11th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2007, Hammamet, Tunisia, 05-09 September, 2007.

STRATEGIES FOR CONTROLLING ELEVATOR GROUP SYSTEMS

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ABSTRACT
In high-rise buildings, elevators must be safely and efficiently moving people during daytime. Generally, elevator up-peak traffic is predominant traffic between a lobby and various upper floors. Especially, the main expectation from elevators in buildings is increasing in a rush-hour time. Therefore, the passenger's waiting time in their floor are increased. We can say that the services given by the elevator group control system are not sufficient in this building. The passenger service level in an elevator system depends on the controlling of the elevators. The purpose of this paper is to demonstrate that an effective way to control of elevators group using optimization algorithms and the results show that the average journey and waiting time of passengers are decreased by means of suggested method.
Keywords: Elevator, elevator traffic, vertical transportation, up-peak traffic.

1. INTRODUCTION
Elevator has been used safely and efficiently moving people in buildings for 150 years. If the elevator did not exist, buildings would be limited to five or six stores and also most of the high-rise buildings of the 20th and 21st century would be impossible. The number of high-rise buildings over 20 floors has increased rapidly in all over the world. Therefore, elevator is the most used vertical transport systems in the world. By creatively applying new technologies, elevator system is continued to develop for ride quality, reliability and safety in high-rise buildings, besides, to give better service to passengers, providing service at every floor in the buildings to as many as possible at a minimum time. In other words, an optimal elevator system must be reduced passenger's journey, travel and waiting time in a rush-hour time.

In a multi-stores office building, passengers take the elevators to the lobby floor forming the up-peak traffic at the beginning of the day. Hence, elevator traffic can be calculated analytically for up-peak situations where passengers arrive at the entrance floor and travel to the upper floors. Although the other traffic situations exist, such as outgoing, two-way or mixed lunch-hour traffic, the elevator group control strongly affects the up-peak traffic [1]. The first aim of this study is to describe optimization method of a group elevator that optimizes passenger service level. Therefore, the genetic algorithm in this study is applied to tackle the up-peak traffic problems in high-rise buildings and the optimization results obtained from the algorithm has been discussed.

2. THE ELEVATORS GROUP CONTROL SYSTEMS

Generally, modern high-rise buildings are serviced by collectively controlled groups of elevators. Therefore, in this building, efficient performance is getting strongly required for an elevator group control system. The most common way of improving elevator performance is to install larger on additional elevator cars and/or to accelerate the speed of elevator cars [2].

In designing a building, deciding how many elevators are needed according to the building populations and all passengers should be able to transport every floor in the building with minimum time. However, it is often restricted by space limitation in buildings, cost problems or other conditions. Hence, an intelligent elevator control has been studied by many scientist and elevator engineers who have made to analyze elevator system performance with a lot of different studies.

An elevator system in a building has to be acceptable to the traveling public. A passenger expects a good service from an elevator system, so other criteria used in elevator design is that a passenger journey time which is the sum of the average passenger travel time (ATT) and the average waiting time (AWT) should be minimum. The average passenger travel time is simple to calculate, but the average passenger waiting time depends on car loading which can only be determined after the car size has been selected. And also, the average passenger waiting time would be the best indicator of the quality of service. However, the passenger waiting time cannot be easily measured. For that reason, the interval of car arrivals at the main terminal is used as an indication of service quality. When considering office buildings as an interval of [3]:

- 20 s or less would indicate an excellent system,
- 25 s would indicate a good system,
- 30 s would indicate a satisfactory system,
- 40 s would indicate a poor system,
- 50 s or greater would indicate an unacceptable system.

In this study, we present a genetic algorithm for the minimization of expected average journey time of all passengers using elevators. The genetic algorithm described in [4, 5] is used in the solution of problems which are difficult to solve with traditional methods. Firstly, genetic algorithm was formed the populations consisted of chromosomes which composed of up and down hall call allocations. The chromosomes are evaluated according to the fitness function. The aim of fitness function is to minimize the way of elevators according to the hall call allocations. The fitness function is evaluated according to the up car and down car direction. After evaluating the fitness function, genetic algorithm operators which are selection, crossover and mutation are applied the chromosomes. The roulette wheel technique has been applied as a selection method.

Crossover takes any two chromosomes from the generation, selects a number of genes from one of the parents and swaps them with the same number and positioned genes in the other parent. There are different crossover techniques which is single point, two point and uniform crossover. In this study, all of the crossover techniques were applied and the different results were obtained. Mutation is simply the random selection of a percentage of the new populations' genes and the random alteration of these genes' values [6]. The algorithm continues until an acceptably good solution.

3. SIMULATION RESULTS

Each elevator test bed was conducted under the following conditions:

- Velocity 1 m/s, 8 persons, 2-6 cars,
- 24 stories office building,

An example of simulation results is shown in Figure 1. Simulations were run for only up-peak traffic condition. In Figure 1, it is clearly seen than whenever the number of car in the group is increased; the average passenger waiting time is decreased.

