# The Effect and Reaction of Information Presentation in Surveillance Service

Mitsunari Uozumi [1], Kouichi Yamada [2], Shuto Murai [2], Hajime Asama [3], Kaoru Takakusaki [4]
[1] MITSUBISHI ELECTORIC Corp., 5-1-1 Ofuna Kamakura 247-8501, Japan
Tel: +81 467 41 2549, Fax: +81 467 41 2639, E-mail: uozumi.mitsunari@ab.mitsubishielectric.co.jp
[2] MITSUBISHI ELECTORIC Corp.
[3] The Univ. of Tokyo
[4] Asahikawa Medical Univ.

**Abstract**
A surveillance service is passivity work. A surveillance operator is waiting for alarm continuously. By adding active work to waiting time, the alarm disposal time of surveillance operator becomes short. We have built the simulated environment of surveillance and compared subjects whose experiences were different. As a result, alarm disposal time is shortened in adding active work case. The physiological reaction of the subject with few amounts of experiences is small difference in passive and active cases. The subject with many amounts of experiences is high tension and little stress in the case of adding active work. It is thought that adding active work to surveillance has effect to improve the productivity of surveillance service and to stable in the surveillance operator with many amounts of experiences.

**Keywords**:
Surveillance Service, Service Engineering, Human Interface

## 1 INTRODUCTION

System surveillance is a function required for continuous operation of a system which consists of various apparatus and networks.

These system components break in aged deterioration or carry out unusual behavior.

Surveillance detects these abnormalities and surveillance operator performs predetermined disposal for returning to normal.

The entrepreneur who provides service may maintain a system at low cost. So it is not rare to contract out surveillance to a service provider.

The entrepreneur who offers surveillance as a service has the equipment which supervises intensively, prepares some operators, and carries out the surveillance on 24/7 [1].

The entrepreneur of supervisory service is advancing rationalization of surveillance business. They raise their productivity and offer a competitive charge [2], [3].

As one of the methods of the rationalization, it can be considered that a surveillance system shows some information to the operators in the waiting time.

Using the shown information, the disposal time of a operator is shortened by doing active work (Fig.1) [4].

We evaluated by measuring the difference in the physiological reaction of the subject with different amount of experiences.

## 2 SURVEILLANCE OPERATION MODEL

An operator's work consists of these three states.

- The state that an operator waits for alarm
- The state that an operator recognizes alarm
- The state that an operator disposes of alarm

An operator changes these states in order (Fig.2).

In the waiting stats, an operator is waiting for change of a display for indication etc.

In the recognizing stats, an operator notices change of a display for indication etc. and starts to dispose of alarm.

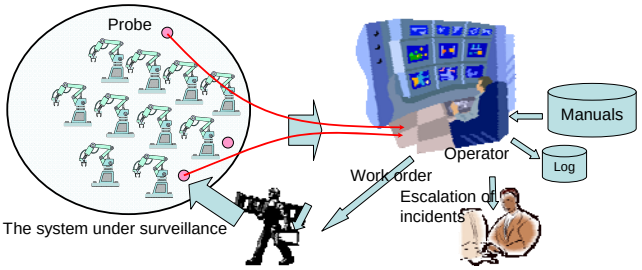


Fig.1 The system and surveillance operator

In the disposing stats, an operator deals with alarm according to the statement of a manual etc., and completes disposal.

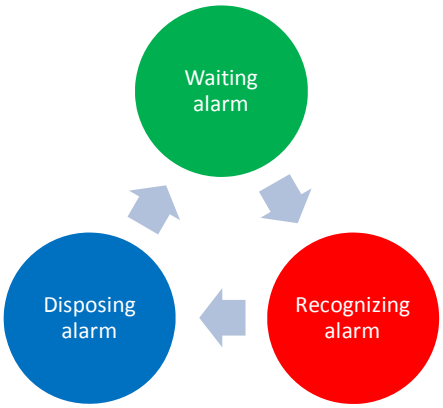


Fig.2 Surveillance operation model

## 3 EXPERIMENTS WITH SIMULATED ENVIRONMENT

### 3.1 Simulated environment

We have built the simulated environment of the surveillance system using a computer, and carried out measurement using several subjects.

A subject waits for change of alarm by seeing the screen of a computer.

