



ELEVATOR SUPERVISION SYSTEM

This invention relates to improvements in a system for supervising the operation of elevator car or cars in accordance with the operational learning procedure.

Lately there have been proposed measures to control
5 the operation of an elevator car or cars by storing the past status of traffic of the elevator car or cars or making the statistic thereof and predicting the status of traffic thereof in the future. For example, such measures are discribed in Japanese laid-open patent application Nos.
10 115,566/1980, 62,179/1982, etc. These Japanese laid-open patent applications disclose the co-called operational learning procedure in which the statistic of the past traffic of the elevator car or cars is made and the present or future traffic and service is accurately predicted at an
15 early stage from the results of the statistic thereby to improve the service by the elevator car or cars.

On the other hand, it is known that specified traffic congestions occur within buildings for offices, hotels etc. In buildings for offices, for example, traffic
20 streams from the entrance floor flowing to the individual floors are thick in the office-going hour while traffic streams from the individual floor directed to a restaurant floor increases in the first half of the lunch hour and those from the restaurant floor directed to the individual
25 floors are great in the second half of the lunch hour. Also traffic streams from the individual floors directed to the

entry floor increase in the office closing hour. A group supervision device involved is responsive to traffic patterns formed of different traffic streams as described above to operate two elevator cars or perform the preference operation thereby to improve the service by the elevator cars.

However time periods for which those traffic patterns are selected are not particularly fixed and it is difficult to predict the time periods. Especially before the establishment of a building, the abovementioned prediction is extremely difficult. Thus it is difficult to be said that sufficient regard is paid to the prediction.

Accordingly it is an object of the present invention to provide a new and improved elevator supervision system for predicting traffic patterns with a high accuracy while being capable of flexibly accommodating traffic within a building which traffic can not be predicted before the establishment thereof.

According to the invention there is provided an elevator supervision system for supervising operation of a plurality of elevator cars, by

making a statistical analysis of variable traffic statuses of said elevator cars with respect to time on successive days and predicting future traffic statuses of said elevator cars from results of the statistical

analysis, said system comprising traffic pattern sensing means for sensing commencement of a heavy volume traffic pattern by sensing that one of said cars has a load of not less than a predetermined magnitude and sensing
5 termination of said heavy volume traffic pattern by sensing that none of said cars for a predetermined time interval has such a load, means for recording commencement times and termination times of such heavy volume traffic patterns on successive days, means for
10 making a statistical analysis of the commencement and termination times and predicting future commencement and termination times from the statistical analysis and means for controlling the elevator cars accordingly.

The present invention will become more readily
15 apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

Figure 1 is a block diagram of one embodiment according to the elevator supervision system illustrated in functional means except for some components;

Figure 2 is a block diagram of the details of the arrangement shown in Figure 1;

Figure 3 is a flow chart for programming the sensing of a congestion pattern due to getting-on in the office going hour by using the statistic device shown in Figure 2;

Figure 4 is a flow chart for programming the transfer of statistical values, and calculations of the mean values and dispersions of past starting and ending times of an operation pattern developed in the office going hour;

Figure 5 is a flow chart for programming the selection of the operation pattern in the office going hour; and

Figure 6 is a flow chart modified from that shown in Figure 3 so as to sense a congestion pattern developed in a first half of a lunch hour.

Referring now to Figure 1 of the drawings, there is illustrated one embodiment according to the elevator supervision system of the present invention. The arrangement illustrated comprises a load sensor 10 for sensing a load on an associated elevator car, a traffic volume sensing means 12 connected to the load sensor 10 to sense a traffic volume of the elevator car from an output from the load sensor 10, a traffic pattern sensing means 14 connected to both traffic volume sensing means 12 and a clock 16 to sense commencement and termination times of a heavy volume traffic pattern from outputs from the traffic volume sensing means 12 and an output from the

clock 16, a traffic pattern predicting means 18 connected to both the traffic pattern sensing means 14 and the clock 16 to predict future traffic pattern commencement and termination times and a traffic pattern setting means 20 connected to the traffic pattern sensing means 14 to be responsive to a dispersion of the past times of commencement and termination of the traffic patterns sensed by the traffic pattern sensing means 14 in excess of a predetermined magnitude to set predetermined commencement and termination traffic pattern times.

The arrangement comprises further a driving control 22 connected to the traffic pattern predicting means 18 to drive and control a hoist motor 24 in accordance with the traffic pattern from the traffic pattern predicting means 18.

