hall call at *i*th floor HC_i is assigned to that car *i*th bit is 1, otherwise it is 0.

In the initial population HCs are distributed among the cars randomly. In the reproduction crossover is applied between randomly selected car pairs. In this problem mutation operator is applied as randomly changing a HC's car. Particularly if a up hall call HC_i is assigned to *n*th car, it is assigned to another car by setting *i*th bit of *n*th car from 1 to 0 and *i*th bit of the new car from 0 to 1.

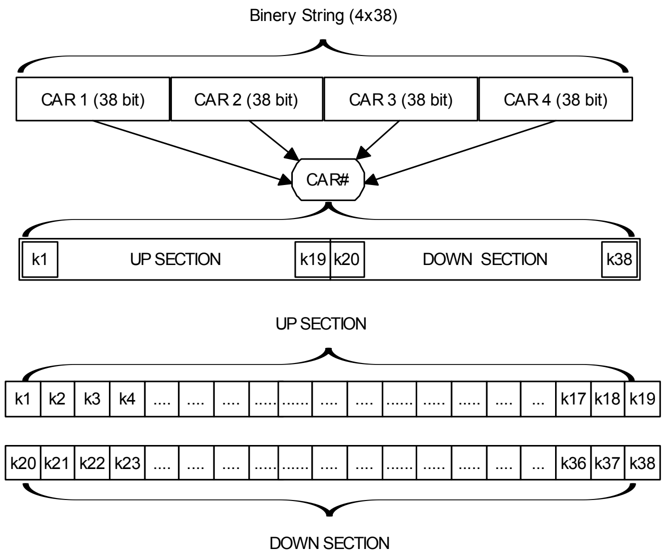

Fig. 2. Problem encoding as a binary string for group elevator

IV. PROPOSED ALGORITHMS

The optimization algorithm has been applied in two cases that are as follows

1- Destinations are not known
   - WT optimization
2- Destinations are known;
   - WT optimization
   - CTT optimization
   - JT optimization

In the first case, passengers can select only travel direction and the optimization algorithm aims to reduce passenger WT. In the second case, it is assumed that passengers can select destination floor by destination button panel. In this case CTT, passenger WT and JT optimizations are investigated. Results are compared with a previous study and conventional duplex algorithm.

A. Destinations are not known

In buildings with conventional elevator systems, passenger demands a car by specifying destination direction using call button. Such systems conventionally use duplex algorithm.

In [9] the author has applied a GA-based optimization algorithm considering preload conditions to optimize passenger WT and compared with the conventional duplex algorithm when destinations are not known. The average time and fitness function for the average time T_{av} parameter optimization are as follows

$$T_{av}=\frac{1}{M}\sum_{1}^{M}T_i \tag{1}$$

$$\text{fitness}=\frac{1}{T_{av}} \tag{2}$$

where M is the number of hall calls and T_i is the time parameter. The crucial part in optimization performance is the estimation of waiting time Ti. Waiting time estimation can be considered according to the two car states:

- when car is stopped or going up
- when car is going down

The parameters that will be used in WT estimation are as follows:

- HC_i: *i*th hall call floor
- CF_n: current floor of the *n*th car
- NF: number of floors
- TF: inter floor trip time
- NS_i: number of known stops on the segments from CF_n to HC_i
- PT passive time; sum of passenger time, door opening time and door closing time

In [9], when car is stopped or going up, WT of the HC_i assigned to CF_n, was calculated according to the following three cases

i. If HC_i is up and greater than CF_n, car trip has one segment
ii. If HC_i is down, car trip consists of two segments
iii. If HC_i is up and less than CF_n car trip consists of three segments

Similarly, when car is going down, WT calculation was considered considering following three cases

i. If HC_i is down and less than CF_n, car trip has one segment
ii. If HC_i is up, car trip consists of two segments
iii. If HC_i is down and greater than CF_n car trip consists of three segments

In the conventional systems destination floors are not known, hence definition of estimated WT has great importance. However in [9], the time spent when a car arrives at a floor, which consists of passenger transfer time with door opening-closing times, was ignored in WT calculation. In this study we name this time which results in delay, as passive time PT and involve it into the estimated WT calculation. Although we assume that the destinations are not known, we regard the minimum number of stops before the car arrives at HC_i. In the applied algorithm these are the known stops on the segments between HC_i and car floor. These can be other HCs assigned to that car and car destination floor which take place prior to HC_i. Regarding above considerations, we updated the equations used in [9] by adding the term $NS_i.PT$ as given in (3) and (4) , where NS_i is the number of known stops between hall call floor HC_i and car floor CF_n. When car is stopped or going up, WT is calculated according to (3) and when the car is going down WT is calculated according to (4). In the case where car destinations are not known, we will refer to the method used in [9] as GA1 and the method proposed in this study as GA3.

