Posture Detection Using Infrared Array Sensors

Shohei Waga
Department of Information
and Computer Sciences
Kanagawa Institute of Technology
Atsugi-shi Kanagawa 243-0292, JAPAN
Email: s1321149@cce.kanagawa-it.ac.jp

Naohiro Takahashi
Course of Information
and Computer Sciences
Graduate School of
Kanagawa Institute of Technology
Atsugi-shi Kanagawa 243-0292, JAPAN
Email: s1685025@cce.kanagawa-it.ac.jp

Shingo Otsuka
Department of Information
and Computer Sciences
Kanagawa Institute of Technology
Atsugi-shi Kanagawa 243-0292, JAPAN
Email: otsuka@ic.kanagawa-it.ac.jp

***Abstract*—The risk of lonely death is growing because the number of solitary old people is increasing in Japan. Hence, it has been proposed approach to watch the elderly from remote. For example, several systems for detecting an abnormality has been proposed using electricity and gas. But it is difficult to check the status of residents in real time using these systems. In contrast, there are methods of monitoring in the room using the camera. However it is difficult to introduce them by privacy issues. We propose a method to grasp the situation of the people using the infrared array sensor in order to watch while considering the privacy of the elderly. In this paper, we propose the method of estimating the state of the person using the temperature data of the infrared array sensor.**

I. Introduction

Aging of society has become a big problem in recent years in Japan. About 25 percent of the total population is greater than or equal to 65 years of age according to an investigation of the Cabinet Office. And increase of the elderly living alone is also a problem. The proportion of elderly people living alone to total elderly population is about 13% in 2010 and it is estimated to reach 20% in 2020 [1].

As a method for safety confirmation of the elderly to live apart, several systems for watch over the elderly have been proposed. These systems can be divided into two types. One is 'human monitoring solution' and the other is 'ICT solution'. The former is a method to confirm the safety by volunteers and postmen. The latter is a method of monitoring the status of the elderly people living alone in the house using ICT. For example, there are method of detecting the abnormality using the usage of electricity and the movement by the sensor [2]. However, these methods are difficult to collect information in real time. Moreover, there is a case to get the wrong information due to failure of the machine or operation mistake.

We propose a method to grasp the situation of the people using the infrared array sensor in order to watch while considering the privacy of the elderly. In this paper, we propose the method of estimating the state of the person using the temperature data of the infrared array sensor and show the experimental results.

II. Apparatus

1) Single Board Computer: We use Raspberry Pi as a single board computer in this study. It is the single board computer developed in the United Kingdom. A single board computer is the one equipped with the necessary function in one substrate. We use Raspberry Pi Mod-el-B for using a network in this study.

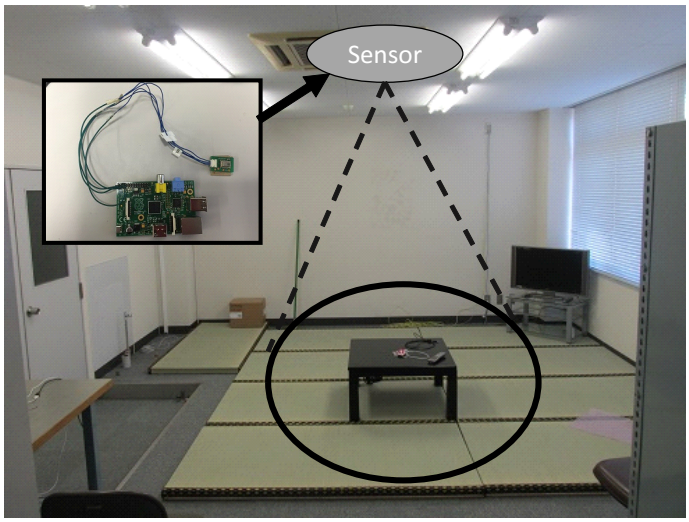

Fig. 1. Installation of the infrared array sensor.

2) Infrared Array Sensor: Infrared ray sensor is the sensor which receives the infrared rays issued from an object. This sensor can measure the temperature without touching a target. We use Grid-EYE which is very small sensor in this study [3]. This sensor can measure two-dimensional area temperature by 64 picture elements of 8*8 and the digital output of I2C is also possible. A view angle is 60-degree and the measurement range is five meters.