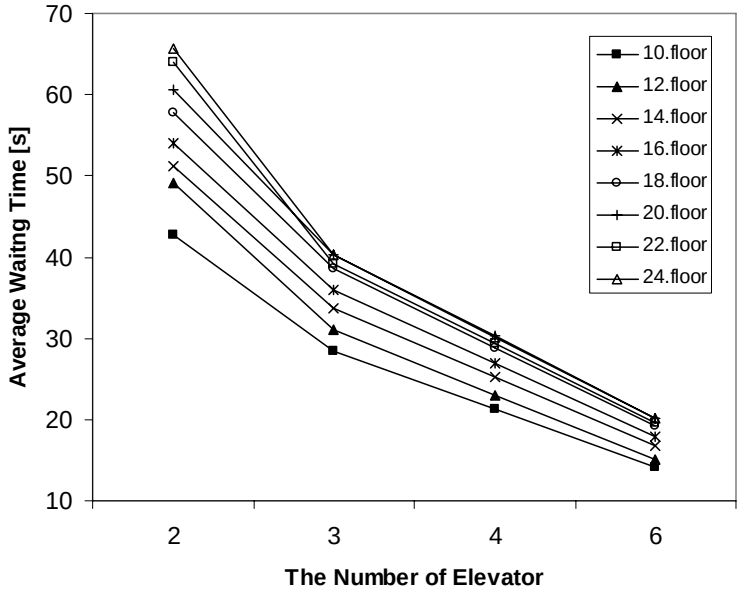

Figure 1. The effects of the number of car on Average Waiting time

The average journey time in a genetic algorithm and a conventional system is depicted in Figure 2. The graph shows the results of a conventional system and genetic algorithms system. We can obviously see the traffic efficiency is improved when the genetic algorithms are used.

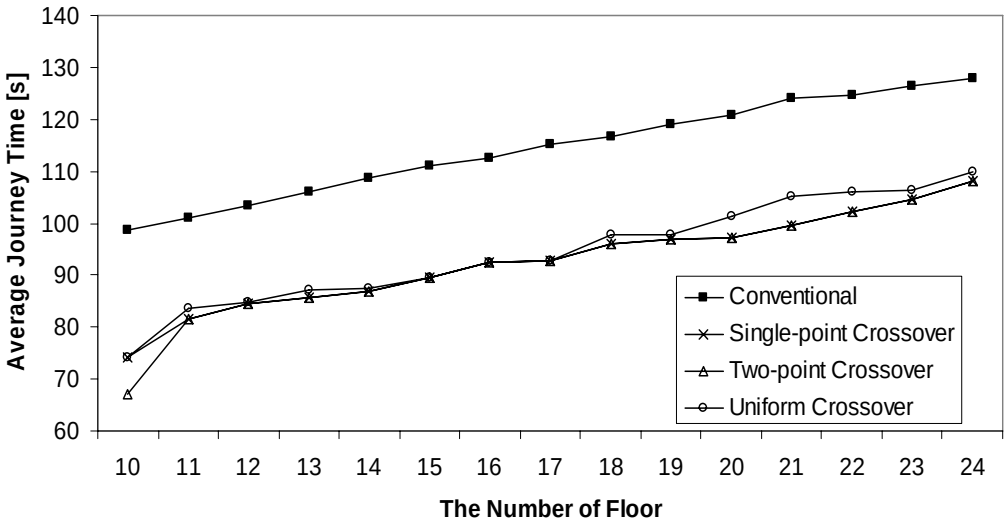

Figure 2. Average Journey Time vs. the number of floors

An average waiting time of simulation result is shown in Figure 3. It is clear that average waiting time is reduced when the genetic algorithms are applied. When the results are evaluated, genetic algorithms increased the performance of the elevator group control system. Accordingly, a decrease of 20%- 25% in average journey time (AJT) and average waiting time (AWT) has been obtained due to the use of crossover techniques.

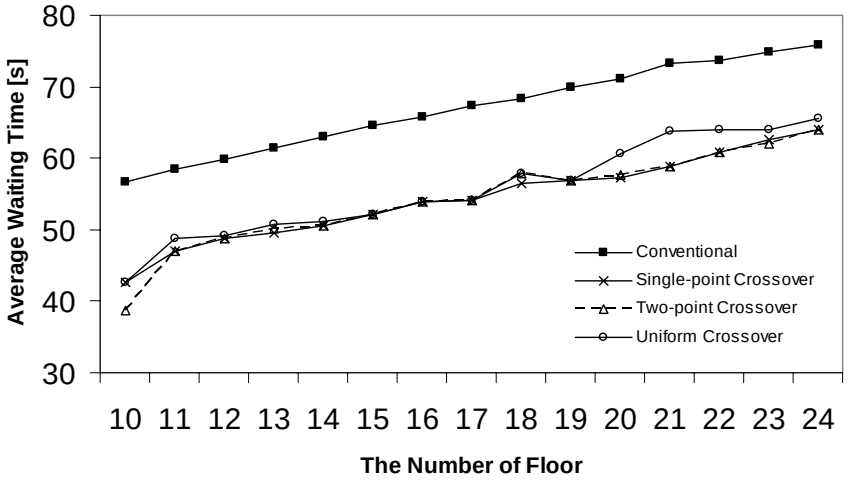

Figure3. Average Waiting Time vs. the number of floors

4. CONCLUSION

In this paper, the outline of an elevator group control system with genetic algorithm has been introduced. The study on elevator group control system has motivated by the different building types. Average journey time and average waiting time that affect the performance of elevators are decreased when an intelligent system in the elevator group control system is used. The graphs have shown that average journey time and average waiting time give better results over conventional control system.

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