$$T_i=\begin{cases}[HC_i-CF_n].TF+NS_i.PT & ;\uparrow HC_i \geq CF_n\\ [2.NF-CF_n-HC_i].TF+NS_i.PT & ;\downarrow HC_i\\ [2.NF-CF_n+HC_i-2].TF+NS_i.PT & ;\uparrow HC_i < CF_n\end{cases} \tag{3}$$

$$T_i=\begin{cases}[CF_n-HC_i].TF+NS_i.PT & ;\downarrow HC_i \leq CF_n\\ [CF_n+HC_i-2].TF+NS_i.PT & ;\uparrow HC_i\\ [2.NF+CF_n-HC_i-2].TF+NS_i.PT & ;\downarrow HC_i > CF_n\end{cases} \tag{4}$$

B. Destinations are known

The innovative developments suggest that if the passenger selects the destination floor instead of destination direction more efficient service can be provided by grouping passengers with common destinations. For this objective destination input panels should be placed at every floor instead of direction indicator panels. For a particular distribution of HCs, this system makes possible to compute times, journey times and car trip times exactly. Utilizing the knowledge of destination floors in GA the proposed algorithm can be enhanced to yield optimal results for the desired parameter. Considered three performance parameters are car trip time, WT and JT. CTT is the total time that a car serves. JT includes passenger's travel time and WT.

In [9] ignoring delays due to the car stops and assuming destinations are known average WT was optimized. Naming this algorithm in [9] as GA2, it was stated that GA2 outperforms the duplex algorithm and GA1. In this study we will name the proposed algorithm as GA4 for the case that destinations are known and compare with GA2. We compute the above three parameters at each generation by taking into account the passive times. Then application of the algorithm is straightforward, by placing the average of the parameter that is desired to be optimized as T_{av} in fitness function (2).

For the computation of above parameters we define additional parameters as follows:

- HC_DF_i : destination floor of HC_i
- $\uparrow HC\_DF_{max}$: maximum destination floor of up HCs greater than CF_n
- $\downarrow HC_{max}$: maximum down HC
- $\downarrow HC\_DF_{min}$: minimum destination floor of down HCs less than CF_n
- $\uparrow HC_{min}$: minimum up HC
- CAR_DF: matrix of car destination floors (if car is stopped, it is equal to CF)
- Y: maximum of the destination floors of up HCs less than CF_n
- Z: minimum of the destination floors of down HCs greater than CF_n

The terms MAX and MIN are given by (5) and (6), in which max operator yields the maximum and min operator yields the minimum of the parameters inside the brackets.

$$MAX=\max(\uparrow HC\_DF_{max}, CAR\_DF, \downarrow HC_{max}) \quad (5)$$

$$MIN=\min(\downarrow HC\_DF_{min}, \uparrow HC_{min}) \quad (6)$$

1) Waiting Time Optimization

WT of HC_i, represented by T_i is computed by (7) or (8) according to the assigned car's state. If car is stopped or going up WT is given by (9), otherwise (10) is used. For an individual in GA, average WT of *M* HCs, is used in (2) to calculate its fitness.

$$T_i=\begin{cases} [HC_i-CF_n].TF+NS_i.PT & ;\uparrow HC_i \geq CF_n \\ [(2MAX-CF_n-HC_i)].TF+NS_i.PT & ;\downarrow HC_i \\ [(2MAX-CF_n+HC_i-2MIN)].TF+NS_i.PT & ;\uparrow HC_i < CF_n \end{cases} \quad (7)$$

$$T_i=\begin{cases} [CF_n-HC_i].TF+NS_i.PT & ;\downarrow HC_i \leq CF_n \\ [CF_n+HC_i-2MIN].TF+NS_i.PT & ;\uparrow HC_i \\ [2MAX+CF_n-HC_i-2MIN].TF+NS_i.PT & ;\downarrow HC_i > CF_n \end{cases} \quad (8)$$

2) Car Trip Time Optimization

Trip time of the *n*th car T_n is obtained by (9) and (10) respectively for the car states in which the car is going up or stopped and the car is going down. The term NS_n is the total number of stops that the car will stop. Here it should be emphasized that the conditions in (11) and (12) are checked sequentially and the last satisfied condition gives the CTT. Particularly, in the case that the car is going up, if there is a down HC, but no up HC assigned to that car, second equation in (11) gives the CTT. To calculate fitness of an individual in GA, average CTT of *N* cars, is used in (2) as T_{av}.

