# Evaluation of Human Sitting-up Detection System using Electromagnetic Noise from Power-supply Line

Yuki Wakasa, Yuri Tanai, Koichi Shin, and Masahiro Nishi
Graduate School of Information Sciences, Hiroshima City University,
3-4-1, Ozuka-Higashi, Asa-Minami-ku, Hiroshima, Japan
wakasa@wave.info.hiroshima-cu.ac.jp

***Abstract* – Recently, there has been a growing need to detect human siting-up actions in a care home for the elderly. We have proposed the contact sensor system which detects human sitting-up actions using electromagnetic noises from power-supply lines. In this study, the authors compared the contact sensor system with the other sitting-up detection ones using force pressure sensor and using the TV broadcasting wave based on the measurement at the care home. And we have evaluated characteristics of the proposed system using contact sensors with various shapes of conductors.**

***Index Terms* — Electromagnetic noise, Power-supply line, Contact detection.**

## 1. Introduction

Recently, there has been a growing need to detect human sitting-up actions in a care home for the elderly. The system called "call mat" putting on the floor has been generally used for detecting sitting-up actions from a bed. However, this system has a risk that the elderly trip up due to uneven floors caused by the call mat before the carer flies to the elderly getting oneself up from the bed. In this study, the authors focused on a handrail used for supporting the sitting-up on the bed, and newly proposed hand-to-handrail contact detection system using electromagnetic noises from power-supply lines. In this study, the authors compared the contact sensor system with the other sitting-up detection ones using force pressure sensor system and using the TV broadcasting wave system based on the measurement at the care home. Further, we evaluated characteristics of the proposed system using various shapes of conductor.

## 2. Human siting-up detection system

Fig. 1 depicts the concept of our proposed human sitting-up detection system. In the handrail on the bed, which is a conductors the electrical voltage arises from the power-supply lines as an electromagnetic noises [1]. The electrical voltage in the handrail fluctuates according to human contact. This system can detect sitting-up actions by monitoring the fluctuation of electrical voltage between human body and the ground earth caused by the hand-to-handrail contact. This system can place wherever power wire is laid because this system uses electromagnetic noises from the power-supply line. And the elderly is not strained because this system can work on only measuring the electrical voltage.

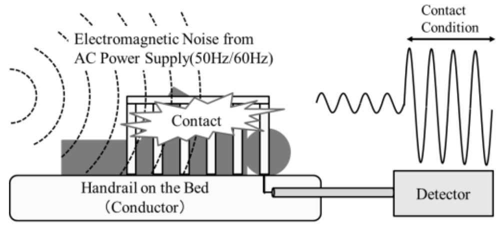


Fig. 1 Concept of human sitting-up detection system

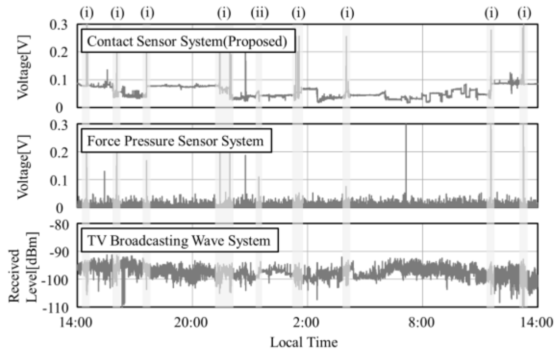


Fig. 2 Measurement results on comparison experiments

## 3. Comparison experiment of detection capability

In this study, we compared the proposed system with other sitting-up action detection systems using the force pressure sensor and using the TV broadcasting wave.

We used a force pressure sensor FSR-402 in which the register is changed according to the pressure [2]. Sitting-up actions can be detected by the sensor placed at shore of handrail on the bed because pressure arises on the handrail.

In the sitting-up detection system using TV broadcasting wave, the sitting-up actions can be detected by fluctuations of indoor multipath environment [3].

Fig. 2 shows measurement results on comparison experiments conducted in the care home for 24 hours. In this figure, (i) are fluctuations at sitting-up action, (ii) are fluctuations at roll-over action. Other large fluctuations are caused by human movement in the room and hand-to-handrail contacts at indoor human other actions.

In the proposed system, electrical voltages fluctuated only at sitting-up actions and didn't fluctuate at roll-over actions. When not the skin but the sleeve contacted the handrail, electrical voltages didn't fluctuate. The proposed system didn't react against creaks of the bed, thus misdetections didn't arise.

