Genetic Elevator Group Control

Jung-Hwan Kim and Byung-Ro Moon
School of Computer Science & Engineering, Seoul National University
Shilim-dong, Kwanak-gu, Seoul, 151-742 Korea
e-mail: aram@soar.snu.ac.kr, moon@cs.snu.ac.kr

Summary

In a tall building with multiple elevators, it is a notoriously difficult task to control the elevators in the most efficient manner [1].The system proposed in this paper contains two key ideas. First, it continuously generates dispatch functions by adaptation to changes in passenger traffic. Second, it tries to reduce passengers' waiting time by *multiple elevator allocation* when it is expected that one elevator cannot serve all the passengers for a hall call at a floor.

In selecting a car to serve a hall call, there are a number of factors to consider. For example, if a car is distant from the hall-called floor, it is desirable to have some penalty; if the car has been assigned to serve a floor near the hall-called floor, it is desirable to have some reward; if the car has car calls for a number of floors between its current location and the hall-called floor, it is desirable to have some penalty; the current crowding in the car also affects its merit. We need to have a selection function which considers all theses factors. In the following, we describe the elevator-selection function that is tuned by a GA. We assume that there is a hall call in the floor j and the system wants to evaluate the merit of the car i. We denote by $f(i,j)$ the merit function of the car i for a hall call at the floor j:

$$f(i,j) = w_1 h(i,j) + w_2 g(i,j) + w_3 c(i) + w_4 t(i).$$

$h(i,j)$ reflects the distance between the floor j and the elevator i's current location. $g(i,j)$ gives some reward if the elevator i is already assigned to serve a floor near the floor j. $c(i)$ is the elevator i's crowding. $t(i)$ is the number of car calls for the floors between the floor j and the elevator i's current location.

A steady-state GA is used and a solution is encoded with a linear string. A chromosome has twelve genes. Each gene includes the four weighting factors (w_1 through w_4) and the eight parameters of $h(i,j)$ and $g(i,j)$; all of them are real values. The GA used a traditional 2-point crossover. The population size was set to 50. The roulette-wheel selection was used.

When a hall call is issued, the system just knows that the number of waiting passengers is at least one. This information is intrinsically insufficient. We thus install a camera at each floor to obtain more information. In our work, we predict the numbers of upward and downward passengers by a rule not described here.

When a car arrives at the destination floor and the remaining capacity of the car turns out to be not enough to serve all the waiting passengers, some passengers have to wait until another car comes. In previous works, the systems select another car to serve the remaining passengers right after this problem has occurred. This turns out to be an important factor contributing towards the increase of passengers' waiting time according to our investigation. If a system predicts the number of waiting passengers at the hall-called floor in advance, it can result in greater efficiency. This is an important feature of the proposed system, which periodically analyzes and predicts passengers' movements with the help of cameras.

The experimental results showed that the use of cameras notably decreased the average waiting time when the average crowding of elevators reached between 45% to 75% of their capacity. Combined with the genetic adaptation, up to 25% improvement was observed. If the system can predict situations more accurately, one can expect further improvement.

This work was supported by Brain Korea 21 Project.

References

[1] D. Pepyne and C. Cassandras. Optimal dispatching control for elevator systems during uppeak traffic. *IEEE Transactions on Control Systems Technology*, 5(6):629–643, 1997.