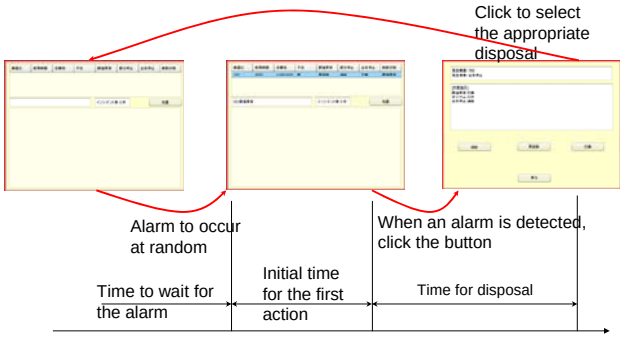


Fig.3 Simulated environment of surveillance system

Alarm is generated at random and the average of the generating interval is 25 seconds. Generated alarm will display a alarm message on the screen which the subject is looking at.

A subject will click the button on a screen, if the alarm is noticed. The time from alarm generated to this click is initial time.

The screen of disposal to the alarm is displayed by this click. A subject opts for disposal according to the contents of the screen, and clicks an applicable button on the screen. The time from the display of disposal to this click is disposal time (Fig.3).

If disposal is completed, it will return to the state of waiting again. This sequence is repeated 20 times per test. The number of the apparatus for surveillance is 1000. There are three kinds of generated alarm and disposal is three kinds. This combination is generated for every test.

### 3.2 User Interface for active and passive case test

The screen that is shown to the subject on waiting alarm stats is prepared following two kinds.

Passive case test is using passive (A) screen.

Active case test is using active (B) screen.

- Passive waiting screen (A)
  No additional information is shown on this screen until alarm will be generated. Generated alarm will display on the upper row of the screen.
  A subject will click the button for disposal, if the display of alarm is recognized.
  Fig.4 is an example of the screen when alarm was generated.

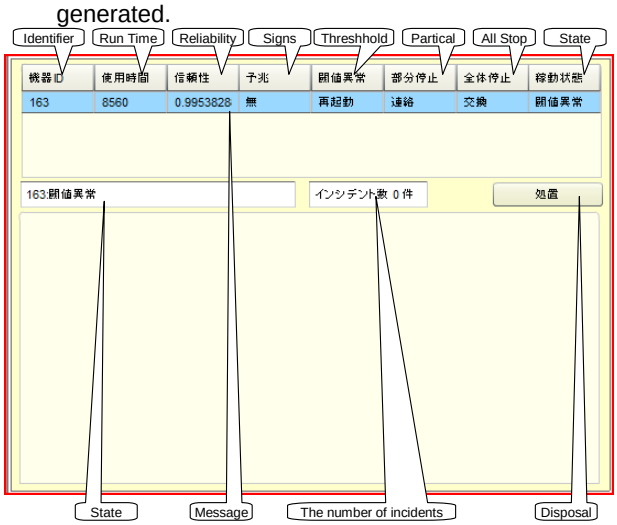


Fig.4 Passive waiting screen (A)

- Active waiting screen (B)
  A list for surveillance is always shown in the lower part of the screen. While waiting for alarm, a subject can scroll this list or can sort a list by items, such as apparatus ID or hour of use.
  This list is contained hour of use, reliability, probability sign etc. But these items have no correlativity in this simulated environment.
  In a real system, the influence of the probability of occurrence on alarm of these items is slight. In this test, the subject disposes 20 alarms. So, there are not influenced by these items.But the subject is interesting in this list.
  Fig.5 is an example of the screen when alarm was generated.

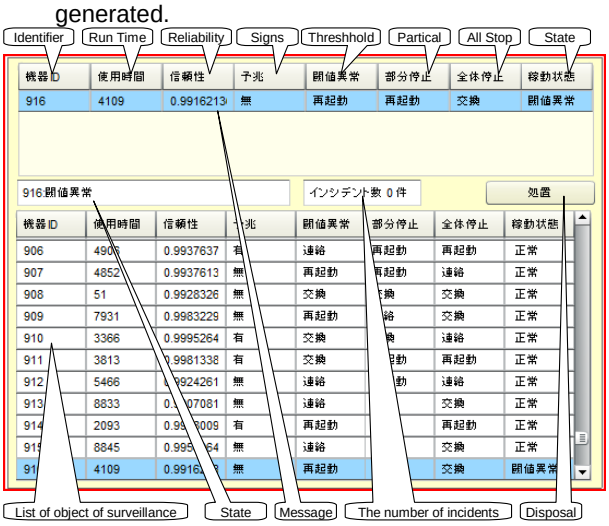


Fig.5 Active waiting screen (B)

### 3.3 Physiology measuring device

For evaluates the difference of the Passive case and the Active case in physiological reactions, physiology measuring device has been used.

