

Elevator Group Control Method Based on Face Recognition

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Abstract. In order to further improve the efficiency of elevator service, this paper uses the method of face recognition to obtain the number of elevators. In the case of known number of elevators, the elevators in the elevator group are dispatched through the integration of elevator operation status and elevator load. Through theoretical analysis and simulation results, it can be seen that in the elevator group containing two elevators, if the elevator group control method of this paper is adopted, the ratio of passengers in the 60s waiting ladder is lower than that of the existing elevator group. The ladder time has also been reduced, and the method can be applied to an elevator group control system.

Keywords: Elevator group control, face recognition, elevator group, elevator scheduling.

1. Introduction

Due to its vertical operating characteristics, the elevator has become an indispensable special transportation equipment in middle and high-rise buildings. Most of the existing residential buildings and office buildings are equipped with two or more elevator groups. The efficient dispatching of elevators is the main reason that affects the efficiency of elevator operation. The existing elevator group control methods mostly use the prior probability to predict the number of waiting persons and then perform elevator scheduling. If using face recognition technology, we can get more accurate current passengers. By analyzing the current number and the elevator operation information, the elevator can be operated more efficiently and can meet the monitoring requirements^[1,2].

Face recognition is divided into face detection and face recognition. Face detection can more accurately determine the number of people in the image collection range. Therefore, the system proposed herein uses face detection to obtain real-time information on the number of elevator passengers to complete the dispatch of elevators within the elevator group. The passenger information of waiting elevator is captured by the camera in front of the elevator and processed using a real-time face recognition method. Then, the elevator allocation is determined according to the number of people waiting for the elevator on each floor and the operating state of the elevator^[3]. The content of this paper is arranged as follows: section 2 introduces the structure of the elevator group control system, section 3 introduces the elevator group control scheme, section 4 carries out the software design, and section 5 compares with the existing elevator group control scheme. The test is summarized in section 6.

2. Elevator Group Control System Structure

The elevator control system selects the miniPC that can perform face detection and face recognition more efficiently as the back-end server, and monitors the passenger flow information through the video surveillance equipment installed at the front end. In this paper, the elevator group consisting of two elevators is designed. In reality, only the number of elevators needs to be increased or decreased^[4].

The video acquisition module communicates with the miniPC through the RS-485 bus. The elevator and the back-end server also use the bus to realize the communication of data such as the elevator floor and the passenger call position and the elevator load status^[5]. When an elevator call is generated, the elevator analyzes the traffic information identified in the video data, and then

combines the collected information with the back-end server through the communication module in combination with the load device of the car.

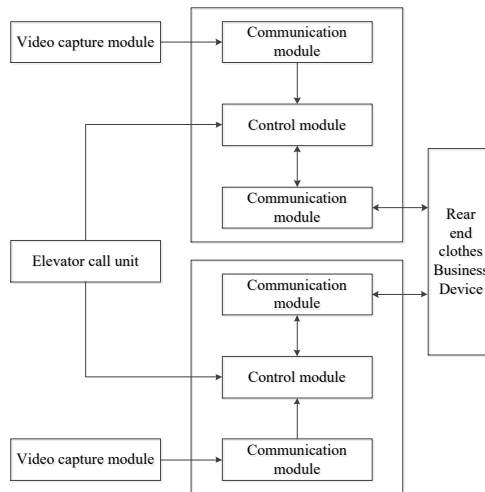


Fig. 1 Group control elevator structure

The video acquisition module is the center of face recognition and video surveillance of the elevator group control system. The system detects the number of faces and identifies the identity information in real time. The back-end server carries the aggregation of information such as the running status of the elevator to integrate with the passenger quantity information. The user calls the elevator through the elevator call unit, and the video collection module starts collecting the face information of the call elevator floor and uploads it to the server. Each elevator judges its own running state through the mounted detection device, and the server integrates the above information to perform elevator scheduling. In addition, the detected face information can be compared to achieve security authentication.

3. Elevator Group Control Scheme

The elevator scheduling scheme designed in this paper is improved on the traditional elevator scheduling method based on the minimum distance. When an elevator call is generated, the system needs to collect the location of all elevators in the elevator group, the elevator load condition and the number of passengers on the elevator, and design based on the least scheduled time, the closest route, and the incidental principle^[6]. Let D denote the distance between the call floor and the elevator, $F1$ is the floor where the elevator is currently located, and $F2$ is the floor where the elevator is called.

$$D = |F1 - F2| \tag{1}$$

In order to ensure that the elevator runs in accordance with the principle of minimum distance, five situations need to be considered in the scheduling. The system needs to generate an adaptive reference quantity S according to the actual situation, and the value of S will determine which elevator in the elevator group is specifically assigned. Details are as follows:

Case 1: If the running trajectory of the elevator passes just the floor of the calling elevator and is in the same direction as the call request, an adaptive reference amount S is generated.

$$S = (N + 2) - D \tag{2}$$

Where N is the floor to which the elevator is to be reached and D is the distance between the elevator and the calling floor.

