Interface-State-Density Evaluation of p-type and n-type Ge/GeN\textsubscript{x} Structures by Conductance Technique

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Keywords : Ge, MIS, Ge-MIS, Interface State, Conductance Technique

A Ge-MIS structure has attracted the attention for next generation CMOS devices. We have reported that the GeN\textsubscript{x}/Ge structure with low interface state density can be made by ECR (Electron Cyclotron Resonance) plasma technique, and that the interface state density of Ge-MIS structures can be evaluated by the characteristic analysis in the inversion region even at room temperature. In this report, we evaluated the interface state density of n- and p-type GeN\textsubscript{x}/Ge structures by conductance technique at low temperature and the characteristic analysis at room temperature, and these of process dependences.

Samples evaluated here were MIS capacitors with Al / Si\textsubscript{3}N\textsubscript{4} (5nm) / GeN\textsubscript{x} (2nm) / Ge structure, which was formed by using ECR plasma nitridation and ECR sputtering. After the deposition of the Si\textsubscript{3}N\textsubscript{4} layers, some samples were annealed for 30 min in N\textsubscript{2}+10\% H\textsubscript{2} ambient. The annealing variation was as follows.

1) Without annealing (As Deposited)
2) With Post-Metallization Annealing (PMA) at 200°C
3) With Post-Deposition Annealing (PDA) at 500°C

Figures 1 (a) and (b) show the measurement-frequency dependences of C-V characteristics (at 180K) for p- and n-type-PDA-500°C samples, respectively. The small variations in C-V characteristics indicate that the samples do not contain high-density interface states.

Figure 2 shows the energy distribution of the interface-state-density (D\textsubscript{it}) obtained by conductance technique using C-f and G-f measurements results for p- and n-type samples at 180K. The distributions of the D\textsubscript{it}s are symmetric, and the D\textsubscript{it} of the PDA-500°C sample near midgap shows very low value which close to that of GeO\textsubscript{2}/Ge system.

In summary, we have successfully evaluated the interface characteristics of GeN\textsubscript{x}/Ge structures. The D\textsubscript{it}s were symmetrically distributed with respect to midgap, and the D\textsubscript{it} near midgap for PDA-500°C sample was close to that of the GeO\textsubscript{2}/Ge structure.

Fig. 1. C-V characteristics of PDA-500°C samples at 180 K.

Fig. 2. D\textsubscript{it} distributions by low-temperature conductance method.
A Study of Image Analysis for Tree Drawing Test of Patients with Mental Health Problems

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Keywords: tree drawing test, image analysis, psychosomatic internal medicine, psychological test, psychiatric disorder

1. Introduction

Tree drawing tests, in which patients draw a picture of a tree with nuts, have often been used in psychosomatic internal medicine as a conventional psychological test. The tests guess their character and mental state from the morphological feature of trees. Their picture was analyzed using an image processing method, and the characteristic quantities, such as gray levels and drawing volume, were calculated. We considered relationship between those indices and their mental conditions. As a result, the picture features allow psychiatrists to diagnose their psychiatric disorder and perform more effective diagnosis with patients.

2. Results

2.1 Relationship between Characteristic Quantities and Depression Scale

The drawn sheets of 989 patients were analyzed using an image processing method in order to find the relationship between the quantitative characteristics of the tree drawing test and the depression scale. The depression scale of patients was measured using self-rating depression scale (SDS) test.

We calculated a function of the SDS score as the quantitative characteristics using multiple regression analysis. Fig. 1 shows the relationship between calculated and measured SDS scores. We compared the calculated data with clinical data, and this result has improved the reliability of psychological test.

2.2 Discriminant Analysis of Bipolar Disorder and Monopolar Depressive Patients

Bipolar disorder is different from monopolar depression. However, the symptoms of the both are similar, and thus it is difficult to distinguish the former from the latter.

We calculated a mahalanobis distance $D_{1k}$ and $D_{2k}$. $D_{1k}$ is a mahalanobis distance between the average of the bipolar data and the data of patient $k$. $D_{2k}$ is a mahalanobis distance between the average of monopolar data and the data of patient $k$.

Fig. 2 shows the relationship between $D_{1k}$ and $D_{2k}$. In this figure, the 1st group consists of patients of bipolar disorder, and the 2nd group consists of patients of monopolar depression.

As a result, we could distinguish between these bipolar disorder patients and monopolar depression ones using this discriminant method.

Fig. 1. Relationship between calculated SDS scores using tree drawing test and measured SDS scores using Self-rating Depression Scale test.

Fig. 2. Relationship between $D_{1k}$ and $D_{2k}$. 
Classification of Blink Type by a Frame Splitting Method using Hi-Vision Image

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Keywords: Eye blink, Hi-Vision, Interlace image, Frame splitting method, Image analysis

Recently, input interfaces that use information derived from a user’s eye blinks have been reported. Users can input text or commands into personal computer systems via these interfaces. In general, eye blinks are detected by estimating the open-eye area. If the entire eye blink process is captured, the wave pattern of the eye blink can be measured. 1080i Hi-Vision video cameras are capable of detecting eye blinks. However, it is difficult for these cameras to measure the detailed temporal changes that occur during the eye blink process because eye blinks are relatively rapid (a few hundred milliseconds). Therefore, a high-speed camera is required for detailed eye blink measurements.

1080i Hi-Vision video cameras capture moving images at 60 fields/sec, and these field images are mixed with other images having a frame rate of 30 frames/sec to produce interlaced images. We propose an eye blink detection method that utilizes split interlaced images. These split images are odd- and even-numbered field images in the 1080i hi-vision format, which are generated from interlaced images. The proposed method delivers twice the time resolution of the 1080i Hi-Vision format. We refer to this approach as a “frame-splitting method”. Using our frame-splitting method, the detailed temporal changes that occur during the eye blinking process can be detected. An overview of our frame-splitting method is shown in Fig. 1.

Furthermore, we developed a new method for extracting wave patterns from eye blinks. Using this method, eye blink patterns can be extracted automatically from the detection results. This method detects eye blink events and their start and end points.