In order to evaluate mental sweating, Galvanic Skin Reflex (GSR) is measured.

In order to evaluate the grade of irritation by stress, electromyogram (EMG) of the muscle of mastication is measured.

In order to evaluate mental tension, electro- cardiogram (ECG) is measured.


Fig.6 PowerLab 26T

The ADInstrument[5] PowerLab 26T with Bio Amp (for ECG and EMG), GSR Amp is used as a measuring device (Fig.6).

Fig.7 is the example of a measuring result.

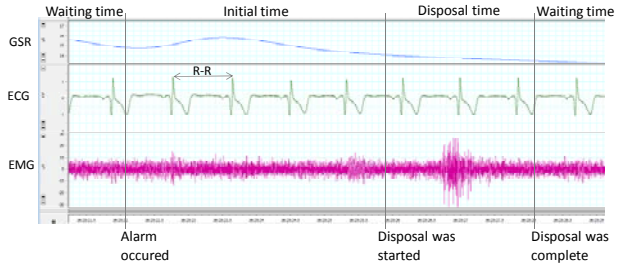


Fig.7 Example of a measuring result

### 3.4 Evaluate method of measurement data

The measurement data has been evaluated by following methods.

In these methods, "i" is a test number and "j" is a alarm number. And each phase of action for alarm is called "W" (wait time), "I" (initial time) and "D" (disposal time). Each measurement data is called "n".

- Reaction time
  Reaction time is evaluated as an average of each phase.

$$\mathrm{Time\_I_i} = \frac{1}{20}\sum_{j=1}^{20} \mathrm{I_j} \tag{1}$$

$$\mathrm{Time\_D_i} = \frac{1}{20}\sum_{j=1}^{20} \mathrm{D_j} \tag{2}$$

- ECG
  The R-R interval is extracted from ECG.
  RR is evaluated as an average of each phase.

$$\mathrm{X_i} = \mathrm{W_i\ or\ I_i\ or\ D_i} \tag{3}$$

$$\mathrm{RR\_X_i} = \frac{1}{n}\sum_{n=\text{Start of this phase}}^{\text{End of this phase}} \mathrm{RR_n} \tag{4}$$

- EMG
  The measurement values are changed into rectification. And the absolute values of the difference with the average value at quiet time are calculated. RMS (Root Mean Square) is calculated as N=100 from 1000Hz of sampling frequencies.
  EMG is evaluated as an average of each phase RMS.

$$\mathrm{e(n)} = |\mathrm{S_d(t)} - \overline{\mathrm{S_d}}| \tag{5}$$

$$\mathrm{RMS(n)} = \sqrt{\frac{1}{N+1}\sum_{k=0}^{N} e^2\left(n - \frac{N}{2} + k\right)} \tag{6}$$

$$\mathrm{EMG\_X_i} = \frac{1}{n}\sum_{n=\text{Start of this phase}}^{\text{End of this phase}} \mathrm{RMS(n)} \tag{7}$$

- GSR
  A galvanic skin reflex (GSR) measures the electric fluctuation of the skin accompanying mental sweating.
  It is thought that GSR reflects two change.
  One is the increase in perspiration by activity of the sympathetic nerve accompanying work.
  Another is change of GSR by change of the emotions by the stimulus under work.
  Therefore, average value is calculated as a level of a GSR, and the difference of the maximum and the minimum is calculated as amplitude in each section of waiting time, initial time, and disposal time.

## 4 EXPERIMENTAL RESULTS AND DISCUSSION

In this simulated environment, measurement using 5 subjects was performed. 3 subjects were beginners and 2 subjects were experts.

The beginners were the subjects that took this test first time. The experts were the subjects that took this test more than 10 times.

Before measurement, each subject took this test twice for the purpose of study of operation.

In this discussion, we presented the measurement results of one beginner and one expert as typical examples.

### 4.1 Reaction time of the subjects

Fig.8 and Fig.9 show initial time and disposal time.

Fig.8 is the time of the beginner and Fig.9 is the time of the expert. Each Fig. showes the time of passive type test and active type test.

