A Highly Human-Friendly Remote Monitoring System

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ABSTRACT

The remote monitoring system of the elevator has developed in the direction of improving serviceability by the mechanization and efficiency improvement at maintenance. Now, we think that the time has come to review a basic monitoring function whether it is really possible to respond promptly in the all events of elevator failures, or whether quick response is fairly offered to all users. We have thus developed a new remote monitoring system, featuring high-speed multimedia communication over ISDN, in-car video monitoring, universal design and remote inspection. Our new remote maintenance system has enabled many people to use elevators with a sense of safety in addition to the improvement of availability.

1. INTRODUCTION

From the viewpoint of the social role of elevators, it is imperative to secure safety and reliability. The remote monitoring system, which ensures the contact to the outside if some failure has occurred, and enables two-way voice communications, is becoming indispensable for the elevator system.

Recently, to satisfy the requirements of improving elevator availability and the efficiency at maintenance, the remote maintenance systems which automatically diagnose failure signs and parts longevity have been developed. On the other hand, the basic function of the remote monitoring system, "Safe even when the elevator breaks down unexpectedly", has turned out not to be necessarily enough for the users in a current system, though it is one of the natural requirements.

The main concept of our newly developed system is a human-friendly remote monitoring system. Besides improving the serviceability of the elevator by remote maintenance, we also enhanced the basic function of monitoring, to make users of the elevator feel more relieved. Moreover, our system has various functions that not only users but also maintenance engineers and monitoring center operators can be benefited from.

2. SYSTEM CONFIGURATION

Figure 1 shows the overall system configuration.

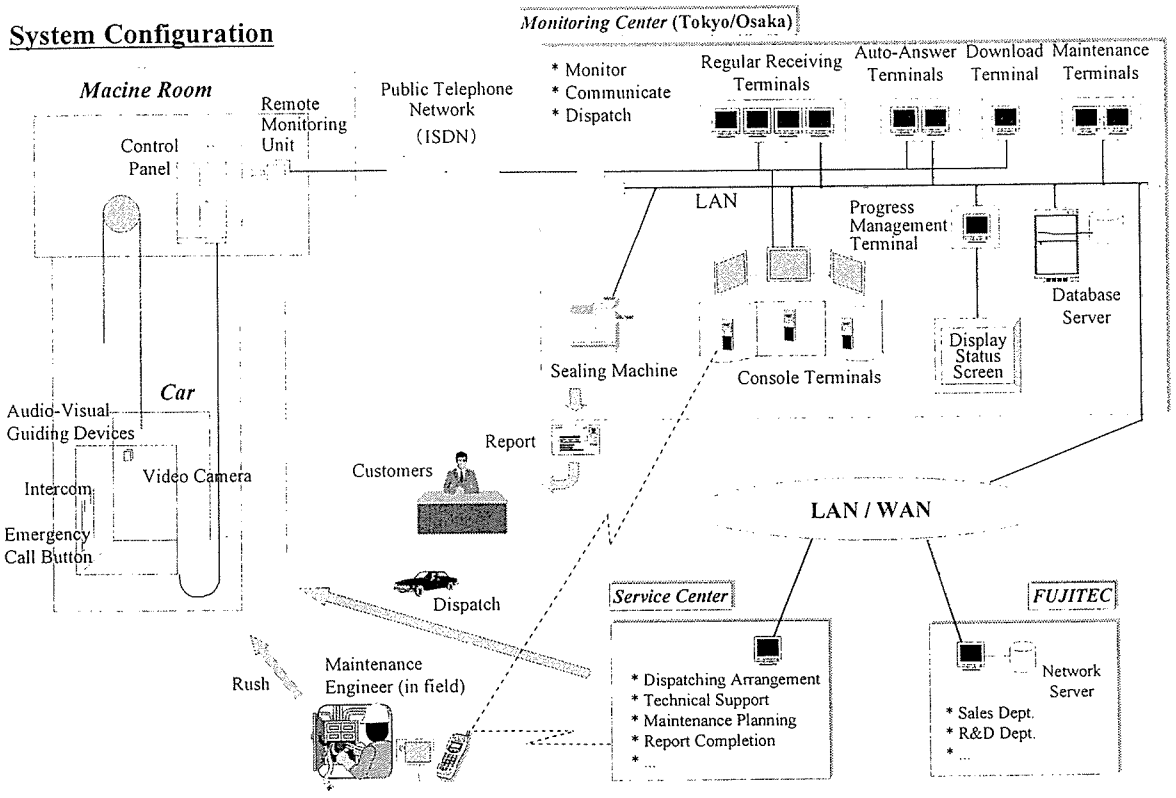

Figure 1: System configuration

2.1 Functions of Devices

The functions of the elevator controller include not only the operation control of the elevator, but also the continuous self-diagnosis of the control status. Concretely, this means the detection of failure and the recording both of the symptoms of the failure and the operation history.