It is noted that a respective arrangement as in Figure 1 is provided for each one of a plurality of elevator cars included in one group.

As shown in Figure 2, the load sensor 10 is connected to an elevator car control generally designated by the reference numeral 30. The car control 30 is shown only for a single elevator car and is composed of a microcomputer. More specifically, the car control 30 includes a central processing unit 30A (which is abbreviated hereafter to a "CPU") connected to a memory 30B, a transmission device 30, and a pair of converters 30D and 30E. The memory 30B is formed of a read only memory (which is abbreviated hereafter to a "ROM" and not shown) for storing a program and fixed value data therein, and a random access memory (which is

abbreviated hereafter to a "RAM" and not shown) for temporarily storing data concerning the results of calculations and others and capable of reading out and writing data therefrom and therein. The transmission device 30C is operative to send and receive data to and from the central processing unit 30A. Also the converter 30D is connected to the load sensor 10 to change a signal level between its input and output and the converter 30F is connected in two ways to the driving control 22 and is similar in operation to the converter 30D.

In Figure 2 a group supervision device generally designated by the reference numeral 32 and formed of a microcomputer is shown as including a CPU 32A, a memory 32B, transmission device 32C and a pair of converters 32D and 32E interconnected in the same manner as the corresponding components of the car control 32 excepting that another transmission device 32F is connected to the CPU 32A and that the converter 32D is two-way connected to a floor pushbutton 34 disposed at each of a plurality of floors in a building served by associated elevator cars and the converter 32E is connected to the clock 16. Also the transmission device 32C is two-way connected to the transmission device 30E included in the car control 30.

It is noted that the group supervision device 32 is provided for each group including a plurality of elevator cars.

Furthermore Figure 2 shows a statistical device generally designated by the reference numeral 36. The statistical device 36 is also formed of a microcomputer and

a CPU 36A, and a memory 36B and a transmission device 36C connected to the CPU 36A. The transmission device 36C is also two-way connected to the transmission device 32F included in the group supervision device 32.

5 The CPU, the memory, and the transmission device included in each of the group supervision device 32 and the statistical device 36 are identical to the corresponding components disposed in the car control 30.

10 The operation of the arrangement shown in Figure 2 will now be described. When the floor pushbutton 34 is depressed, the resulting signal enters the CPU 32A through converter 32D until it is registered in the CPU 32A. Then a floor call at that floor having the depressed floor pushbutton 32 is assigned to the optimum one of the elevator cars 15 included in an associated group. The assigned signal is entered into the CPU 30A through the transmission devices 32C and 30C to be processed by the CPU 30A to provide the processed result. This result from the CPU 30A is delivered via the converter 30E to the driving control 22 20 which, in turn, drives the hoist motor 34 resulting in the operation of the assigned elevator car. That is, the assigned elevator car responds to the floor call assigned thereto.

25 The process as described above is well known in the art.

On the other hand, the statistical device 36 is operated to sense a traffic volume of the assigned elevator car from the output from the associated load sensor 10 and also sense commencement and termination times of a congestion pattern due to

getting-on in the office going hour at the main floor (which is normally the first or ground floor) from both the sensed traffic volume and the output from the clock 16. Then the times of commencement and termination of the congestion pattern or data thus sensed are stored in the memory 36B for a number of past days. Subsequently a starting time and an ending time are determined of an operation pattern in the office going hour from those data and the outputs from the clock 16 and the associated elevator cars.

At that time, a dispersion of each of the past starting and ending times relative to the now determined associated time may exceed a predetermined magnitude. In this case the starting and ending times are set to predetermined starting and ending times stored in the memory 36B followed by the operation of the elevator cars.

The foregoing is equally applicable to a congestion pattern due to getting-off at a restaurant floor in a first half of the lunch hour.

The description will now be made in conjunction of the operation of sensing a congestion pattern due to getting-on at the main floor in the office-going hour and with reference to Figure 3 wherein there is illustrated a program stored in the memory 36B to sense such a congestion pattern. The program is repeatedly executed with a period of, for example, 0.1 second.

