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Design of Elevator Group Control System Simulation Platform Based on Shortest Distance Algorithm

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Abstract: **From the perspective of the characteristics of the elevator group control system, this paper selects the shortest distance algorithm as a scheduling strategy, and constructs elevator running model. On this basis, this paper uses VC++6.0 as development platform, by adding SQL server database as the background, using multi-threaded, dynamic allocation of memory and other technology to build an elevator group control system simulation platform. The platform is verified through a large number of simulation data based on the actual operation of the acquisition, whose results show the feasibility, stability and the superiority of the programmer.**

Keywords: elevator group control system simulation platform; shortest distance algorithm; visual C++; SQL server; multithreading

I. INTRODUCTION

Elevator group control system is one of the most important parts of the traffic system in modern buildings, its design has great influence on reliability and stability of the construction traffic system. Therefore, the simulation platform of elevator group control system is extremely necessary and important. At present, there are some researchers at home and abroad, who have developed various types of elevator group control system simulation platform, and has proposed various types of intelligent group control scheduling algorithms [1-8].

This paper selects as the shortest distance algorithm for scheduling strategy. This algorithm selects the average ladder waiting time, the average travel time of the passengers as the evaluation system parameters, in the multi-objective programming based on the evaluation function, by weight of the set, highlight the different objectives in different transport modes the specific requirements, and achieves the most optimal elevator group scheduling. On this basis, this paper uses VC++6.0 as the development platform by adding SQL server database as the background, and uses multi-threaded, dynamic allocation of memory and other technology to build an elevator group control system simulation platform. The platform is verified through a large number of simulation data based on the actual operation of the acquisition, whose results show the feasibility, stability and the superiority of the programmer.

II. LADDER ALGORITHM FOR THE SHORTEST DISTANCE TO SEND

A. Analysis

The shortest distance ladder algorithm is to call the signal of each layer of station assigned to respond to the signal of the recent elevator, in the calculation of distance with calling in the same direction and reverse running elevators were assigned to a different position deviation.

There are mainly two parameters for controlling the elevator. (1) The selection signal within each floor; (2) The call signal between floors. Elevator control system is based on these two signals and directs elevator the upstream, downstream direction and stop floors. Let us cite a simple model of the elevator group consisting of two elevators and analyze the following:

1) Suppose two elevators: A , B , Y_A means the current floor of A; Y_B means the current floor of B. We study the elevator A as an example (the case B as the same as A),setting up D as the number of the call signal's floor.

2) We have established four data registration form: Uplink calling signal registration form, down calling signal registration form, A staircase inside the electoral registration form layer of the signal and B staircase inside the electoral registration form layer of the signal. When a zone selection button is pressed, the registration form is filled with corresponding floor data.

3) to set a variable M_A , M_B , M_W ; M_A means the extreme value of the ladder in the same direction within the selected layers, and M_B means the extreme same direction value of ladder in the same direction within the selected layers, and M_W call for the extreme value of external reverse ladder.

When the elevator is running up, M_A = max (A ladders to choose a layer of signal tables), that is, to achieve the highest floors; When the elevator is running down, M_A =min (A staircases to choose a layer of signal tables), that is, to achieve the lowest floor. When the elevator is running on the line, if the number of the upstream called signal floor >= the number of the elevator current floor, then M_W = 0, else, the number

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of the upstream called signal floor < the number of the elevator current floor, then M_W = min (uplink called signal registration form). When the elevator is running down, if the number of the down called signal floor <= the number of the elevator current floor, then M_W = 0, if the number of the down called signal floor > the number of the elevator current floor, then M_W = max (downlink called signal registration form).