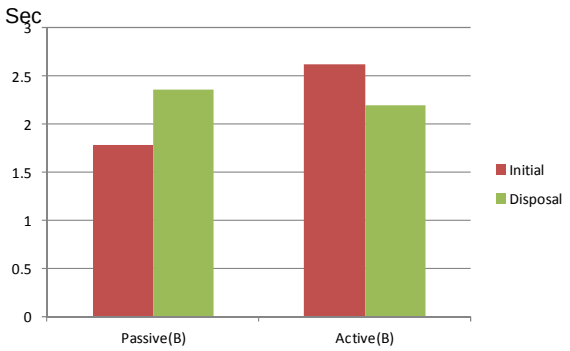


Fig.8 Reaction time of the beginner


Fig.9 Reaction time of the expert

In initial time, the time of active type test was longer than the time of passive type test.

These differences are considered because of becoming late to notice alarm by active work. This difference will improve with the display method of alarm.

In disposal time, the time of active type test is shorter than the time of passive type test.

These differences are considered that subject's limbic system judged the alarm as a supposing thing by active work [6], [7], [8].

In differences between the beginner and the expert, expert's initial time is hard to be affected by active work.

And expert's disposal time is effectively shortened by active work.

It is considered that the difference of the amount of experiences of beginners and experts have appeared as these differences.

### 4.2 Changes of R-R interval

The R-R interval is extracted from ECG. And each R-R interval of test and the phase is calculated as average value.

Fig.10 and Fig.11 show the beginner's average of R-R interval and the expert's average of R-R interval.

Each fig. shows each average of R-R interval in each phase and each type of test.

Since R-R interval is a reciprocal of cardiac beats rate, low R-R interval means high cardiac beats rate. If subject's mental tension becomes high, R-R interval shows low value.

In Fig.10, the beginner's mental tension increases after alarm generating. This tendency is same at the passive type test or the active type test.

In Fig.11, the expert's mental tension is not seen remarkable change in the passive type test. In comparison of the passive type test and the active type test, expert's mental tension of the active type test is higher than that of the passive type test. Average R-R interval in waiting time was tested using t-test. There was a significant difference between passive type test and active type test ($p < 0.01$).

And expert's mental tension decreases after alarm generating in the active type test.

These tendencies show that the active work let expert to strain the tension and urge stable work. An expert might commit the mistake by self-conceited in practice. Moderate strain is desirable in management.

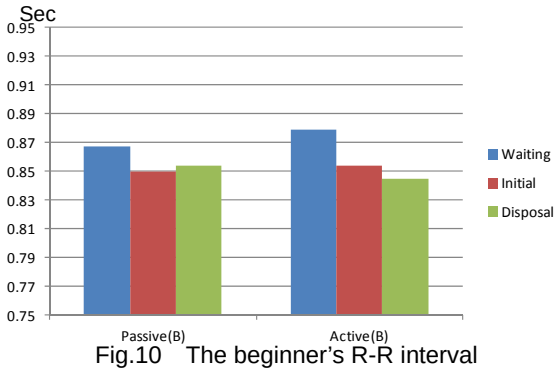

Fig.10 The beginner's R-R interval

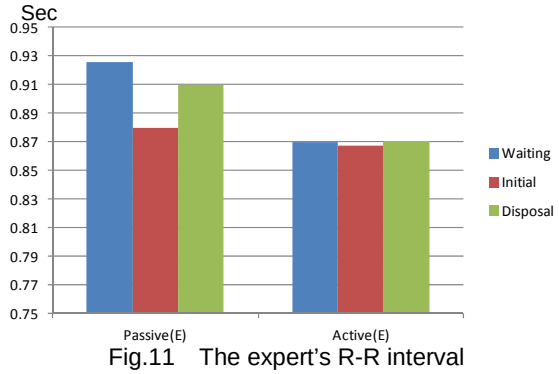

Fig.11 The expert's R-R interval

### 4.3 Activity of muscle of mastication

A reaction, such as gritting one's tooth, is seen in a situation with irritation. This is detectable as change of EMG of a muscle of mastication [9].

In this experiment, EMS is estimated by RMS, and the average value for each phase is calculated, and these are compared.

Fig.12 and Fig.13 show the beginner's average of EMG and the expert's average of EMG.

Each fig. shows each average of EMG in each phase and each type of test.

Since EMG is changed into rectification and evaluated, the value became high when activities of the muscle of mastication became active.

EMG of the active type test is lower than that of the passive type test on the beginner and the expert.