Starting with the step labelled "START", the step 100 determines if the present time is in the office-going hour, that is to say, if the present time is at or after a time J_1 when the office-going hour begins and before a time

J_2 when the same is ended. It is noted that a time interval between the times J_1 and J_2 is preset to be somewhat larger than a predetermined time interval. When determined so in the step 100, the step 102 determines if a signal UPE
5 indicating the setting of the ending time is of a binary ONE. When the signal UPE is of a binary ZERO as determined in the step 102, the step 104 initially sets the serial number n of a scanned elevator car to a ZERO. Then the step 106 is entered where the serial number n of the scanned elevator car is
10 raised to the next number; initially the serial number n of the scanned car is updated to a decimal ONE indicating an elevator car No. 1. Generally, the serial number n of the scanned car is updated to the serial number $(n + 1)$ of the next scanned car. Thereafter the step 108 determines if the
15 scanned elevator car No. 1 has departed from the main floor in an up direction. When determined so in the step 108, the step 110 determines if a load LD_n on the elevator car No. 1 is not less than a predetermined magnitude K_1 which is, for example, 70% of a rated number of passengers in the elevator
20 car. When the load LD_n is less than the predetermined magnitude K_1 as determined in the step 110, the step 112 determines if all the elevator cars have been scanned. When all the elevator cars have not been scanned as determined in the step 112, the program is returned back to the step 106
25 to repeat the steps 106, 108 and 110.

If the step 108 gives an answer "NO" then the same directly goes to the step 112.

After all the elevator cars have been scanned as determined in the step 112, the step 114 determines if the

signal UPS is of a binary ONE. Since the signal UPS at that time is still of a binary ZERO, the step 114 does not go to the step 116. As a result, the step 116 and the succeeding steps 118 and 120 are not executed.

5 When the load LD_n on the elevator car No. 1 is not less than the predetermined magnitude K_1 as determined in the step 110, the step 122 determines if the signal UPS is equal to a binary ONE. Since the signal UPS is still of the binary ZERO as described above, the step 122 goes to the
10 step 124 where the signal UPS is set to a binary ONE and the present time is set to a starting time on this day. Then the step 126 clears a count T_1 on a counter (not shown) after which the step labelled "END" is entered.

 Following this the next succeeding calculation
15 period is started. In this calculation period, the step 122 determines that the signal UPS is of a binary ONE. Thus the step 124 is not executed but the step 126 is entered.

 Then the steps 110, 122 and 126 are successively executed so long as the load LD_n on the elevator car No. 1
20 is not less than the predetermined magnitude K_1 . However, if the step 110 determined that the load LD_n on the elevator car No. 1 is less than the predetermined magnitude K_1 then the step 110 goes to the step 116 through the steps 112 and 114. In the step 116 the counter (not shown) updates its
25 count T_1 by adding the calculation time of 0.1 to a time interval SEC elapsed from the preceding calculation period in incremental manner. Then the step 118 determines if the elapsed time interval SEC continues for a predetermined time interval K_2 (which may be for example of 120 seconds). When

determined so in the step 113, the step 120 sets a signal UPE indicating the setting of the ending time to a binary ONE and also sets an ending time UEJ_0 on this day to the present time after which the step END is entered.

5 On the other hand, when step 128 gives an answer "YES", the step END is entered. Also when the step 118 gives an answer "NO", the step END is entered.

For the next succeeding calculation period the step 102 determines that the signal UPE indicating the
10 setting of an ending time is of a binary ONE and the steps 104 through 120 are not executed. When the step 100 determines that the present time is not in the office-going hour, the same goes to the step 128 where whether or not the signal UPE is of a binary ONE is determined. When the
15 signal UPE is not of the binary ONE as determined in the step 128, the step 130 sets the signal UPE to a binary ONE and also an ending time UEJ_0 on this day to the present time after which the step END is entered. When the signal UPE is of the binary ONE as determined in the step 128, the latter
20 goes directly to the step END.

From the foregoing it is seen that, upon sensing the elevator car with its load not less than the predetermined magnitude K_1 departing from the main floor in the up direction, the starting time USJ_0 is set. Thereafter when
25 such elevator cars are continuously sensed within the predetermined time interval K_2 , the operation of the elevator cars in the office-going hour is regarded to be continuous. On the other hand, when the elevator cars as described above are not sensed within the predetermined time interval K_2 ,

the ending time UEF is set to a time point when such elevator cars are not sensed.

Subsequently the operations of transferring statistical values and calculating mean values of the starting and ending times set as described above on a number of past days and dispersions of the latter will now be described in conjunction with Figure 4 wherein there is illustrated a flow chart of a program for those operations stored in an ROM (not shown) included in the memory 36C of the statistical device 36. The program is executed once a day, for example, just at twelve o'clock midnight.