The in-car devices are composed of the emergency call button, an intercom for getting in contact with the outside, guiding devices to notify the passengers about the progress of dealing with the emergency, a video camera to monitor the in-car situation, and so on.

The remote monitoring unit is provided with a function to inform the monitoring center of the results of the diagnosis received from the elevator controller periodically and in case of emergency through the public telephone line. Furthermore, it handles conversations over the intercom between the car and the monitoring center, the output control of the guiding devices, and also has various other functions, such as the storage of images on a video camera and its transmission to the monitoring center.

The monitoring center is composed of the terminal equipment such as console terminals which receive emergency calls from the remote monitoring units, regular receiving terminals which receive periodical calls, auto-answer terminals which receive emergency calls when the console terminals are busy, and the database server. All of these equipment, the monitoring centers, and the service centers across the country are connected by network. Several monitoring centers are established across the country, and the monitoring centers are backed up mutually.

2.2 Behaviors of System

The remote monitoring unit immediately calls the monitoring center when a serious fault is detected by the elevator controller, or emergency call button in the car is operated. In the monitoring center by which the call is received, the failure contents and situation in the car are confirmed using the intercom and the video camera, and engineers are dispatched if necessary. The passenger is notified about the progress of these steps at appropriate timing through the guiding devices.

In addition, information on the working condition and the operation history of the devices inspected with the elevator controller automatically is regularly reported to the monitoring center by the remote monitoring unit. At the monitoring center, these information are stored in the database server, and forwarded to the service center. At the service center, the maintenance control, that is, the planning of schedule and work of the maintenance, is done based on these information.

3. FEATURES OF SYSTEM

3.1 Multiplex Transmission by ISDN

The most outstanding feature of this system which we have developed is the adoption of ISDN(Integrated Services Digital Network) as the interface of the remote monitoring unit to the monitoring center.

The merits of using ISDN are as follows:

- High speed
- High quality
- Shorter time for completing the connection

Using ISDN makes it possible to get much more detailed failure information and maintenance information, and also it can transmit rapidly such a large amount of data as the in-car image. In addition, in case the amount of information is small as a periodical transmission, costs and times for the communication are reduced by using the UUI(User-User Information) communication function of ISDN.

Since ISDN is a digital communication line, high-quality communication is provided with extremely few errors and no fallback (dropping the transmission rate according to the condition of the line). Also, the communication quality does not change by the region and the time period because of no transmission loss with the trunk line.

The merit of high-speed communication by digital signals is seen in the time for the line connection between the remote monitoring unit and the monitoring center. It takes only several seconds in ISDN for the establishment of connection comparing with tens of seconds to negotiate between the modems in such communication that uses the analog line.

Making the best use of high-speed communication of ISDN, transmission of information with different nature such as elevator information, in-car image, and the intercom voice has become the reality. These information are wholly treated as digital data and multiplexed

before being transmitted to the monitoring center.

As mentioned above, using ISDN makes it possible to confirm rapidly the situation of elevators reliably and to respond promptly in the event of failures. It is therefore possible to get rid of users' anxiety in the early stages of the failure.

3.2 Monitoring the In-car Image

In our system, a small video camera is set up in the car, and the images taken by this camera can be seen in the monitoring center when necessary. Figure 2 shows a sample of display image on the console screen. This function has made it possible for a center operator to surely understand the in-car situation by means of both in-car image and conversation. Furthermore, since center operator can understand a present elevator conditions at the same time by means of the above-mentioned multiplex communication function, he can make a more adequate judgment.

Since the remote monitoring unit is capable of internally storing the images shot by camera at specific timing, the center operator can examine the in-car situation before and after a failure occurs or the emergency call button is operated. The image data is digitally compressed before transmission and storage, and the compression ratio can be set freely according to the transmission efficiency and the resolution which is necessary. The camera set up in the car can be doubly used by the option as a camera of the security system.