Case 2: If the running trajectory of the elevator passes the floor of the calling elevator but is opposite to the direction of the call request, the value of the reference quantity S is

$$S = (N + 1) - D \tag{3}$$

Case 3: If the elevator trajectory is far from the call floor, the value of S is 1 regardless of the running direction.

Case 4: If the elevator is idle and there is no elevator call, then

$$S = (N + 1) - D \tag{4}$$

Case 5: If the elevator capacity cannot accommodate the number of elevators, the value of S is 1 regardless of the running direction.

According to the above five situations, an arithmetic framework can be designed for the elevator group control system to deal with the elevator allocation problem when calling different floors. The computing framework first collects the elevator position, the load situation and the number of elevators. When an elevator call is generated, the framework will generate corresponding parameters according to the above situation, and then select an appropriate situation to further calculate the fitness value S, whenever the elevator generates once. When the docking is stopped, the fitness value S is recalculated, and finally an elevator response call with the largest fitness value S in the calculation result is selected.

For convenience of description, we refer to an elevator with a large adaptation value S selected after calculation as a priority elevator, and an elevator other than the priority elevator in the elevator group is called a slave elevator. Then, the elevator operation is divided into two situations, one is that the priority elevator is at rest, and the other is that the priority elevator is in operation.

When the priority elevator is in a stationary state, if an elevator call is generated and the priority elevator can be found by the face recognition to carry the evacuation personnel, the priority elevator responds to the call. If the priority elevator cannot carry the passengers on the waiting ladder, it is judged whether the running subordinate elevator passes the calling floor, and if it passes, the subordinate elevator simultaneously responds to the call.

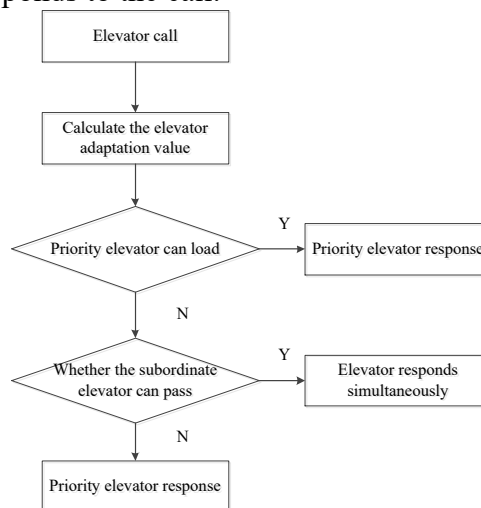


Fig. 2 Elevator quiescent state

When the priority elevator is in the running state, the response call is similar to the static call, except when the priority elevator cannot transport all the passengers on the elevator, if the slave elevator running track is away from the floor of the elevator call, the adaptability value of the slave elevator after reaching the target floor is performed. Calculate and compare with the priority elevator to re-select the priority elevator and the slave elevator.

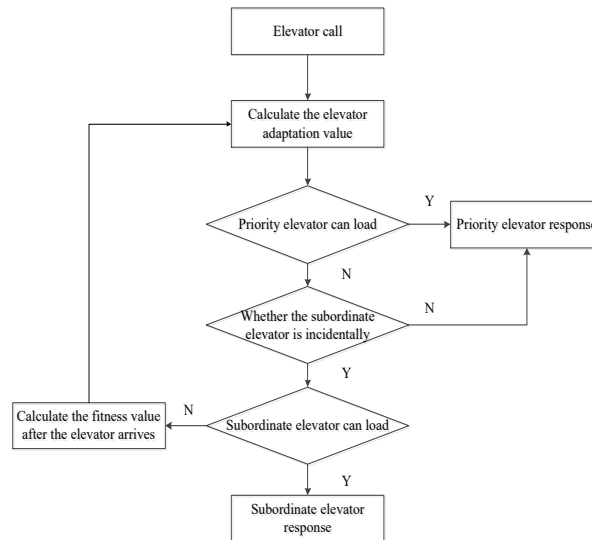


Fig. 3 Elevator running status

Because the passengers' demand for elevators is different at each time, and the idling rate of the elevators is up or down in a certain period of time, the office building is roughly divided into three types of requirements.

The first type is a period of high demand for the uplink. Most passengers will take the elevator from the first floor to other different floors during working hours. In this mode, you can set the elevator car to return to the first floor when there is no elevator call, which saves the elevator's response time. The second type is a period of time when there is a lot of demand for off-duty^[7]. During this period, most passengers will take the elevator from the different floors on the first floor to the first floor. In this mode, the elevator needs to be set in the idle time, the elevator car. Automatically return to the top floor. The lunch time can be divided into two time periods according to the demand to respond to the demand of the downward peak and the upward peak respectively. Adjusting the operating mode according to the needs of passengers in different time periods can make it easier for passengers to take the elevator and reduce the time for some elevators to respond to the call.