$$T_n=\begin{cases} [MAX-CF_n].TF+NS_n.PT & ;\uparrow HC \geq CF_n \\ [(2MAX-CF_n-MIN)].TF+NS_n.PT & ;\downarrow HC \\ [(2MAX-CF_n+Y-2MIN)].TF+NS_n.PT & ;\uparrow HC < CF_n \end{cases} \quad (9)$$

$$T_n=\begin{cases} [CF_n-MIN].TF+NS_n.PT & ;\downarrow HC \leq CF_n \\ [(MAX+CF_n-2MIN)].TF+NS_n.PT & ;\uparrow HC \\ [(2MAX+CF_n-Z-2MIN)].TF+NS_n.PT & ;\downarrow HC > CF_n \end{cases} \quad (10)$$

3) Journey Time Optimization

The travel time that passes after a passenger enters the car can be regarded as a factor in service quality as WT. Therefore JT which includes both WT and travel time can be considered as a more comprehensive measure for quality of service. In the considered system enables the controller to calculate journey times. JT calculation is similar to WT calculation. To obtain JT we add the travel time to WT by substituting HC_i with HC_DF_i. If car is stopped or going up JT is given by (11) otherwise JT is obtained by (12).

$$T_i=\begin{cases} [HC\_DF_i-CF_n].TF+NS_i.PT & ;\uparrow HC_i \geq CF_n \\ [(2MAX-CF_n-HC\_DF_i)].TF+NS_i.PT & ;\downarrow HC_i \\ [(2MAX-CF_n+HC\_DF_i-2MIN)].TF+NS_i.PT & ;\uparrow HC_i < CF_n \end{cases} \quad (11)$$

$$T_i=\begin{cases} [CF_n-HC\_DF_i].TF+NS_i.PT & ;\downarrow HC_i \leq CF_n \\ [CF_n+HC\_DF_i-2MIN].TF+NS_i.PT & ;\uparrow HC_i \\ [2MAX+CF_n-HC\_DF_i-2MIN].TF+NS_i.PT & ;\downarrow HC_i > CF_n \end{cases} \quad (12)$$

V. SIMULATION RESULTS

In simulations maximum number of generations and population size are set as 100 and 50 respectively. The crossover probability is 0.7 and mutation probability is 0.01. To calculate WT, similar to previous study [9] some constant time values have been adopted as given in Table 1.

The two versions of the proposed algorithm have been applied considering preload car conditions for a 20-floors building with 4 cars. The performance of the algorithms has been checked for 100 runs of simulations and it is seen that with the adopted population size and maximum number of generations, convergence to the same result is ensured. To explicitly describe the algorithm, from the applied 20 scenarios, the scenario used in the referred study is selected [9]. This scenario is depicted in Fig.3. The HC floors, directions and destination floors have been presented in table II. . Additionally the current floor of each car, its direction and related destination has been given in Table III. For instance, at 7th floor there is a HC whose destination is 1 and second car is going down carrying its passenger to 3th floor.

A. Destinations are not known

In the case that destinations are not known, WT optimization has been achieved by WT estimation and fitness function calculation given in equations 1-4. The results of the optimization have been compared with the GA1 in [9] and conventional duplex algorithm. The results given in tables IV and V show that the proposed algorithm GA3 outperforms other algorithms in terms of WT by providing %30.77 reduction whereas other algorithms yield the same performance. The list of assigned HCs is given in table VI.

TABLE I. TIME PARAMETERS

Time parameters	
Parameter	**Time**
Inter-floor time	2 sec
Door opening time	2 sec
Passenger transfer time	3sec
Door closing time	2 sec
Passive time	7 sec

TABLE II. HALL CALL FLOORS, DIRECTIONS AND DESTINATIONS

Hall Calls	Direction	Destinations
H7	Down	1
H9	Up	16
H11	Down	2
H12	Up	20
H13	Down	6
H15	Down	9

TABLE III. CAR CONDITIONS

Cars	Car Floors	Direction	Destinations
Car1	5	Up	7
Car2	17	Down	8
Car3	3	Up	18,20
Car4	19	Down	1,6

TABLE IV. NUMBER OF CAR STOPS IN GA1 AND GA3

Algorithm	Car 1 stops	Car 2 stops	Car 3 stops	Car 4 stops	Total stops
Duplex Algorithm	5	9	2	2	18
GA1	5	9	2	2	18
GA3	3	5	4	4	16