In the detection system using the force pressure sensor, the electrical voltage fluctuated at not only sitting-up actions and but also roll-over actions. Because the force pressure sensor reacted against creaks of the bed, it was difficult to differentiate between these two actions, and it was possible to make misdetections.

In the detection system using the TV broadcasting wave, the received levels fluctuated at sitting-up actions and roll-over actions, but it is difficult to differentiate other actions, such as human movement around the bed.

As a result, proposed system can detect sitting-up actions with the highest accuracy of the three systems.

## 4. Units

In this study, the authors evaluated characteristic of the proposed system using the electromagnetic noises. Fig. 3 illustrates experimental configuration for characteristic evaluation. As a conductor, we utilized the stainless-steel of a stick, a board, a boll, and wires placed at the height of 0cm, 25cm, 50cm, and 75cm, and measured the electrical voltage at each of the situations. These heights were assumed for the ladder, the chair, and the desk. We chose the stainless-steel stick, board, and boll with a weight of 300g, and the stainless-steel wire with a length of 0.5m, 1m, and 2m.

Fig. 4 shows measurement results of the stainless-steel stick, board, and boll. In each of the shapes, this figure depicts the voltages measured under the four situations, non-contact, contact (wearing shoes), contact (barefoot), and contact (ungrounded). For the stick and the board, in the case of the height of 0cm, we measured almost same electrical voltages under contact and non-contact situations. In this case, it is difficult to find difference between contact and non-contact situations. However, in the case of the height of 25cm or more, we can clearly differentiate contact and non-contact situations, because the differences of electrical voltages are sufficiently large.

Fig. 5 shows measurement results of the stainless-steel wires. In each of the lengths, this figure depicts the voltages measured under the four situations, non-contact, contact (wearing shoes), contact (barefoot), contact (ungrounded). For the 2m wire, in the case of the height of 0cm, we measured almost same electrical voltages under contact and non-contact situations. In this case, it is difficult to find difference between contact and non-contact situations. However, in the case of the height of 25cm or more, we can clearly differentiate contact and non-contact situations, because the differences of electrical voltages are sufficiently large.

From the above results, we can confirm that there are differences of electrical voltages among contact (wearing shoes), contact (barefoot), and contact (ungrounded) cases, and we can find that the strength of electrical voltages is affected by the degree of coupling between human body and the earth ground.

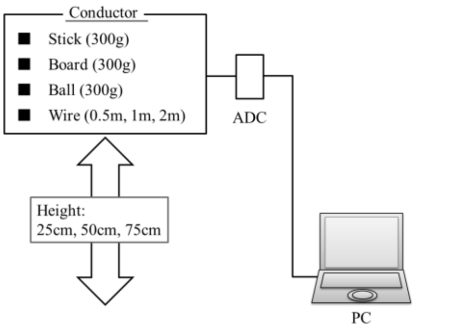

Fig. 3 Configuration for characteristic evaluation

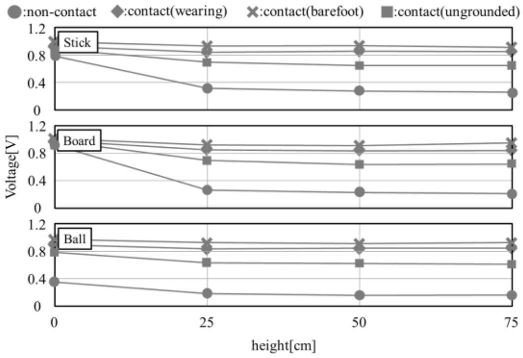

Fig. 4 Measurement results in each of shapes

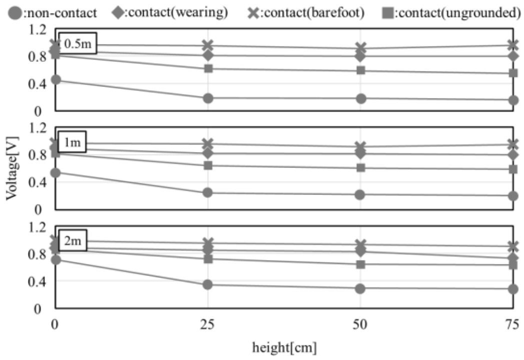

Fig. 5 Measurement results in each of lengths

## 5. Conclusion

In this study, the authors newly proposed the sitting-up detection system using electromagnetic noises and evaluated characteristic of the system based on the measurement at the care home. From the measurement results, it was found that the proposed system was able to detect sitting-up actions without misdetections and that it was possible to detect the contacts to the conductors with various shapes and lengths placed over the height of 25cm.

## References


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