This tendency is strongly seen on the expert. Average EMG was tested using t-test. There was a significant difference between passive type test and active type test in each phase ($p < 0.05$).

It is thought that expert understands the relation between the displayed information and alarm well.

It can be said that adding the active work to surveillance business reduces irritation of the surveillance operator.

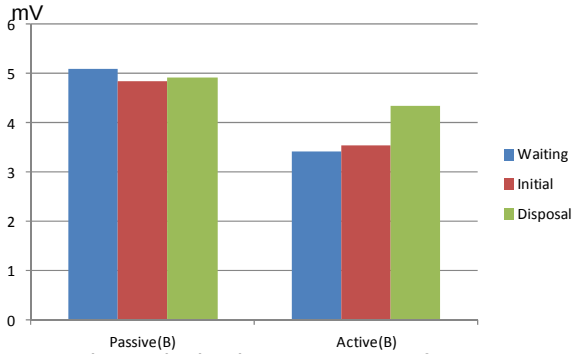

Fig.12 The beginner's average of EMG

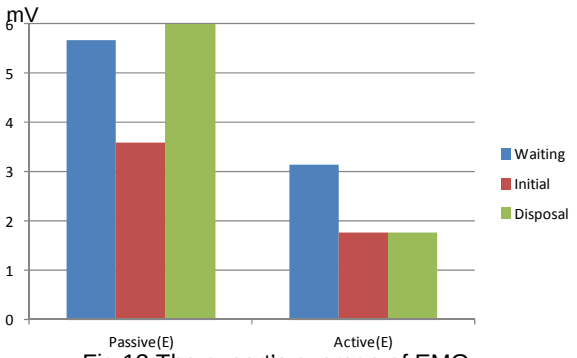

Fig.13 The expert's average of EMG

### 4.4 Changes of GSR

GSR level and amplitude of each subject's passivity type and an activity type are shown in Fig. 14, Fig. 15, Fig. 16, and Fig. 17.

The level of beginners' GSR is in the tendency for initial time and the disposal time to be higher than waiting time.

It is thought that the work after alarm generated has been loaded for the subject.

Although the level of an expert's GSR shows a little tendency for initial shock time and disposal time to be higher than waiting time, in a passivity type, it cannot be said to be a remarkable difference. The level of an

expert's GSR shows the tendency that initial shock time and disposal time are high in the passivity type. However, this cannot be said to be a remarkable difference. In an activity type, there is no difference in the level of a GSR through all the sections. It is thought that the work after alarm is slight load for a subject.

The level of beginners' activity type GSR is generally high. However, such a tendency is not seen in an expert. It is thought that information presentation has been loaded in beginners.