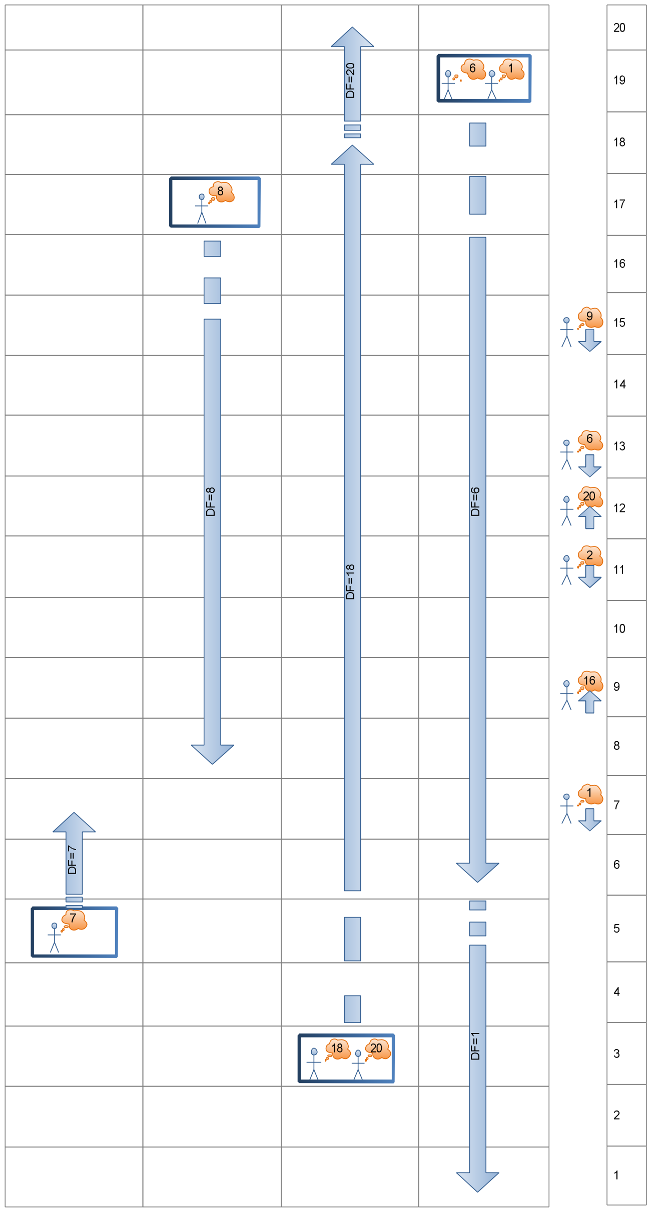

Fig.3. The suggested scenario

TABLE V. WAITING TIMES IN GA1 AND GA3

Algorithm	H7	H9	H11	H12	H13	H15	Total
Duplex Algorithm	55	15	26	28	15	4	143
GA1	55	15	26	28	15	4	143
GA3	31	12	19	21	12	4	99

TABLE VI. ASSIGNED HALL CALLS BY GA1 AND GA3

Algorithm	Car 1	Car 2	Car 3	Car 4
Duplex	H_9,H_{12}	H_7,H_{11}, H_{13}, H_{15}	-	-
GA1 [9]	H_9,H_{12}	H_7,H_{11}, H_{13}, H_{15}	-	-
GA3	H_{12}	H_{11}, H_{15}	H_{12}	H_7, H_{13}

B. Destinations are known

1) Waiting Time Optimization

WT optimization is carried out by the proposed algorithm GA4 using (7) and (8) to calculate T_{av} in (2). Here we compare the GA4 with GA2[9]. The simulation results of two algorithms are given in tables VII, VIII and IX. Results show that the proposed algorithm GA4 improves WT %11.63 in comparison with GA2, by regarding passive time spent during the car stops.

TABLE VII. ASSIGNED HALL CALLS IN WAITING TIME OPTIMIZATION BY GA2 AND GA4

Algorithm	Car 1	Car 2	Car 3	Car 4
GA2[9]	H_7	H_{11}, H_{13}, H_{15}	H_9,H_{12}	-
GA4	H_7	H_{11}, H_{13}	H_9,H_{12}	H_{15}

TABLE VIII. CTT AND NUMBER OF CAR STOPS IN WAITING TIME OPTIMIZATION BY GA2 AND GA4

	Car 1	Car 2	Car 3	Car 4	Total
Number of Car Stops / GA2	2	7	5	2	14
Number of Car Stops / GA4	2	5	5	4	16
Car Trip Time GA2	30	79	69	50	228
Car Trip Time GA4	30	57	69	64	220