Eye blinks can be classified into voluntary (conscious) blinks and involuntary (unconscious) blinks. A more user-friendly interface might be developed if voluntary blinks could be detected automatically. Thus, users could employ this interface to input commands into their PC consciously. We confirmed the feature parameters of the eye blink types in an experiment with 10 subjects (subject A to J). In this experiment, the subjects blinked consciously, i.e., the subjects closed their eyes firmly when they listened to a beep sound emitted by the PC. The beep sound was randomly generated with an interval of 5-7 sec. In this experimental process, the involuntary blinks also occur. We confirmed that there is large difference in the duration of voluntary and involuntary blinks.

A typical result from this experiment is shown in Fig. 2, where the y-axis and the x-axis indicate open-eye area pixels and the sampling point (interval = 1/60 sec), respectively. These plots were normalized relative to the pixels in the open eye area in the first field image in order to compare the two different eye blink wave patterns.

From Fig. 2, it is evident that the voluntary blinks had a longer duration than involuntary blinks. We propose a new method for classification of blink types using the duration time as threshold value. The evaluation experiments indicated that the average classification rate of our method was 95.0%. We confirmed that our proposed method can classify eye blink types such as voluntary and involuntary blinks.
Development of Management Systems for Traffic Regulation Devices in Expressways

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Keywords: Traffic Regulation Devices, Management Systems, Risk Estimation, Visualization, Expressways

Since traffic networks in modern societies play very important role such as vein and artery in the human being, traffic and/or transportation networks are being improved to maintain safety and comfortable traffic environments. In particular, expressways are most important and essential in order to achieve safety and comfortable travel, transportation of various resources and so on. Therefore, one can see that good traffic environments in expressways have to be maintained by all means.

By the way, in order to maintain or fix expressways, it is necessary to regulate and/or control the traffic by using the traffic regulation devices, referred to as “Rubber Cone” or “Road Cone” (see Fig. 1). In expressways, the distance of a work area to be regulated (call “the regulated area”) becomes about 1,000–6,000 [m] and the rubber cones are arranged at intervals of 20–30 [m] in the regulated area. Since typical distance of a work area is about 2,000 [m], in this case it is necessary to arrange about 100 rubber cones. The arranged traffic regulation devices (rubber cones) may move by means of wind, rain and sideswipe and so on. Actually, about ten accidents are occurred in Shikoku section at every year and from the result of the questionnaire of West Nippon Expressway Engineering Shikoku Co. Ltd., it was proved that 86% of 150 workers have found rubber cones falling down. As you know, it is very dangerous when the rubber cone is on the non-regulation area and such situation should be improved immediately. Therefore, workers are supervising the arranged rubber cones periodically. However, this method cannot discover the movement of the arranged rubber cones immediately. Furthermore, there are some problem for safety and efficiency.

From the above, we develop a new management system for traffic regulation devices which are used in order to control the traffic in expressways. The proposed management system consists of the following items.

- Rubber Cone Sensor (RCS):
  RCS consists of a microcomputer, data communication modules, an acceleration sensor and so on.
- State Management Computer (SMC):
  In SMC, the visualization software which is installed in SMC identifies the arrangement of RCSs, and manages the RCSs.

The proposed management system can generate the arrangement information for rubber cone sensors and detect some accidental events, because RCS has the following functions.

- Data communication function
- Recording function of acceleration data
- Measurement function of electric field strength
- Power management function

Fig. 1. Traffic regulation by using “Rubber Cone (Road Cone)”.

Fig. 2. An example of the monitor display of the state management computer

On the other hand in the proposed management system, the movement of a rubber cone can be established as “the grades of risk (2-dimensional contourmap)”. The grades of risk are obtained by the following procedure.

1. Estimate the displacement of the rubber cone.*
2. By checking the database constructed by using experimental data, the variance for the grades of risk is determined.
3. By using obtained data, 2-dimensional contourmap is shown via normal distribution.

Figure 2 represents an example of the monitor display of the proposed management system. In Fig. 2, the center red point in the left side is an arranged position for a rubber cone, ellipsoidal regions show the grade of risk and the center point in the ellipsoidal region is the estimate of the displacement for the rubber cone.

The future research subjects are improvement of estimation algorithm for the grade of risk, actual environmental experiment, examination for power saving strategy and so on.

* In this paper, the estimate of the displacement can be obtained by using well-known impulse response for linear dynamical system model.
Reproduction of Phonograph Record Sound using Digital Image Processing

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Keywords : Phonograph Records, Flatbed Scanner, Digital Image Processing, Linearization, Edge Extraction, Sound Signal

We have conducted a series of studies on a non-contact groove sensing and reproduction of sound signal from phonograph records based on digital image and signal processing. Fig. 1 shows the processing overview.

First, we have examined whether a groove geometry of stereo-record could be digitized based on a resolution of a flatbed scanner which is commercially available. And we have confirmed that it is possible to reproduce the original audio information from the scanned image.

Next, we have equalized a histogram of an original image (Fig. 2) captured by the scanner in order to enhance its contrast. Then we have investigated filtering methods to extract the position of the groove edges. Particularly, we have tested for three spatial filtering methods: Roberts, Sobel, and Laplacian. As a result, we have found the Sobel filter to be the best among the three methods (Figs. 3-4). In addition, we have linearized the arc-shaped groove lines of the record for making subsequent signal processing easy.

After selecting each groove area (i.e. ROI) from the pre-processed image, we have digitized sound signal within the ROI. Finally, we have created a WAVE file based on the digitized data. The reproduced sound waveform contains strong high-frequency noise superimposed on the original sinusoidal wave of 1 kHz (Fig. 5).

From these results, we have concluded that the extraction accuracy of the groove edges should be improved further by reducing the disturbance of the filtered waveform (Fig. 4). We will study the adoption of more advanced filtering methods in the near future.