Starting with the step labelled START, the step 200 initially sets the number of scanned day m to the number of past days M during which the statistic has been permitted to be done. Then the step 202 updates the number of scanned days m to the number of past $M-1$ days by subtracting one from the number of scanned days m . Then the step 204 is entered where data on the m days ago are set to data on the $(m + 1)$ days ago. That is the starting and ending times USJ_m and UEJ_m respectively on the m days ago are set to those on the $(m + 1)$ days ago designated by reference characters USJ_{m+1} and UEJ_{m+1} respectively. Subsequently the step 206 determines if the number of scanned days m is null, that is to say, if the scan has continued up to this day. When the scan is not yet completed as determined in the step 206, the program is returned back to the step 202 to repeat the steps 202, 204 and 206 one after another.

Thus data on this day is transferred to data on one day ago, which is, in turn, transferred to data on the

two days ago and so on. Thus data on M days are successively transferred and stored in the memory.

When the scan up to this day has been completed as determined by the step 206, the step 208 calculates the mean value USJM of the starting times USJ_m and the mean value of the ending times UEJ_m on the past M days according to $\sum_{m=1}^M USJ_m/M$ and $\sum_{m=1}^M UEJ_m/M$ respectively. Then the step 210 calculates a dispersion USJV of starting times and that UEJV of the ending times on the past M days with respect to the respective mean values according to

$$\sum_{m=1}^M |USJ_m - USJM|/M$$

and

$$\sum_{m=1}^M |UEJ_m - UEJM|/M$$

respectively. Thereafter the step 212 resets the signal UPS indicating the setting of the starting time and the signal UPE indicating the setting of the ending time to binary Zero's.

Then the program is entered into the step labelled END whereupon the the program is ready for the next succeeding operation.

The operation of sensing the operation pattern developed in the office-going hour will now be described in conjunction with Figure 5 wherein there is illustrated a flow chart of a program for performing such an operation stored in the memory 32B included in the group supervision device 32.

Starting with the step labelled START, the step 230 determines if a fault occurs on the statistical device 36. When no fault occurs on the statistical device 36 as determined by the step 230, the step 232 determines if the dispersion USJV as described above is not larger than a predetermined magnitude V_1 which may be, for example, of ten minutes. When determined so in the step 232, the step 234 sets a starting time x to the mean value USJM of the starting times calculated by the statistical device 36 as described above. On the other hand, when the dispersion USJV exceeds the predetermined value V_1 as determined in the step 232, the step 236 sets the starting time x to a starting time USJR preliminarily stored in an ROM (not shown) included in the memory 323.

In either case, the step 238 is entered. The step 238 determines if the dispersion UEJV of the ending times is not larger than a predetermined magnitude V_2 which may be, for example of twenty minutes. When determined so in the step 338, the step 240 sets an ending time y to the mean value UEJM of the ending times calculated by the statistical device 36 as described above. When the step 238 gives an answer "NO", the step 242 sets the ending time y to an ending time UEJK preliminarily stored in the abovementioned ROM.

In either case the step 244 is entered. The step 244 determines if the present time is at or after the starting time x and before the ending time y . That is, if the present time is in a selected pattern hour. When determined so in the step 244, the step 246, sets a command operation signal

UP in the office-going hour to a binary ONE with the result that the elevator cars are operated in the manner as predetermined in the office-going hour. However such an operation is not described because the same does not form a part of
5 the present invention.

When the present time is not in the selected pattern hour as determined in the step 244, the step 248 sets the command operation signal UP as described above to a binary ZERO. This results in the release of the operation
10 in the office-going hour.

Either of the steps 246 and 248 goes to the step labelled "END".

When the occurrence of a fault on the statistical device 36 is determined in the step 230, the step 250 sets
15 the starting and ending times x and y to the starting and ending times USJK and UEJK preliminarily stored in the ROM as described above. Then the steps 244 and 246 or 248 are repeated.