TABLE IX. WT AND JT IN WAITING TIME OPTIMIZATION BY GA2 AND GA4

	H7	*H9*	*H11*	*H12*	*H13*	*H15*	*Total*
Waiting Time / GA2	4	12	26	25	15	4	86
Waiting Time / GA4	4	12	19	25	8	8	76
Journey Time / GA2	30	47	79	69	64	44	333
Journey Time / GA4	30	47	65	69	50	34	295

TABLE X. CTT AND NUMBER OF STOPS IN CAR TRIP TIME OPTIMIZATION BY GA4

	Car 1	Car 2	Car 3	Car 4	Total
Number of Car Stops	1	3	5	6	15
Car Trip Time	11	39	69	78	197

TABLE XI. WT AND JT IN CAR TRIP OPTIMIZATION BY GA4

	H7	H9	H11	H12	H13	H15	Total
Waiting Time	38	12	23	25	12	4	114
Journey Time	78	47	69	69	54	30	347

2) Car Trip Time Optimization

Besides the WT optimization we apply the proposed algorithm GA4 to optimize JT and CTT. CTT is the total time that a car serves until its last passenger is transported. The proposed algorithm uses (9) and (10) to calculate CTT. Then average car trip can be used as T_{av} in fitness function (2). From the results given in tables X and XI, it is seen that there is a tradeoff between CTT and WT. In comparison with WT optimization, reduction in CTT has resulted in %50 increase in WT.

3) Journey Time Optimization

JT calculation is similar to WT calculation. To obtain JT we add the passenger travel time to WT by substituting HC_i with HC_DF_i. If car is stopped or going up JT is given by (11) otherwise JT is obtained by (12). Simulation results in JT optimization by the proposed algorithm GA4 are given in tables XII and XIII.

As presented in simulation results JT optimization also provides remarkable WT which is only %5.26 worse than WT optimization. It is a consequence of the fact that JT consists of both travel and waiting times. Therefore JT has correlation with WT. JT optimization also reduces CTT in comparison with WT optimization which is %6.09 worse than CTT optimization.

Finally, assigned hall calls in the optimization of WT, JT and CTT, are given in table XIV.

TABLE XII. CTT AND NUMBER OF CAR STOPS IN JOURNEY TIME OPTIMIZATION BY GA4

	Car 1	Car 2	Car 3	Car 4	Total
Number of Car Stops	2	3	5	5	15
Car Trip Time	30	39	69	71	209

TABLE XIII. ASSIGNED HALL CALLS IN JOURNEY TIME OPTIMIZATION BY GA4

	H7	H9	H11	H12	H13	H15	Total
Waiting Time	4	12	23	25	12	4	80
Journey Time	30	47	62	69	47	30	285

TABLE XIV. ASSIGNED HALL CALLS IN WT, JT AND CTT OPTIMIZATIONS BY GA4

	Car 1	Car 2	Car 3	Car 4
Waiting Time Optimization	H_7	H_{11}, H_{13}	H_9,H_{12}	H_{15}
Journey Time Optimization	H_7	H_{15}	H_9,H_{12}	H_{11}, H_{13}
Car Trip Optimization	-	H_{15}	H_9,H_{12}	H_7,H_{11}, H_{13}

VI. CONCLUSION

In this study we proposed GA based optimization algorithms for the optimal elevator dispatching problem considering different system performance parameters. Differently from the referred study [9], we involved the passive time in estimation functions by taking into account the known stops.

In the first case conventional elevator system in which passengers can only select the trip direction has been considered. Simulation results showed that the proposed algorithm GA3 improves WT in comparison with the referred algorithm GA1 and the conventional duplex algorithm.

In the second case, it is assumed that passengers can register their destinations by destination input panels. Since the destinations are known, besides WT it is possible to involve travel time into optimization process. Hence three different parameters can be optimized; WT, JT and CTT.

In this case, firstly WT has been optimized by GA4 and results have been compared with GA2. Simulation results have showed that GA4 outperforms GA2.

Secondly, CTT is selected to be optimized for the purpose of energy efficiency. Simulation results have showed that there is a tradeoff between CTT and WT. As a consequence, an optimization strategy purely based on CTT increases passenger WT and results in an unbalanced distribution of HCs among cars.

Finally, the utilization of the knowledge of known destinations, allowed us to compute JT which is not possible to determine in GA1 and GA3. JT optimization provided a more balanced tradeoff between three parameters.

In conclusion, proposed algorithm GA3 outperforms the referred algorithm GA1 and duplex algorithm in the first case, whereas in the second case GA4 provides better WT than the referred algorithm GA2. Moreover CTT and JT optimizations are also investigated. As a result in case that destination button panels are available it is possible to provide a control according to the desired parameter. Alternatively weighted average of these parameters can also be tuned and used in fitness function to balance the quality of service and energy consumption.

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