Fig. 2. Scanned original image (Grayscale).
Fig. 3. Sobel filtered image on Fig. 2.
Fig. 4. Pixel value waveform between A and B in Fig. 3. Circle represents the position of left-channel edge.
Fig. 5. Extracted waveform of sound signal (1 kHz, left channel).
Academic Education and Vocational Training via Electric Control System Design
— Guidance for Graduate Study at National Defense Academy —

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Keywords: system, electronic control, graduate study, academic education, vocational training

Graduate studies to construct electronic control system, through resolving problems in their own sets, introduce cases of self-discipline. Efforts to solve the problems become assets not only in academic education including graduate studies, but also in vocational training including life in harmony and cooperation with others. Moreover both academic education and vocational training properly evaluate the effect of efforts. The combination of education and training is illustrated by giving examples of guidance for the graduate studies.
Subkey Driven Hybrid Power Analysis Attack in Frequency Domain against Cryptographic LSIs and its Evaluation

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Keywords: Hardware security, Side-channel attack, Power analysis attack, Frequency domain, Cryptographic LSI

Recently, the threat level of power analysis attacks has been raised. Power analysis attacks acquire confidential information from cryptographic circuits that are embedded in hardware, such as credit and cash cards, by analyzing their power consumption. Therefore, it is important to secure resistance against power analysis attacks.

This study proposes a new power analysis attack method that can be used to improve the efficiency of the resistance evaluation of cryptographic LSI. Fig. 1 shows the proposed method. The proposed method performs power analysis not in the conventional time domain but in the frequency domain.

Moreover, it uses a partial key that is specified through the use of conventional power analysis attack to estimate other partial keys. Fig. 2 shows the comparison results of the attack accuracy between conventional CPA and the proposed method. Table 1 shows the comparison results of the total computational amount between conventional CPA and the proposed method when using 10,000 waveforms. Compared with resistance evaluation that uses typical attack methods, the proposed method reduces the computational amount required for resistance evaluation greatly while maintaining the attack accuracy, as shown in Fig.2 and Table 1.

![Fig. 1. Proposed method](image1)

![Fig. 2. Comparison of the attack accuracy between CPA and the proposed method](image2)

<table>
<thead>
<tr>
<th># Loop</th>
<th>Conventional Total</th>
<th>Proposed Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-loop</td>
<td>100,000</td>
<td>100,000</td>
</tr>
<tr>
<td>1-loop</td>
<td>200,000</td>
<td>200,000</td>
</tr>
<tr>
<td>10-loop</td>
<td>1,100,000</td>
<td>1,100,000</td>
</tr>
<tr>
<td>16-loop</td>
<td>1,700,000</td>
<td>1,700,000</td>
</tr>
</tbody>
</table>

Table 1. Comparison of the total computational amount between CPA and the proposed method when using 10,000 waveforms
An Avoidance of Local Minimum Stagnation in Designing IIR Filters Using SOA

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Keywords: digital filter, PSO, heuristic

IIR (Infinite Impulse Response) filter is a discrete time signal processing circuit which is needed a wide range of fields including communication, measurement, control and so on. The design problem of the IIR filter is generally formulated as a complex approximation problem in which both a magnitude response and a phase response are approximated simultaneously. In addition, a stability of filters must be considered. Therefore, the problem falls into a nonlinear optimization problem.

In this paper, we propose a design method of IIR filters using SOA (Seeker Optimization Algorithm). The SOA has been proposed as one of the heuristic methods which can solve the nonlinear optimization problems approximately. The SOA is based on the swarm optimization, and inspired by a human activity in searching anything. Some seekers have three informations which are described by a position $x$, a search direction $d$ and a step size $\alpha$. The position $x$ is constructed by poles and zeros of the filter to be design and is updated by the following equation at $t$-th iteration,

$$x_{ij}^{t+1} = x_{ij}^t + \alpha_t d_{ij}, \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots \cdots (1)$$

where, $i$ and $j$ is a seeker number and a demension number, respectively. The search direction $d$ is decided stochastically by a direction toward the best solution of each seeker or the best solution of the whole swarm. Also, the step size $\alpha$ which features the SOA, is set appropriately to each position using a membership function. In this paper, the step size which is decided by the gradient of the objective function is proposed to avoid from the stagration to the local minimum that offen occurs in heuristic approach.

Several design examples are shown to present the efficiency of the proposed method when a random initial value was applied. The PSO (Particle Swarm Optimization) is employed as comparative methods. The design results are shown in Table 1. Moreover, in a case that the random initial value which was generated by the different generation method is given, the design performance are shown in Table 2.

Table 1. A comparison of design performance.
\begin{tabular}{|c|c|c|c|c|c|}
\hline
\multicolumn{6}{|c|}{$\times 10^{-2}$} \\
\hline
 & ex.1 & ex.2 & ex.3 & ex.4 & ex.5 \\
\hline
proposed  best & 3.7152 & 2.5816 & 2.0585 & 1.4743 & 3.6336 \\
method average & 5.1184 & 4.3679 & 3.6837 & 3.3977 & 5.6336 \\
LP+PSO  best & 2.7358 & 2.2900 & 2.0337 & 1.3412 & 2.7152 \\
average & 2.3992 & 2.6015 & 2.1730 & 2.0454 & 2.7570 \\
normal SOA  best & 4.3475 & 3.6334 & 2.8720 & 2.3232 & 3.8581 \\
\hline
\end{tabular}

It was shown by Table 1 that the proposed method could achieve a equivalent performance to the LP+PSO using a good initial value. Also, regardless of generation method used, a good design is possible. Finally, A magnitude response and group delay characteristic could be attained as shown in Fig. 1 and Fig. 2, respectively.

Table 2. Effects by different generation methods.
\begin{tabular}{|c|c|c|c|c|c|}
\hline
\multicolumn{6}{|c|}{$\times 10^{-2}$} \\
\hline
 & ex.1 & ex.2 & ex.3 & ex.4 & ex.5 \\
\hline
generating  best & 3.7152 & 2.5816 & 2.0585 & 1.4743 & 3.6336 \\
method 1 average & 5.1184 & 4.3679 & 3.6837 & 3.3977 & 5.6336 \\
generating  best & 3.7384 & 2.6174 & 2.2710 & 1.6331 & 3.2076 \\
generating  best & 3.7111 & 2.8321 & 2.0537 & 1.6849 & 2.9021 \\
method 3 average & 5.4642 & 4.3680 & 3.4310 & 3.2955 & 5.2130 \\
\hline
\end{tabular}

Fig. 1. Magnitude response.