Figure 6 is a flow chart illustrating a modification
20 of the present invention for sensing a traffic pattern crowded due to getting-off at the restaurant floor in the first half of the lunch hour. The steps are identical to those shown in Figure 3 respectively and designated by the reference numerals identifying the corresponding steps shown
25 in Figure 3 and prefixed with 300 but not 100. For example, the step 230 determines if the present time is in the first half of the lunch hour. In other words, the term "office-going hour" reads "the first half of the lunch hour" in Figure 6. Similarly the term "stating time J_1 of the office-

going hour" reads a "starting time J_3 of the first half of the lunch hour" and the term "the ending time J_2 of the former" reads an "ending time J_4 of the latter". The term "signal UPS indicating the setting of the starting time of the office-going hour" reads a "signal LPS indicating the setting of the starting time of the first half of the lunch hour" and the term "signal UPE indicating the setting of the ending time of the office-going hour" reads a "signal LEP indicating the setting of the first half of the lunch hour".

Also the term "starting time USJ_0 of the office-going hour on this day" read a "starting time LSJ_0 of the first half of the lunch hour on this day" and the term "ending time UEJ_0 of the office-going hour on this day" reads an "ending time LEJ_0 of the first half of the lunch hour on this day".

Furthermore the term "predetermined magnitude K_1 " appearing in the step 110 reads an predetermined magnitude K_3 (which may be, for example, of 40% of the rated number of passengers appearing in the step 310 and the term "predetermined time interval K_2 " appearing in the step 118 reads "predetermined time interval K_4 " (which may be, for example, of 120 seconds) appearing in the step 318. Finally the term "count T_1 " set forth in the step 116 reads a "count T_2 " denoted in the step 316 and the term "load LD_n on the elevator car" reads a "decrease in load LDO_n on the elevator car".

By reading the terms as described above, and using the arrangements shown in Figures 1 and 2, the steps illustrated in Figure 6 are successively executed in the same manner as those illustrated in Figure 3.

When the step 310 determines that a decrease in load LDO_n due to getting-off at the restaurant floor in the first half of the lunch hour is not less than the predetermined magnitude K_3 , the step 324 sets a starting time LSJ_0 . Thereafter when the elevator cars decreased in load as described above appear continuously within the predetermined time interval K_4 , the operation in the first half of the lunch hour is regarded as being continuous. However, in the absence of such elevator cars within the predetermined time interval K_4 as determined in the step 318, the step 320 sets an ending time LEJ_0 to the end of the predetermined time interval K_4 .

A decrease in load LDO_n on the elevator car can be determined by subtracting from a load on the elevator car just reaching the restaurant floor, a load upon the initiation of opening of the associated elevator car as described, for example, in Japanese laid-open patent application No. 70,544/1979.

Subsequently calculation is effected in terms of the mean values of the starting and ending times during the past M days and dispersions of those times, in accordance with a program (not shown) similar to that shown in Figure 4. Then the operation of the elevator cars is set or released in the first half of the lunch hour in accordance with program (not shown) similar to that shown in Figure 5. In that operation the elevator cars directed toward the restaurant floor are arranged to quickly reach the restaurant floor by passing a greater part of the elevator cars under full loading through an intermediate floor or floors. This

measure is not directly pertinent to the present invention but it is described, for example, in Japanese laid-open patent application No. 88,075/1981.

The present invention is responsive to a dispersion of times of commencement and termination past traffic patterns in excess of a predetermined magnitude to set predetermined times of commencement and termination for the traffic pattern. Thus in an unstable traffic and/or with the statistical device not put in normal operation, abnormal service can be prevented from occurring.

CLAIMS:

1. An elevator supervision system for supervising operation of a plurality of elevator cars, by

making a statistical analysis of variable traffic statuses of said elevator cars with respect to time on successive days and predicting future traffic statuses of said elevator cars from results of the statistical analysis, said system comprising traffic pattern sensing means for sensing commencement of a heavy volume traffic pattern by sensing that one of said cars has a load of not less than a predetermined magnitude and sensing termination of said heavy volume traffic pattern by sensing that none of said cars for a predetermined time interval has such a load, means for recording commencement times and termination times of such heavy volume traffic patterns on successive days, means for making a statistical analysis of the commencement and termination times and predicting future commencement and termination times from the statistical analysis and means for controlling the elevator cars accordingly.

2. An elevator supervision system as claimed in claim 1 wherein said time predicting means calculates the mean value of said commencement and termination times of past traffic patterns and predicts commencement and termination times of a future traffic pattern from said calculated mean values.



3. An elevator supervision system as claimed in claim 1 or 2, wherein there is provided traffic pattern setting means for calculating dispersions of said commencement and termination times of past traffic patterns and setting predetermined commencement and termination traffic pattern times in response to said calculated dispersions being in excess of a predetermined magnitude.

