Study on the Evaluation and Operation Efficiency of Elevator Service Quality Based on MATLAB

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Keywords: MATLAB, Statistical characteristics, Service quality, Operational efficiency.

Abstract. The statistical characteristic of lift transport system is the statistics laws which study the lift traffic with the statistical methods. The rate of 5-minute load (CE), the number of lift(N), the average aperture time(AI), the time of average travel(AP) and the acceleration distance(Sa) are the parameters of describing the statistical characteristics. This thesis will be mainly based on the statistical characteristics of the lift transport system, using statistical methods to design a specific and simulated model analyzing the lift service quality and operational efficiency for medium and large office building. It aims to make the users according to the simulation result analyze the design parameters reasonably, and lead to practice.

Introduction

Elevator traffic configuration theory and engineering application are always promote each other and common development. The statistical characteristic of elevator traffic system refers to the statistical regularity of elevator traffic statistical method. For example, as output components: 5 minute rates CE, the number of elevator N, the average number of elevator clearance time AI, average travel time AP and the acceleration distance Sa are the parameters to describe the statistical characteristics.

Analysis of Elevator Service Quality and Operating Efficiency Principle

General Description

The elevator traffic system is a multi input and multi output system overall. The main external factors influence the efficacy group service quality and operation of the elevator has characteristics of buildings, elevator equipment characteristics and the elevator operating characteristics.

Describe of Input and its Relationship with Intermediate Variables

Type of Building

The type of building is m1. The type of building is usually divided into 5 kinds: office buildings, residential buildings, hotels, hospitals and department store. Building types can expect to such as determine the rated speed Ve and rated load variables Re, and so on.

Building Scale

Building scale is m2. The size of the building includes the building of every layer of the construction area of Ai, each layer of the effective utilization coefficient ¦Â, elevator service layers fm. The size of the building can directly determine the elevator using cardinal Q, car travel distance SL and short interval class service level n.

Elevator Dragging Category

Elevator dragging category is m3.

Elevator equipment types, are generally divided into four types:

(1) the AC single speed gear

(2) dc gear
(3) AC double speed gear
(4) brushless DC gear

Through the elevator dragging category m3 can directly determine the short interval single station running time of TR, the acceleration distance Sa and the acceleration time ta. For example, by the elevator dragging category m3, rated speed Ve and short interval average running distance S can determine the shortest interval single station running time of tr.

The elevator dragging category m3 can directly determine the short interval single station running time of TR, the acceleration distance Sa and the acceleration time ta.

m3 and Ve can be determined by Sa and ta. For example, the tooth direct-current ladder, when Ve=1.75m/s, the maximum acceleration a=1.1m/s, variable acceleration time is t=0.75s, the corresponding acceleration time and the acceleration distance are ta=2.35s and S=2.04m.

m3 and Ve can be determined by Sa and ta.

Elevator Service

The elevator service mode indicated by m4. The operation mode of the elevator. Can be divided into 6 types:

(1) single speed
(2) and the interval speed
(3) single interval speed
(4) a single high-level service
(5) the layer or interlayer service
(6) a single underlying service

Elevator Car Door Category

The elevator door category J. In the lift formula J represents the car door width. All the physical quantities here J refers to the cabin door, including door way. The elevator door is not directly determine the door unit time TD and each passenger access time tp. For example, the automatic door AC Lift double doors, door entrance width 900mm. To open the door, electric door opening time of t=3.2s.

m1, m2, m3, m4 and j can both directly (or expected) to determine the elevator traffic system of one or several physical quantities, so is the system input component of the whole.

Describtion of Output and its Relationship with Intermediate Variables

Operation Period of Elevator

Elevator operation period of RTT refers to the elevator running a week time required, namely the car from the base station, the passengers to each floor, back to the base station need time.