4. Software Design

The system will recognize the real-time face information collected by the video, and the recognized face information is transmitted to the elevator group controller through RS-485, and the elevator group controller combines the elevator running state to perform elevator control. The specific steps can be divided into five steps.

1) Communication method

Using video capture equipment to detect the number of passengers in the waiting room in real time, we first need to establish a communication method. Because of the different heights of high-rise buildings, this paper uses RS-485 communication method to realize the communication between the face data collector and the elevator group control PC.

2) Define intermediate variables

The integration of the face information data with the elevator group control signal needs to be completed by variables. For example, in the face data collector, it is necessary to define the relevant analog quantity, and in the elevator load data, it is necessary to define whether or not the switch amount of the passengers can be carried. Integration of intermediate variables.

3) Using intermediate variables

The variables of face information transformation need to be connected to the elevator real-time control process, and the elevator scheduling is realized by connecting these variables.

4) Alarm design

When there is a problem with the system operation, the alarm can be issued in time.

5) Operation mode design

In the software, two elevator operation modes, an uplink mode and a downlink mode, are set, and the two operation modes can be switched by the system time. The system can select the preset operating mode through the system time, or manually switch the current operating mode. The selection process is shown in Fig. 4.

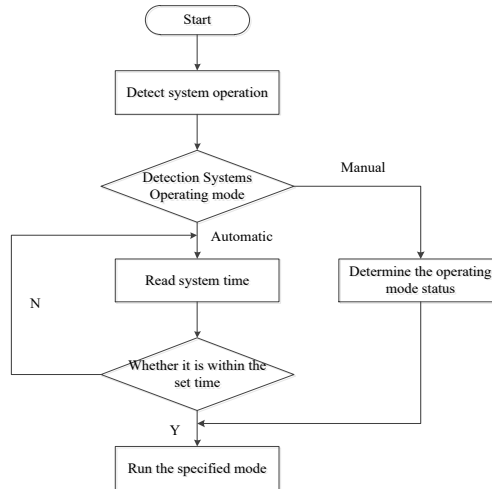


Fig. 4 Operating mode selection

In the automatic mode, the specific running time of the uplink mode and the downlink mode should be set in advance, and the system time needs to be read to determine whether the system time is within the set time period of the mode to be operated, and then the operation mode and the operation mode time are specified. The operator is required to make settings. In manual mode, the operator can select the operating mode that the elevator control system should perform.

5. Case Simulation Analysis

This paper takes the elevator group composed of two 10-story elevators as an example, and compares the proposed method with the general elevator group control algorithm. According to the elevator group control strategy of this paper, the elevator simulation software system is programmed with C#. The system can set the floor environment setting, elevator parameter setting, boarding number preset and face recognition accuracy rate, and carry out elevator load simulation through the set parameters.

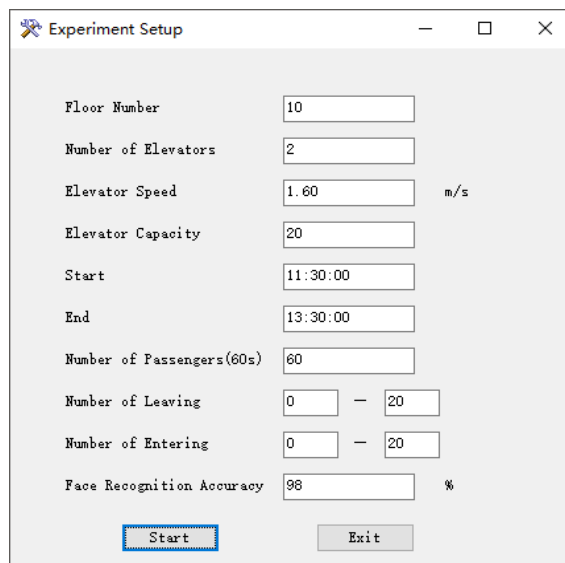


Fig. 5 Experiment setup

Experiment, Fig. 5 shows the elevator simulation conditions and Table 1 shows the simulation comparison results. It can be seen that under the same pre-set conditions, the proportion of

passengers with a waiting time of more than 60s is obviously reduced and the average waiting time is also reduced in the case of the elevator using the scheduling method.

Table 1 Comparison of experimental results

Comparison item	60s passengers ratio	Average time
General group control strategy	8.0%	24s
Face recognition group control strategy	4.2%	14.3s

6. Conclusion

In this paper, the miniPC with faster real-time face recognition operation replaces the traditional PLC as the core of the elevator group control. The face information is collected through the video surveillance system. The priority elevator and subordinate elevator are designed according to the principle of minimum distance and elevator load. The classified elevator group control method expands the scheme of the group-controlled elevator, and proposes the operation modes of the elevator under different states and time periods, so that the elevator can meet the passenger demand during the peak period of use and improve the manned efficiency. In this paper, the specific face recognition rate is selected for experiment, but the accuracy of face recognition in real life will fluctuate with the choice of light, people movement, camera resolution and face recognition algorithm, so more actual needs are needed. Operation to verify the group control strategy proposed in this paper.

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