Fig. 2. Passband group delay.
A New Clustering Routing Algorithm for WSN based on Brief Artificial Fish-School Optimization and Ant Colony Optimization

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Keywords : Wireless Sensor Networks, clustering routing, BAFSO, ACO, bridge diagnosis, system design

In this paper a novel clustering routing algorithm for Wireless Sensor Network (WSN) based on Brief Artificial Fish-School Optimization and Ant Colony is proposed. This algorithm contains two routing levels. In the first level (intra-cluster), we propose a cluster routing algorithm based on an intelligent optimization algorithm: Brief Artificial Fish-School Optimization (BAFSO) for one hop WSNs. The second level (inter-cluster) is used for multi-hop WSNs. In the second level, the first level is employed to create cluster and select cluster head at first. Then the cluster heads uses ant colony optimization (ACO) algorithm to find a route to the base station.

In the first routing level (intra-cluster), The BAFSO is used to forms clusters and selects cluster heads. The operation of our routing algorithm, named BAFSOCR (BAFSO-based Clustering Routing), is based on BAFSO that can produce better clusters by dispersing the CH nodes throughout the network. During the cluster set-up phase of BAFSOCR, each node in the WSN sends its current location information and current remaining energy to the base station. The sensor nodes whose energy is lower than the average energy cannot be selected as the cluster head for the current round. The execution of BAFSOCR is as follows:

(1) Initialize the state of artificial fish-school \( X = (x_1, x_2, \ldots, x_n) \), thus all the nodes can be selected as the cluster head. \( x_i \) (\( i = 1, 2, \ldots, n \)) is the optimization variables. And initialize the other parameters: Field of view of the artificial fish: \( \text{visual} \); Crowding factor: \( \delta \); The maximum step of the artificial fish: \( \text{step} \); The number of cycles in the algorithm: \( N \).

(2) Initialize the value of bulletin board, and calculate the current function value \( Y \) of each artificial fish. If there are \( n \) clusters in the network, which can be expressed as \( \{S_j, j = 1, 2, \ldots, n\} \). \( m_j \) is the cluster center of \( S_j \). Then, the objective function \( Y \) of each artificial fish is calculated as the function below:

\[
Y = f(x) = \min \sum_{j=1}^{n} \left\| Y - m_j \right\| \tag{1}
\]

e.g., if there two clusters in the network (\( n = 2 \)) shown in the Fig. 2. Then according to the diagram above, \( Y \) can be expressed as:

\[Y = \min\{(d_{11} + d_{12} + d_{13} + d_{14} + d_{23} + d_{24})\} \tag{2}\]

The objective function \( Y \) means that we need to put the sensor nodes which have the smallest distance to the same cluster center into one cluster.

(3) According to the BAFSO algorithm, simulate following behavior, swarming behavior and preying behavior to the artificial fish. The BAFSO can consider the results of the three behaviors together. After each artificial fish operated, check the objective function \( Y \) with the value of bulletin board. If better, then update it.

During steady-state phase of BAFSOCR, it is a similar approach like the LEACH. All the nodes of the cluster send their data to the cluster head (CH). After receiving these data, it performs data aggregation to enhance the common signal and reduce the communication burden. Then the resultant data are sent from the CH to the BS.

In the second routing level, a novel clustering routing algorithm based on BAFSO and modified ACO, called BAFSO and MACO-based Routing Algorithm (BMRA), is proposed for multi-hop WSNs. In BMRA, at intervals of definite time (round), first clustering is done using BAFSOCR and then each cluster member sends its data to its own CH (Cluster Head) directly. After gathering the data of the members, the CH find an optimal route by using MACO (Modified Ant Colony Optimization), and sends the gathered data to the BS (Base Station) through the optimal route. When the round ends, clustering is performed again and the process continues. The proposed approach has two steps:

(1) Cluster formation, using BAFSOCR (proposed in the first level) to establish clusters and select CH of each cluster. Then the member of each cluster sends their data to CH.

(2) CHs routing setup, where each CH finds the optimal route to BS based on the MACO.

It should be noted that since just CHs take part in routing, they participate in the process of finding next hop CH. The next hop CH is chosen using (3).

\[p_i^{\text{CH}} = \frac{\tau_{ij}^{\text{total}}(\eta_{ij})^\alpha}{\sum_{k \in N, j \notin M^k} \tau_{ik}^{\text{total}}(\eta_{ik})^\alpha} \quad \text{Otherwise} \tag{3}\]

We compared the proposed routing method with LEACH, LEACH-C, AFSO, HEED and ACO. The simulation results shows BMRA has a better performance in extending lifetime of network, load balancing, energy consumption and delivery delay. This routing algorithm is implemented in the WSN of bridge health diagnosis system, comparing with HEED and ACO. It proved the results of simulation.
A Note on qm-Stability of a Closed-Loop with Purely Random Gain

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Keywords: closed-loop, random gain, stochastic systems, white noise, qm-stability

We consider a closed-loop system composed of a transfer function with steep high-cut characteristic and purely random multiplicative gain as shown in Fig. 1. The transfer function $G$ is a stable rational function satisfying $\left. sG(s) \right|_{s=\infty} = 0$. The block of $\theta(t)$ simply multiplies the signal by $\theta(t)$ at each $t$. $\{\theta(t)\}$ is considered here to be white noise with zero mean and unit spectral density.

The impulse response of the closed-loop system is formally given by

$$y(t) = g(t) - \int_{0}^{t} g(t-\tau)y(\tau)d\tau, \quad t \geq 0.$$  

Where $g$ denotes the unit impulse response of $G$. As a rigorous substitute for the second term of the right-hand side, we consider the Ito integral

$$\int_{0}^{t} g(t-\tau)y(\tau)d\omega(\tau),$$

where $\omega$ is the standard Wiener process. Due to the steep high-cut characteristic, it can be shown that the output process $y$ has differentiability in the quadratic mean. This allows us use of the Ito integral in stability analysis, as well as the Storatonovich integral.