Make L as the floor number of experienced floor from the summoned floor to the reached floor. When the called signal floor is in the opposite direction of the elevator running floor,

$$L = |Y_A - M_A| + |M_A - D|. \quad (1)$$

When the called signal floor is in the same direction of the elevator running floor,

$$L = |Y_A - D|. \quad (2)$$

When the called signal floor is in the back direction of the elevator running floor,

$$L = |Y_A - M_A| + |M_A - M_W| + |D - M_W|. \quad (3)$$

B. *Construction of System Model*

Matrix A to represent the selected car-layer signal: $A=\begin{bmatrix} L_{11} & L_{12} & \cdots & L_{1m} \\ \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & L_{ij} & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ L_{n1} & L_{n2} & \cdots & L_{nm} \end{bmatrix}$, in which the matrix columns represent the elevator number, the matrix rows represent the number of floors, the matrix elements of L_{ij} means that it has selected layer signals on i-layer and j-ladder.

Matrix B to indicate the elevator outside called layer signal: $B=\begin{bmatrix} K_{11} & K_{12} & \cdots & K_{1m} \\ \cdots & \cdots & \cdots & \cdots \\ \cdots & \cdots & K_{ij} & \cdots \\ \cdots & \cdots & \cdots & \cdots \\ K_{n1} & K_{n2} & \cdots & K_{nm} \end{bmatrix}$, Matrix elements of K_{ij} indicates that it has call signals on i-layer and j-ladder.

Matrix C to represent the direction of the elevator: $C=(F_{11}, F_{12}, \ldots, \ldots, F_{1m})$, Element 1 means the elevator running upstream, elements -1 means the elevator running downstream.

Matrix D to represent the called layers: $D=(d_1, d_2, \ldots, d_m)$.

Matrix E to indicate the location of the elevator where the elevator was called:

$E=(e_1, e_2, \ldots, \ldots, e_i, \ldots, e_m)$.

C. *System Model for Solving*

According to the selected Layer signal inside the car, the called layer signal and the direction of the running elevator, we can calculate the distance between elevators when elevator is called(steps below), and select the shortest distance of the elevator to send the called elevator.

Step 1 matrix A and matrix B are added together, to form a distance matrix

$$A+B=\begin{bmatrix} L_{11}+K_{11} & \cdots & L_{1m}+K_{1m} \\ \cdots & \cdots & \cdots \\ L_{n1}+K_{n1} & \cdots & L_{nm}+K_{nm} \end{bmatrix} \quad (4)$$

Step 2 Calculate the distance between each elevator, if $E_i > D_i$ and $C_i = 1$, we can calculate the distance to the farthest aim layer and the distance of the back called layer. If $E_i < D_i$ and $C_i = 1$, we can calculate the distance between the current layer and the called layer.

Step 3 The response matrix is obtained from step 2.

Step 4 We can compare the matrix and send the elevator based on the shortest distance.

D. *To Achieve the Shortest Distance Algorithm*

According to the structure of group control algorithms and characteristics of elevator group control system, the basic flow of elevator group control system simulation platform is shown in Figure 1.

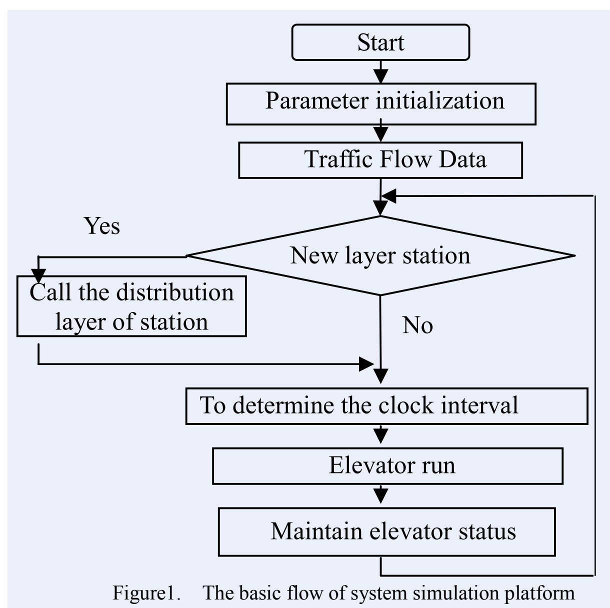

Figure1. The basic flow of system simulation platform

III. SIMULATION PLATFORM

According to the shortest distance algorithm as a scheduling, the platform is designed with VC++6.0,with adding SQL server database as the background, using multi-threaded, dynamic allocation of memory and other technology to build an elevator group control system simulation platform. The platform structure is shown in Figure 2 and Figure 3 below.