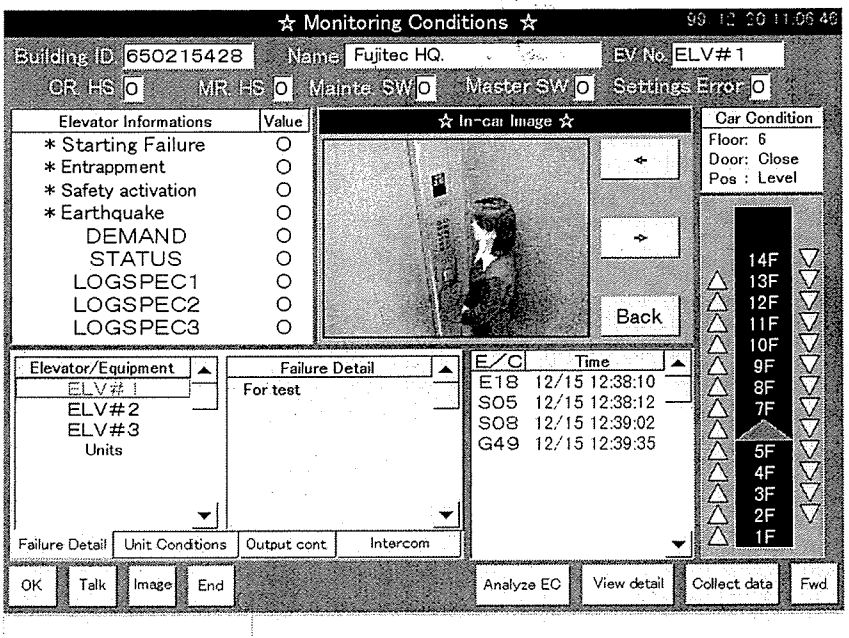

Figure 2: Example of screen on console terminal

3.3 Universal Design

Elevators are designed in consideration of the convenience for the disabled and the elderly. Recently, the idea of "Universal design" (NC State University, 1997) with the intention of creating user-friendly goods for any users has also come to be incorporated in elevator design.

When the idea of a universal design is applied to the remote monitoring system, the system

should be considered to offer equal service to everybody, regardless of the difference of the age and ability even when the elevator breaks down. The intercom is hardly of use for hearing-impaired persons in case of emergency, and all they got was the displayed guidance that emergency call is being made to outside. Although the voice guide is an indispensable function for visually-impaired persons, it did not necessarily work effectively because that function generally became inoperative during power failure.

In our system, the guide display in case of emergency is made more detailed, and the on-going situation from the initiation of emergency call to the dispatch of an engineer for the restoration of failures is displayed in the car point by point as shown in Figure 3. And even if the power failure or the breaking down of elevator controller has occurred, the voice guidance to that effect is announced in the car. In addition, by in-car video monitoring function, center operator can take effective response even if speech-impaired persons or those who fainted are entrapped in the car.

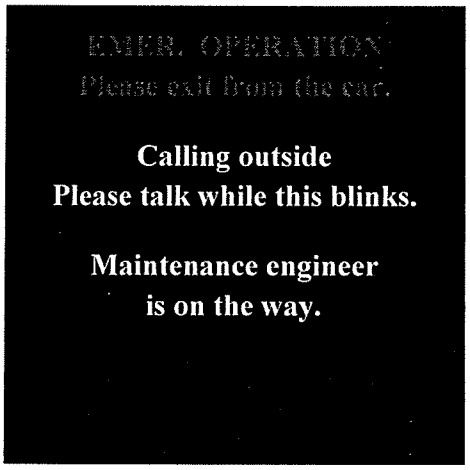

Figure 3: Example of in-car guiding display

3.4 Automatic Remote Inspection

In addition to the detection of failure and recording of operation history, the elevator controller is provided with a new function to perform part of the inspection work periodically or mechanically, which used to be performed by maintenance engineers on the site. This has been made possible by additionally installing sensors and performing automatic inspection running during light traffic period such as nighttime. The monitoring and the inspection items have been made more detailed as shown in Table 1. As a result, more accurate remote maintenance becomes available.

In addition, each remote monitoring unit always stores useful information on elevator control states and working states of the devices for analyzing the elevator failures. The monitoring center is capable of getting those information before and after a failure occurs when it is necessary.

These functions enable drastic reduction of the frequency of maintenance with the operation out of service and also enable prompt response when the failures have occurred. This has brought the effects of improved elevator availability and decreased engineer's unnecessary dispatch.