The closed-loop is defined to be qm-stable, iff the impulse response $y$ is convergent to zero in the sense that

$$\lim_{t \to \infty} E(y(t)^2) = 0.$$  

Analyzing the second moment of $y$ using the property of the Ito integral, we have

$$E(y(t)^2) = g(t)^2 + \int_{0}^{t} g(t-\tau)^2 E(y(\tau)^2)d\tau, \quad t \geq 0.$$  

This means that the behavior of the second moment of $y$ is consistent with the impulse response of the fictitious closed-loop of Fig. 2, where the transfer function $H$ is the Laplace transform of $g(t)^2$:

$$H(s) = \int_{0}^{\infty} g(t)^2 e^{-st}dt.$$  

Based on the assumption on $G$, we can prove the following.

**Lemma1** $H$ is a strictly proper and stable rational function. □

Hence, the argument principle applies and results in a Nyquist-like stability criterion as follows.

**Proposition** The closed-loop is qm-stable, iff the Nyquist plot of $H$ makes no clockwise encirclements around the point $s=1$. □

This result can be combined with the following lemma to yield a simple stability condition.

**Lemma2** $|H(j\omega)| \leq H(0)$ holds for any real $\omega$. □

The main result is stated as follows.

**Theorem** Assume that $G$ is a stable rational function such that $sG(s)$ vanishes at $s=\infty$. Then, the closed-loop is qm-stable, if and only if

$$\left\|G\right\|_1 := \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} |G(j\omega)|d\omega < 1$$

holds. □

The above inequality proves to be also sufficient for almost sure asymptotic stability, since it ensures exponential convergence of the quadratic mean of $y$. This result can be considered to be a counterpart of the small gain theorem for the deterministic closed-loop with the random gain replaced by the constant 1.
An Office Lighting Control System based on Employee Entry/Exit State

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Keywords: lighting, office building, illuminance control, employee entry and exit, energy-saving, experimental evaluation

Lighting control systems have been proposed for energy conservation because lighting accounts for not less than 30% of electrical power consumption in a typical office building. Herein, we propose an office-lighting dimming control system based on employee entry and exit from a room. A spot illuminance control method determines the dimming rate that will satisfy every employee’s illumination needs. The system adjusts the dimming rate to negate the influence that the spot illuminance control for an employee gives to other employees. These methods offer the illuminance necessary and sufficient only to the sitting employee’s area according to the change of employee entry and exit in a room.

In order to evaluate proposed method, we produced a lighting control system and applied the proposed method in part of an office building, corresponding to about 300 m². We evaluated the error of measured illuminance compared with the target illuminance after control, and assessed the energy-saving effect. By the results of experimental evaluations, we confirmed that the difference in target illuminance and measurement illuminance is small enough not to be able to recognize by employee, the energy-saving effect is 24.3% compared with the wall light switch operation, and the operation speed of proposed method is fast enough for the frequency of employee entry and exit in a room.
Obstacle Avoidance of Visual Feedback Control via Navigation Function

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Keywords: visual feedback control, obstacle avoidance, navigation function, passivity, stability, aerial vehicle

In this paper, stabilizing pose control via an obstacle avoidance navigation function is applied to three-dimensional (3-D) visual feedback systems with an eye-in-hand configuration as shown in Fig. 1.

![Fig. 1. Visual feedback system with an eye-in-hand configuration](image)

In position-based visual feedback control, in general, it has to be treated both an estimation problem and a control one in order to bring actual relative pose \( g_{eo} \) to a reference one \( g_{ed} \). The visual motion error system, which consists of an estimation error system and a control one, can be constructed as follows:

\[
\begin{align*}
\dot{V}^b_{eo} &= \begin{bmatrix} 0 & -\text{Ad}_{(g^{-1})} & 0 \\
0 & \text{Ad}_{(g^{-1})} & 0 \\
-\text{Ad}_{(g^{-1})} & 0 & \text{Ad}_{(g^{-1})} \end{bmatrix} \left[ \begin{bmatrix} I \\ I \\ I \end{bmatrix} \right] V^b_{eo} + \cdots \\
\end{align*}
\]

where \( u := [u_e \ u_c]^T \) and \( u_c := \text{Ad}_{(g^{-1})} V^b_{eo} + V^b_{cd} \). If the state \( x := [e^T \ e^T]^T \) is equal to zero, then the relative pose \( g_{eo} \) equals the reference one \( g_{ed} \). This visual motion error system (1) is passive from the input \( u \) to the output \( -x \). Based on the passivity property, we consider the following control law

\[
u = -K(-x), \quad K := \text{diag}(K_e, K_v) \]

**Theorem 1** If \( V^b_{eo} = 0 \), then the equilibrium point \( x = 0 \) for the closed-loop system (1) and (2) is asymptotic stable. Theorem 1 shows Lyapunov stability for the closed-loop system.

Next, we design the path planner in order to move the camera towards a desired pose being away from obstacles without additional sensors such as a range scanner. Obstacle avoidance navigation function-based path planning needs the relative position of the obstacles from the camera frame \( p_{cd} \). We propose the visual motion observer in order to estimate the relative position \( p_{cd} \) as follows:

\[
\dot{V}^b_{cd} = -\text{Ad}_{(g_{cd})} V^b_{wc} + u_{bi} \quad \cdots \cdots (3)
\]

We design the desired body velocity \( V^b_{cd} \) with the obstacle avoidance navigation function \( \phi(p_{cd}) \) and the input for the estimation \( u_{bi} \) as follows:

\[
\begin{align*}
V^b_{cd} &= -e^{-\grad_{ed} K_{dp}} \grad_{ed} \phi(p_{cd}) \\
&\quad -K_{dr} e^{-\grad_{cd} V^b_{cd}} \\
u_{bi} &= K_{e} e_{bi} \\
\end{align*}
\]

The following theorem concerning the convergence of the time-varying desired relative pose \( g_{cd}(t) \) to the given final one \( g_{cd}^f \) holds.