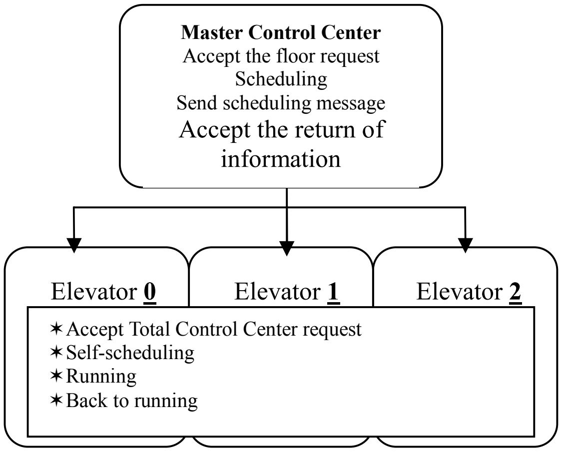

Figure2. Elevator group control system simulation platform's architecture diagram

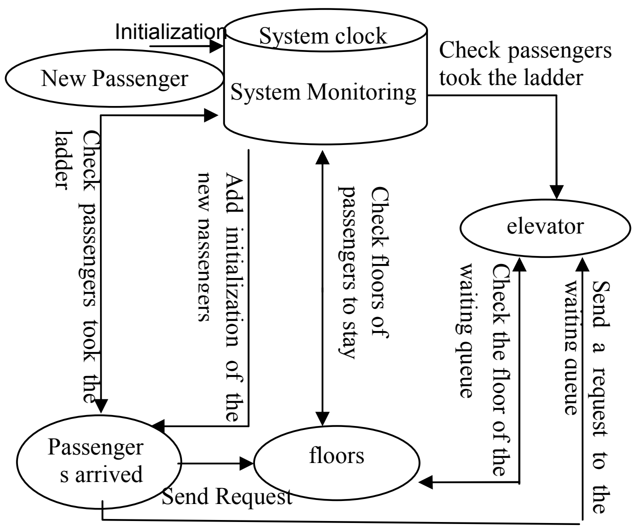

Figure3. Request elevators Map

The elevator group control system simulation platform has following features:

1)The platform can simulate the operation of elevator systems with the graphical interface, and can reflect the elevator five basic state (waiting, parking space, next stop, up, down) (see Figure 4);

2)The platform can simulate the calling control of elevator systems;

3)The platform can simulate the outside calling control of elevator systems and send the appropriate elevator service;

4)The platform can change to send a elevator with the appropriate mechanism;

5)The platform can start to run the operation of scheduling algorithm when the passengers press the button.

6)The platform can control the number of elevator systems in the elevator, the largest passenger volume and the number of floors with the alterable parameter.

7)The platform can automatically read passengers' information and simulate the state when the passengers press the outside call button and the internal call button;

8)The platform can automatically record the number of passengers, enter time, arrival time, etc.

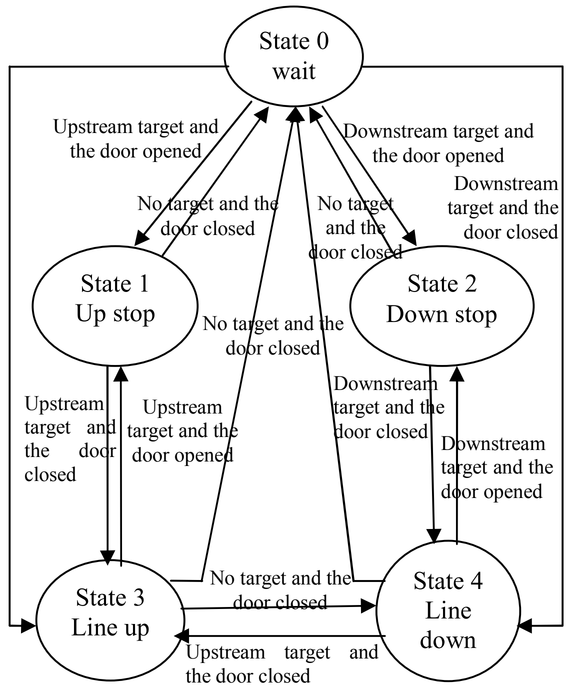

Figure4. Elevator group control system of the basic state

There is the design of an elevator group constitute of five elevators, 18-story layer and flow chartm carrying capacity of 15 persons, as shown in Figure 5 and 6. When the simulation platform starts, log records can be automatically generated and record every movement of each elevator, as well as specific time.