Table 1: Self-diagnosis items in elevator controller

Classification	Detail	
Detection of failure	* Starting failure	* Emergency call button operation
	* Entrapment	* Door operation failure
	* Safety device activation	* Flooded pit
	* Power line failure	* Unit communication failure etc.
Operation history	* Number of operations	* Door operation time
	* Running time	* Number of relay operations
	* Running distance	* Number of car/hall button operations
	* Number of door operations	* In-car lighting time etc.
Remote inspection	* Brake operation	* Door/Gate switch activation
	* Relay operation	* Car/Hall button operation
	* Machine room temperature	* Acceleration and deceleration
	* Door operation	* Emergency light etc.

3.5 Wide Area Disaster

In our system, auto-answer terminals have been set up at the monitoring centers. The remote monitoring unit is provided with a function to automatically change the call destination to this terminal when the signal reception of the monitoring center gets crowded in case of earthquake and power failure.

In the monitoring center by which calls are received from the remote monitoring units, the auto-answer terminal gets minimum necessary information such as building identification and the failure contents, immediately disconnects the line. At this point, because of the display and the voice guidance in the car to the effect that emergency call has been accepted, the users may be relieved to some degree. The list of elevators and their major conditions from which calls have been received appears on the status display screen, and the center operator usually responds to calls when he becomes available.

The function described here has made the better use of the feature of ISDN that the time required for the establishment of line connection is extremely short.

4. DISCUSSION

As described at the beginning, the theme of our developed system is a human-friendliness. Figure 4 shows to whom each of the functions of the system is friendly. In this figure, the degree of the merit that users, maintenance engineers, and center operators, who are the central figures of the system, can enjoy relating to each of the function(including the functions explanation of which are omitted in this paper) by the distance from each apex. You will see from this figure that our system has been designed for not only users but also for various other people concerned with the remote monitoring system.

It goes without saying that considering convenience of users is important. From the viewpoint of basic functions of the remote monitoring system however, it is necessary to give due consideration to the point how safely the users can use elevators without a sense of anxiety. Friendliness is very important not only for the elevator system but also for the remote monitoring system which involves a lot of people such as users (disabled, elderly, children,

and so on), the building owners and managers, maintenance engineers, center operators, and the system developers.

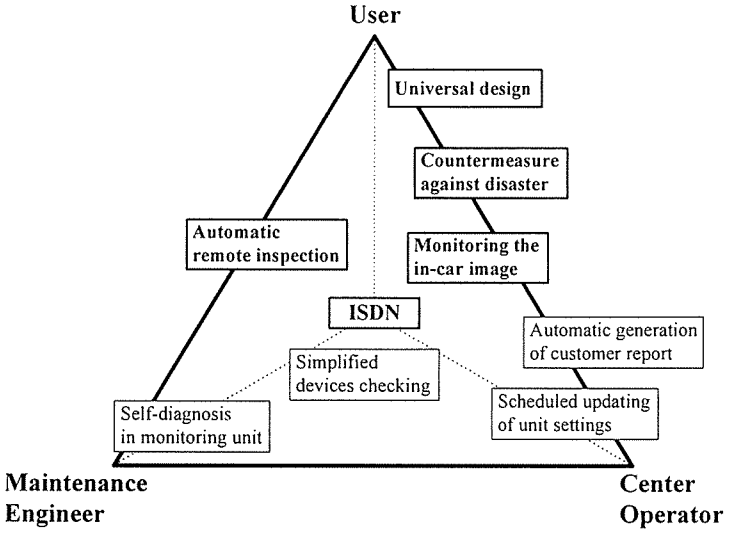

Figure 4: Positioning of system function

5. CONCLUSION

We developed a new remote monitoring system with features of multiplex transmission over ISDN, in-car video monitoring, and universal design in addition to remote maintenance by automatic inspection. As a result, convenience and relief for users, such as elevator availability, speedy and reliable response when an elevator failure occurs, consideration for the disabled and the elderly have been improved.

Now the importance of social welfare is emphasized worldwide, we consider a universal design is an indispensable element in the remote monitoring system in the future. We think it is important to incorporate opinions of more people in making the systems.

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BIOGRAPHY

Yuji Tanaka, graduated from Nagoya Institute of Technology in 1991 and joined Fujitec Co., Ltd. in the same year, currently belongs to Research and Development Headquarters.