**Theorem 2** Suppose that \( V^b_{eo} = 0 \) and \( V^b_{wc} = 0 \), and the initial desired relative position \( p_{cd}(0) \) satisfies \( p_{cd}(0) \in \mathcal{D} \). Then, the desired relative position \( p_{cd}(t) \) ensures that \( p_{cd}(t) \in \mathcal{D} \) and the desired relative pose \( g_{cd}(t) \) has the asymptotically stable equilibrium point \( g_{cd}^f \).

Theorem 2 guarantees the convergence of the time-varying desired pose \( g_{cd}(t) \) to the final one \( g_{cd}^f \). The path planner can be designed to keep collision-free based on the obstacle avoidance navigation function \( \phi(p_{cd}) \). Our proposed approach, which deals with the estimation problem from the visual features explicitly, can be applied to 3-D eye-in-hand visual feedback systems without restriction to the ground vehicle. Thus, the proposed method which is connected the visual motion observer-based pose control and the obstacle avoidance navigation function-based path planner without additional sensors allows us to extend technological application area.

Finally, we present simulation results and actual nonlinear experimental results using an aerial vehicle in order to verify the control performance of the proposed control scheme with obstacle avoidance.
State Feedback Control using Particle Filter

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Keywords: state estimation, particle filter, Kalman filter, observer, state feedback control system

Although the KF (Kalman filters) has been widely used on the conventional regulator-observer systems, the application of it is limited to linear system models and Gaussian noise. On the other hand, since the particle filter is able to apply to non-Gaussian and nonlinear system models, it is capable of wide application than the Kalman filters. In this paper, we describe a construction method of a state feedback control system using the particle filter as an observer for a probabilistic state estimation. In order to be robust to non-Gaussian noise, maximum a posteriori probability estimation extraction method and evaluation method of the effective sample size have been incorporated in the particle filter as shown in Fig. 1. Then, effectiveness of the constructed system is verified experimentally, and the effectiveness of the state observer constructed by the particle filter is indicated by comparison with the Kalman filter.

Fig. 1. A state feedback control system including the particle filter state observer.
Lane Marks Detection Using Particle Filter Based on Voting Results of Hough Transform

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Keywords : lane marks detection, Hough transform, particle filter

This paper describes an algorithm to detect lane marks on a road very fast by means of the Hough transform and the particle filter methods. The algorithm detects candidate lines from input images via the Hough transform, and recognizes left and right lane marks by using the particle filter based on the Hough transform results.

In general, the Hough transform extracts any target pattern such as lines or circles included in a noisy image by a voting procedure in a parameter space. The procedure is applied only to the pixels where feature points of the target pattern are around in the image, which can reduce the processing time for pattern extraction. But the processing time will increase rapidly in dealing with complicated patterns because the parameter space will be high-dimensional.

On the other hand, the particle filter, categorized as Markov chain Monte Carlo method, can reduce the processing time by analyzing the detection results of the previous frames and verifying the parameter spaces. In the original particle filter method, the verifying process is applied to both feature and non-feature points, and we thought that it should have room for the improvement of the processing time.

Our proposed method is composed of two parts, the voting part based on the Hough transform as a bottom-up process and the parameter estimation part using the particle filter as a top-down process. In the bottom-up process, the method extracts candidate lines by voting procedure for each lane marks features. In the top-down process, the method verifies the lane model hypotheses using the voting result of lines extraction. The bottom-up process can be executed fast because the parameter space in extracting lines is low-dimensional, and the top-down process becomes more efficient by using the detection results of primitive shapes.

The processing time of the proposed method is 0.06 ms (Intel Core i7 3.2 GHz). The algorithm is about 1200 times faster than the Hough transform and 60 times faster than the particle filter method.

Fig. 1. Proposed method

Fig. 2. Detection results
A New Method for Elevator Group Control System with Advanced Information

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Keywords: elevator group control system, RFID, optimization

1. Introduction
This paper gives a novel method for elevator group control system with advanced information of passengers riding time and their destinations. Recently, untouched sensing technologies have developed, for example, visual sensing with cameras, RFID, and so on. We make clear a problem of relations between transportation capacity and division of passenger groups, and propose the method to solve the problem by applying new values for selecting rules and a value function for decision of an assigned car.

2. The Proposed Method
In elevator group control with advanced information, unless passengers are divided into adequate groups, transportation capacity would reduce. So, we adopt predicted door open time $t_w$ and interval of passenger boarding time $t_{int}$ for optimization of the division.

In first, the method selects candidate cars to be assigned. $tw$ and $tint$ of each car $n$ arriving at floor $i$, where a passenger will board, is calculated. Conditions to decide candidate cars $M_A$ are given by

\[
(\{tw \leq TW0\} \text{ and } \{tint \leq TINT0\}) \text{ or } (\{tw \leq TW1\} \text{ and } \{tint \leq TINT1\})
\]

where $TW0$, $TW1$, $TINT0$, $TINT1$ are constant.

Next, the method decides an assigned car $C$ in candidate cars $M_A$. In case that $M_A$ includes cars whose stop floors are equal to or lower than a limit value $S$, car $C$ is given by what minimizes a value function $V(n)$. If $M_A$ doesn’t include such car, the limit value $S$ is added 1 to, and the procedures are repeated until car $C$ is decided.

\[
V(n) = \sum_{i_c \in M_A} (T_c(L_{ni}))^2
\]

\[
C = \arg \min_{n} V(n)
\]

where $L_{ni}$ and $T_{ni}$ are each hall call and a set of hall calls of car $n$, and $Ta(L_{ni})$ is each waiting time value of $L_{ni}$.

3. Simulation Experiment
In order to evaluate the proposed method, we compare it to conventional method and system by simulation. Table 1. shows simulation conditions of type A1, A2 and A3.

![Fig. 1. Total Journey Time in Up Traffic.](image1)

Fig. 1. Total Journey Time in Up Traffic.