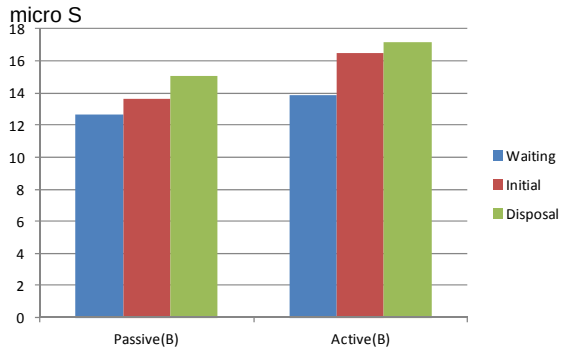

Fig.14 The beginner's level of GSR

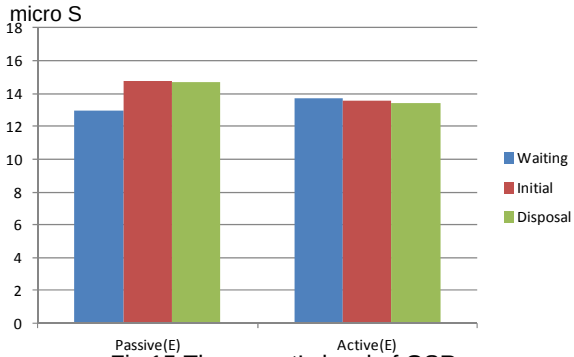

Fig.15 The expert's level of GSR

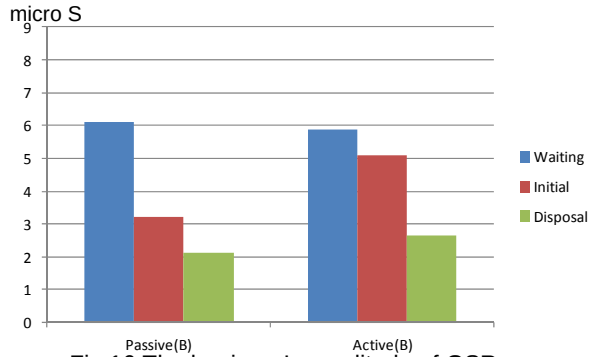

Fig.16 The beginner's amplitude of GSR

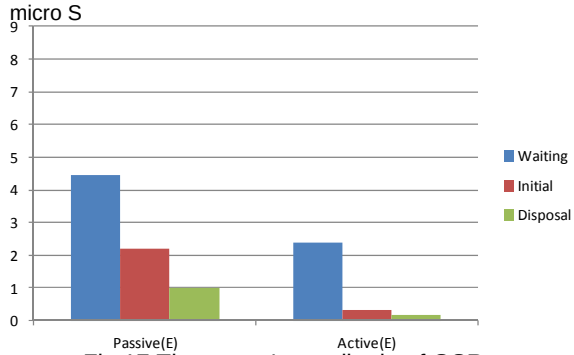

Fig.17 The expert's amplitude of GSR

GSR of the waiting time is large in beginner case and expert case. It is thought that alarm is the biggest stimulus in this experiment.

In the beginner's initial time and disposal time, the amplitude of GSR of active type is large. But in the expert, this tendency is not shown. Average level of GSR was tested using t-test. There was a significant difference between initial time and disposal time in beginner's active type test ($p < 0.05$).

It is thought that the amount of experiences affect the action of information.

## 5 CONCLUSION

In disposal time, the time of active type test is shorter than the time of passive type test. But a beginner and an expert show different physiological reactions. These differences are summarized in Table 1.

It is thought that the rise of the cardiac beats in an expert's activity type heightenes the feeling of tension even if it is the familiar work. If it is a moderate feeling of tension, an effect is expectable in prevention of the mistake by practice, etc.

Activity of a muscle of mastication is falling greatly in an expert's activity type. This can be considered that the irritation over work decreases.

The amplitude of the galvanic skin reflex is falling greatly in an expert's activity type. A mental change is considered to have decreased in an activity type.

The entrepreneur of surveillance service is advancing rationalization of surveillance business. They raise their productivity and offer a competitive charge.

Although automation is advanced as a means for rationalization [10], it is impossible to process all the phenomena automatically. The productivity of a surveillance operator is also important.

This paper showed that the disposal time of alarm is shortened by changing the conventional passive surveillance into active surveillance. It is not concerned with amount of experiences of a surveillance operator. Moreover, in expert, adding the active work lets surveillance operator stain and reduce irritation.

Therefore, the adding the active work to surveillance work has effect not only to increase operation productivity but also to urge the work stable in the surveillance operator with many amounts of experiences.

Table 1 Differencces of Beginner and Expert

| | Beginner | Expert |
|---|---|---|
| Initial Time | Passiv < Active | Passiv < Active |
| Disposal Time | Passiv > Active | Passiv > Active |
| Heart Beat | Passiv = Active | Passiv < Active |
| Mastication | Passiv >Active | Passiv >> Active |
| GSR | Passiv < Active | Passiv >> Active |

## REFERENCE


[1] Integrated Control Center Website, "http://www.mind.ad.jp/service/icc/"

[2] H.Ogata, "Cloud-oriented Data Center Platform", NEC TECHNICAL JOURNAL Vol.5 No.2, 2010

[3] H.Ito, "Operation Efficiency Improvement for IT Infrastructure thought Automation Technology", FUJITSU. 62, 2011

[4] M.Uozumi, "Automation of Supervisory Service, and Examination of the Subject of Operation", SICE2012, 2012

[5] PowerLab Website, "http://www.adinstruments.co.jp"

[6] M.Uozumi, “The Information Presentation to the Operator in Supervisory Service, and its Effect”, FIT2012, 2012
[7] Mobiligence Series Volume 1, 2010
[8] Mami EGAWA: Effects of users’ activeness and passiveness on a searchlight-task, SICE2010, 2010
[9] LE. Quoc Dung, “Estimation of stress on car racer by measurement of masseter muscle’s activity”, Distributed autonomous system symposium, 2013
[10] Masahiro Otsuki: Study of Service Operation under Unattended ICT System, UNISYS TECHNOLOGY REVIEW No.100, 2009