The entry and exit of passengers total time: Tp= ¡Æ(t1i+t5i) (1)

Switch door total time: Td= ¡Æ(t2i+t4i) (2)

Running total time: Tr= ¡Æt3i (3)

Then

Operation cycle: RTT=Tp+Td+Tr (4)

For the single express service, the formula can also be expressed as:
When S<2Sa:

$$\mathrm{RTT}=t_a+1.1t_d+0.88\mathrm{Re}t_p+\frac{h(f_m-1)}{Ve}+n(t_r+1.1t_d)-(\frac{n-1}{n})^{0.8\mathrm{Re}} \quad (5)$$

When S>2Sa:

$$\mathrm{RTT}=(t_a+1.1t_d)[1+n-n(\frac{n-1}{n})^{0.8\mathrm{Re}}]+\frac{2h(f_m-1)}{Ve}+0.88\mathrm{Re}t_p \quad (6)$$

Average Travel Time

The average travel time of AP refers to the elevator car door operating from the departure of arriving at the destination by time statistic average value, the one-way speed service mode, the calculation methods such as:

$$\mathrm{Ap}=RTT-(r_u+2)-1.1t_d \quad (7)$$

Average Clearance Time

The average time between AI refers to a group of N elevator, every two adjacent station to station time difference. Expressed as:

$$\mathrm{AI}=\frac{RTT}{N} \quad (8)$$

Average Waiting Time

The average time of AWT refers to the average passenger waiting time waiting for the elevator, expressed as:

$$\mathrm{AWT}=0.6\mathrm{AI} \quad (9)$$

5 Minutes Occupancy Rate

5 minutes carrying rate of CE is 5 minutes and the total number of elevator conveyer elevator technology use ratio, is an important indicator to set the vertical transport efficiency of the elevator buildings. Expressed as:

$$\mathrm{CE}=\frac{5\times 60\mathrm{rN}}{\mathrm{RTT}} \quad (10)$$

The Simulation Model

Simplified System Model Principle

(1) the experience data adopt national standard;

(2) simulation system is designed only for one building -- large and medium-sized office building concrete.

Determine the Output

(1) the elevator operation cycle RTT (n)
(2) the average travel time of Ap (n)
(3) the average clearance time AI (n)
(4) the average waiting time of AWT (n)
(5) 5 minutes carrying rate of CE (n)

Final Input Variables

(1) Highest number of elevator service fm
(2) Total number of N
(3) Average height of each floor h

Simulation System

Input the fm, h, N, to simulation.**Simulation Results and Analysis**

Simulation Results

Five occupancy rate CE and service layers n relationships are shown in figure:

Relationship between elevator operation period of RTT and the average travel time of AP and the service layer of the n is shown in Figure

The average time between AI and the average waiting time of AWT and service layers n relationships are shown in Figure

For the most high (n=18) the simulation data for:

Elevator operation cycle RTT=259.5634 (s)

The average travel time of AP=73.1234 (s)

The average time between AI=14.4202 (s)

The average waiting time of AWT=8.65211 (s)

5 minutes carrying rate of CE=2.9%

Simulation Results

Based on the above image shows, the income of this simulation system simulation results accord with the reality of the basic statistical law. The following will analyze:

According to the calculation, the highest level in the (n=18) when the output of the expected value respectively:

Elevator operation cycle RTTe=235 (s)

The average travel time of APe=60 (s)

The average time between AIe=16 (s)

The average waiting time of AWTe=13 (s)

5 minutes carrying rate of CEe=1.4%

By the comparison of the above data, most of the parameters meet the design requirements, but the CEe error is relatively large, further calculation, the actual number of passengers five minutes for 74 people, 36 people far more than expected, suggesting that the elevator is free in most cases, this configuration is not reasonable.

To change the setting the number of elevators N value, using this simulation system, we find that, under normal circumstances, only need 2 elevators will be able to meet the requirements, the operation efficiency of the elevator is relatively high. But considering the elevator is in the middle of the day is very uneven, in peak flow conditions, two elevators can not meet the requirements.

Summary

Based on the principle of elevator configuration optimization of transportation system, defines the effectiveness of the quality of service and operation evaluation standard statistical parameters. According to the practical requirements, set up a special for the twenty-five layer below the office building of the Matlab simulation system by using the method of statistics, and then through the simulation of actual examples, to prove the feasibility of this simulation system.

The simulation system, have done the relevant set of building type, the floor height and number of floors, and through the query graph, table and the formula to calculate the statistical parameters to obtain the desired value, then the simulation using the simulation system, the statistical characteristics parameter values, were compared with the expected value. To evaluate the rationality of design

configuration and the optimum design in order to achieve efficiency improving service quality and operation of the elevator.

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