![Fig. 2. Total Journey Time in Variation of Distances.](image2)

Fig. 2. Total Journey Time in Variation of Distances.

and A3 in variation of distances between sensing position and hall. In the result of Fig. 2, the proposed method is robust to variation of distances.

4. Conclusion
In this paper, we developed the method for elevator group control system using advanced information. The results of simulation experiment show that the proposed method can reduce total journey time and is robust to installation environment, compared to conventional method. So that, our method will be effective elevator group control system integrated with human sensing devices.
Basic Properties of Two-Dimensional Composite Dynamical System with Spike Noise

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Keywords: composite dynamical system, spike noise, Poincaré map, period-doubling bifurcation, border-collision bifurcation

It has been reported that the unavoidable non-ideal switching action, e.g., the spike noise or the time delay, occurs via the switching action and seriously affects a behavior of the waveform in the composite dynamical systems operating in high-frequency switching ranges. We have analyzed basic property of a simple 1-dimensional composite dynamical system with non-ideal switching action for essentially understanding dynamical effect of the non-ideal switching action. In the engineering field, however, there are many two- or more dimensional systems. Of course, the non-ideal switching can occur in two- or more dimensional systems. But, no paper analyzes effect of the non-ideal switching action in it. In this paper, we study basic property of the 2-dimensional composite dynamical system with spike noise.

We consider the buck-boost converter, under current-mode control, as an example of the two-dimensional composite dynamical system. The circuit equation is transformed using the dimensionless variables:

\[ y = \sqrt{L_i}, \quad z = \sqrt{C_v}, \quad y_k = \sqrt{L_k}, \quad \tau = t/\sqrt{L C}, \]

\[ T' = T/\sqrt{L C}, \quad \sigma = \sqrt{L/C/(2R)}, \quad B = \sqrt{C E}. \]

Figure 1 shows the behavior of the waveforms in the system with spike noise. Here, we assume that the waveforms start with the initial values \( y_k \) and \( z_k \) at \( \tau = kT \). The state changes from 1 to 2 when the waveform \( y(\tau) \) hits the reference value \( y_r \). Then, the state returns to 1 when the clock pulse arrives. If a maximum size of the spike noise \( h \) is bigger than the reference value \( y_r \), the state changes form 1 to 2 immediately, and then it keeps state-2 until the next clock pulse arrives. We sampled the waveforms at every period of \( T \) for defining the Poincaré map.

Figure 2 shows the 2-parameter bifurcation diagrams in the system with ideal switching and the system with spike noise. The numbers denote the existence region of the period-\( m \) waveform. The shaded region is the existence region of over period-4 waveform including chaotic attractor. The solid and dotted lines denote the bifurcation curve of the period doubling bifurcation and the border-collision bifurcation. It is evident that the occurrence of spike noise makes the bifurcation structure complicated. Figure 3 shows the waveforms of the system with ideal switching and the system with spike noise, respectively. We observe a new type of the waveforms whose state keeps 2 during the clock interval (see the gray areas in Fig. 3). This type of the waveforms is never seen in the system with ideal switching. We conclude that spike noise makes a new type of the waveforms, and affects the system dynamics.

Fig. 1. Behavior of the waveforms in the system with spike noise.

Fig. 2. 2-parameter bifurcation diagrams ((\( \sigma = 0.28, y_r = 0.1 \)).

Fig. 3. Examples of the waveforms ((\( B = 0.098, \sigma = 0.28, y_r = 0.1, T = 0.9 \)).
An Anomaly Detection Method for Individual Service on Web-based System by Selection of Dummy Variables in Multiple Regression

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Keywords: Anomaly Detection, Multiple Regression Analysis, Correlation Coefficient, Dummy Variable

1. Introduction
On web-based systems, an anomaly like increase or decrease of resource usage may occur on a service due to the cause such as bugs in the system. The anomaly is detected by comparing the real resource usage of each service to “design reference value” which is resource usage estimated for each service by system developers. The total resource usage and the number of accesses to each service can be observed in the web-based system, but the resource usage of each service cannot be observed. This problem causes us impossible to identify which services are anomalies by comparing to design reference values. We propose a method of detecting anomaly for individual service based on the total resource usage and the number of accesses to each service.

2. Anomaly Detection for Individual Service
Because the total resource usage is a linear combination of the number of accesses to each service, multiple regression analysis is applied to estimate the resource usage of each service as shown in the following equation:

\[ y(t) = a_0 + \sum_{i=1}^{n} a_i(t)x_i(t) \]

where \( y(t) \) is the total resource usage of the web-based system that has \( n \) services and \( x_i(t) \) is the number of the access to service \( i \). A coefficient \( a_i(t) \) is considered as resource usage per one access of each service. Fig. 1 shows the outline of the proposed method.

The basic approach is to detect anomalies when the resource usage per one access of each service is not between the thresholds estimated from design reference values. Due to the unstable resource usage, it is difficult to identify anomaly services by the thresholds. This research focuses on that an anomaly causes the accuracy of the regression to be wrong, which decreases multiple correlation coefficient “R”. When R value becomes not as high as one estimated from design reference value, the proposed method identifies that anomalies occur at that time (anomaly time).

The proposed method identifies anomaly services by judging whether R value is increased or not in setting the number of accesses to dummy variables. Firstly, the proposed method selects a dummy variable of each service and adds to the regression for calculating R value. A dummy variable is set to 0 before the anomaly time and set to anomaly service's number of accesses after anomaly time. Because correct selection of the anomaly services leads R value to the maximum, the proposed method chooses a service to maximize R value. After the step, the proposed method repeats selecting a dummy variable of each service except the chosen service in the previous step. If R value is increased, the proposed method continues to choose a service to maximize R value for a dummy variable. The proposed method repeats the previous step until R values are not increased anymore. The selected services are identified as anomaly services.