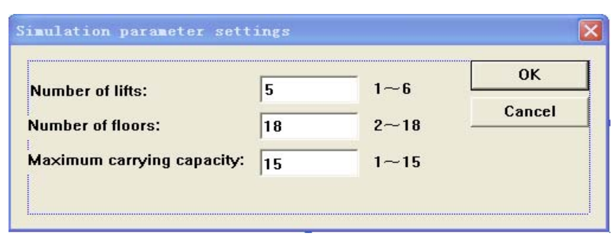

Figure5. Simulation parameter settings interface

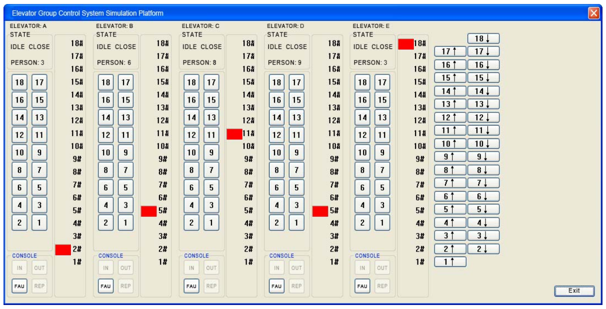

Figure6. Elevator group control system simulation platform main interface

IV. SIMULATION RESULT AND ANALYSIS

This experiment selects a 16-storey building, where there are four available elevators with the maximum capacity of 15 persons, which includes the traffic flow by 100 persons / 5 min, with there testing periods of the rush hour, the period of general business and the peak work. Firstly, set up:① The time of the elevator Moving one layer need 2 seconds, and the time of opening and closing the door need 8 seconds; ② The ratio of the number of passengers taking the elevator up and taking the elevator down is 9:1 in rush hour time, on the contrary, the ratio of the number of passengers taking the elevator up and taking the elevator down is 1:9 in peak work time.

This experiment gets the average value by five experiments.

TABLEI:DIFFERENT TIME PERFORMANCE TABLES

Traffic flow pattern	**Average waiting time (S)**	**Average travel time(S)**	**Average Completion Time(S)**
Rush hour	13.11	33.01	47.16
Period of general business	21.18	26.26	48.07
Peak work	35.45	30.46	65.91

Moreover, we also test the following two other situations: ① different effectiveness of passenger traffic; see table 2; ② the number of different elevator performance, see figure 7.

TABLEП: UNDER THE CHANGES IN TRAFFIC FLOW IN A CONTINUOUS PERFORMANCE TABLE

Traffic flow	**average waiting time (S)**	**average travel time(S)**	**Average completion time(S)**
100persons/5 min	15.89	34.43	50.32
200persons/5 min	46.84	28.97	75.81
300persons/5 min	111.96	42.50	154.46

Figure7. Service time comparison chart in case of changing the number of elevators

From the simulation results, we can see that the main performance such as the average waiting time, the average travel time and the average completion time is within the scope of the passengers' psychological endurance. As a whole, the elevator control system simulation platform is feasible, steady and superior.

V. CONCLUSION

Elevator group control scheduling is a complex scheduling problem of traffic flow, the simulation system platform with the shortest distance algorithms establishes the mathematical model and optimizes the elevator group scheduling, and greatly shortens the average waiting time and the average travel time. In a word, it has the following features: 1) The platform is easy to be applied and runs fast; 2) The platform can simulate a variety of traffic operation; 3) The platform has a certain theoretical and practical value. However, this paper does not study the issue of energy depletion, which remains to be further explored.

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