3. Evaluation
We performed an experiment with a server of CPU: Intel Xeon 5620 (2.40 GHz, 4 cores), Memory: 16 GB, OS: Windows 7. The number of accesses was generated by the Poisson distribution and the resource usage was generated by the normal distribution. We manipulate anomalies of the resource usage of each service increased by 1.5 times. Although false alarms occur on 7 services by the method with thresholds, there are no false alarms by the proposed method. Fig. 2 shows precision rate and recall rate. The precision rate and the recall rate are increased by 28% and 26% on average, respectively. Furthermore, the proposed method successfully detected anomaly services within one second.
1. Introduction
Currently, the Support system of watch over children has been developed based on the child’s position information for child safety. In Japan, we have watch over children systems which are provided by NTT, KDDI and other security service companies. However, these systems only send a simple mail with position information and map view. For example, this simple mail frequency send to parent when a child enter to school and exit from school. It will make parent to uneasy by frequent mail transfer.

So, we propose the system which is called “Sotto”. The Sotto uses knowledge to watch over for children on school comity roads and regional information. The Sotto presents context rich information to parents. For example, in traditional system, the child walking around a bookstore to buy the book, parents only know the position of child. As a result, parents become anxious. In Sotto, when child swing by the bookstore, Sotto estimate the reason about the child swing by the bookstore. Therefore, parents will be relieved.

2. Destination Estimation Method using Regional Information
The purpose of this research is a sophisticated technique to estimate the child’s destination. Therefore, propose a method for estimating the destination used “history of movement”, “history of visited premises” and “history of participated event”. In this method, using regional information, therefore, the facilities have never been visited previously, can be estimated as a destination.

2.1 Configuration of Sotto
The Sotto consists of three estimation destination modules: “destination estimation module based on history of movement”, “destination estimation module based on history of visited premises” and “destination estimation module based on history of participated events”. And the three modules will operate in parallel.

First, the Sotto uses regional information and children’s movement history, to extract premises and events. Next, the Sotto estimate the three modules in each destination using that information. In addition, each module can trade each result for advanced these modules. Specifically, the children’s position history information and map data are used for the extraction of the movement history, visited the premises history and participated in the event history. Next, each history group for each day.

The movement history represents a tree structure. The node of the tree is used for the main point on the map: “crossover point”, “road” and “premises”. The visited the premises history and the participated in the event history represent a list include number of premises visits and number of event participants. When estimating the destination, the module to scan the list and tree corresponding to the estimated day. The child has passed the point is to tighten the criteria for scanning. This process improves the accuracy of the estimates.

2.2 Destination estimation module based on history of movement
This module estimates destination used children’s movement history. Tree generation process create the tree. This tree generation process can be represented movement history in a tree. And the destination can be estimated from this tree. This process is estimated as the destination most visited places in the past from the current position.

2.3 Destination estimation module based on history of visited premises
This module estimates destination used children’s visited the premises history. In this process, to extract the number of visits and the type of premises visited in the past from the movement history information. Type of premises is that bookstore, park, libraries and the others. This module is used the type of premises in order to extract the children’s favorite premises.

2.4 Destination estimation module based on history of participated events
This module estimates destination used children’s participated in the event history. In this process, to extract the number of participated in the event, the type of event and the type of premises from the movement history information. Type of event is that book sale, festival and the others.

2.5 Experimental Prototype System
Implement the proposed system and evaluated. Children’s behavioral patterns and movement history generate and simulated. Fig. 1 shows the experimental results.

3. Conclusion
In this paper, we propose the Sotto. The Sotto uses knowledge to watch over for children on school comity roads and regional information. The Sotto presents context rich information to parents. We design and implement a prototype system of the Sotto. Through the experiment using the prototype system, we confirm that the Sotto can provide the support of watch over children.
Study on the Application of the Privacy Impact Assessment in the Smart City

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Keywords: Personal information protection law, Smart Grid, Privacy, Privacy Impact Assessment, Risk management

Currently, the various views that aims to take advantage of the IT innovation in lifestyle and effective use of energy. Smart City project is being promoted in various countries around the world. For Smart City project specific, argue specifically the privacy risk is too early for this.

Therefore, This Paper discuss the privacy risks of a core technology of Smart City in the smart grid standardization progresses (Fig. 1). in the smart grid standardization progresses (Fig. 1).

Security and privacy issues have become an important theme in order to achieve the system in smart grid. In other words, the social infrastructure equipment to operate and integrate the information network and power system control equipment ranging from power generation to transmission and distribution pose a security risk information such as cyber attacks.

For example, the takeover of the control system by control information false, may lead to a serious situation for the maintenance of life offensive line and stop denial of service DDoS attack (Distributed Denial of Service).

It has also been pointed out as a major issue of concern infringement privacy outflow of personal information, such as consumer power usage through smart meters. Smart meters can monitor energy usage of each household throughout the living environment - that equipment such as is provided, the risk of living information of individuals is discharged on the network exists. Conventional relates to privacy, these problems are a risk that a new problem occurs (Fig. 2).

And the concept of privacy by design, in this paper, we introduce the effectiveness of the (Privacy Impact Assessment) Assessment privacy is an evaluation technique powerful that as a method of time as well to organize the concept of privacy in the smart grid, consider the privacy issues to.

Smart City project has been promoted by several standpoints. Discuss the privacy risks that a bird’s eye view Smart City is premature at this time, I described the privacy risks of smart grid development countries is a challenge common to concrete progress.

Concretely, we describe the effectiveness of the privacy impact assessment methods and critical thinking measures of privacy by design, privacy in the fight against deliberate.

Privacy impact assessment in that smart grid has been limited to the implementation of the United States and Canada, is effective policy measures Identification of privacy and basic risk of the system, the decision-making have been reported. In the report, I have also pointed out that there is a danger produce new problems that are beyond the range that has been discussed in relation to the traditional privacy.

In Japan, it is necessary to proceed as soon as possible to improve the environment for implementing the PIA, Smart City project carried out.

For this purpose, Implementation of objective evaluation to clarify the effects of

1. A development of the measurement method.
   Need a mechanism for the suppression of the implementation costs
2. Example of an automated evaluation method.
   Implementation of the necessary maintenance of the environment
3. For example, the development of handbooks and guidelines to clarify the procedures and implementation system.