A. Experimentation Environment

We construct 'Watching room for elderly' to make the experiments. It is 3.7 meters in width and 3.8 meters in length. Since assuming the living room of general household in Japan, we lay 'tatami mat' on the floor and put the table in center of the room. And we fix the infrared array sensor to the ceiling. The data acquisition range of the infrared array sensor is 230 centimeter because ceiling height is 230 centimeter. A portion surrounded by a circle in Figure 1 is valid range. There is no

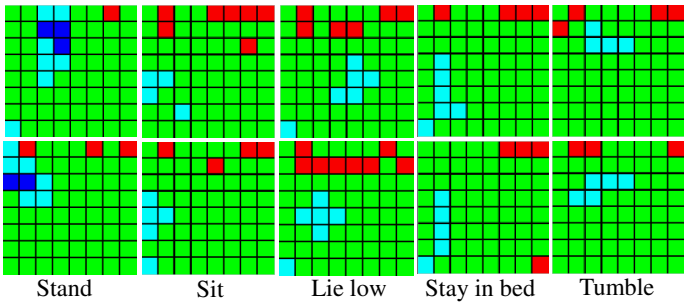

Fig. 2. Posture acquired from the infrared array sensor.

problem about the sensor detection in this experiment because the maximum detection distance of the sensor is five meters.

III. Experimental Result

We use 'Deep Learning' for estimating the five postures such as 'Stand', 'Sit', 'Lie low', 'Stay in bed' and 'Tumble'. The subject performs operations such as 'Stand', 'Sit', 'Tumble' in the experiment room. At the same time we record the temperature information acquired from the infrared array sensor. We get the temperature information of the 153 patterns for the above five posture. The examples of temperature information acquired from the infrared array sensor shown in Figure 2. The color of each square represents a temperature. The blue color is low temperature and the red color is high temperature.

We regard these temperature information as images and create the classifier by deep learning using the postures (such as sit, stand, etc.) at that time. We use 100 images (20 images per posture) for the training data and the remaining 53 images for test data in order to determine the posture. We prepare 'stand postures are 7 images', 'sit postures are 23 images', 'lie low postures are 11 images', 'stay in bed postures are 3 images' and 'tumble postures are 9 images'. We perform learning with the fine tuning because the number of training data is insufficient. And data model used in this experiment is GoogLeNet model.

A. Accuracy of posture determination

First, we show determination accuracy for all postures in Figure 3. The horizontal axis in the graph shows learning number of times and the vertical axis shows the average accuracy rate of 53 test data (images). We show three results in this experiment because googlenet model has three output layers. The softmax0 is a learning result if the hierarchy is shallow and the softmax2 is a learning result if the hierarchy is deep. An accuracy rate of softmax2 is well and it is possible to obtain about 80% of accuracy rate although accuracy rate is different depending on the output layer. And it can be seen that the influence of over-learning in Figure 3.

Next, we show determination accuracy for tumble postures in Figure 4. The horizontal axis in the graph shows learning number of times and the vertical axis shows the average

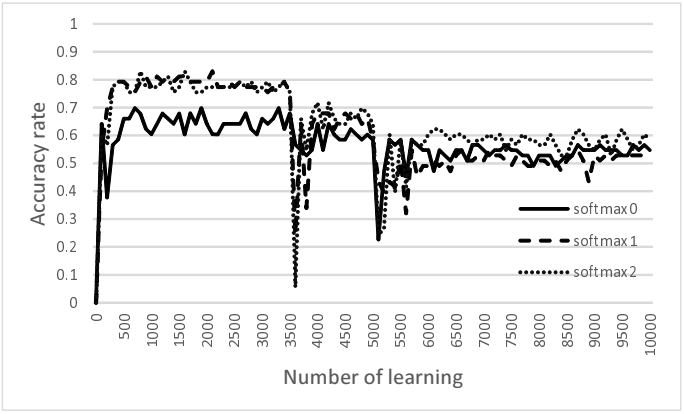

Fig. 3. Average accuracy rate for all postures.

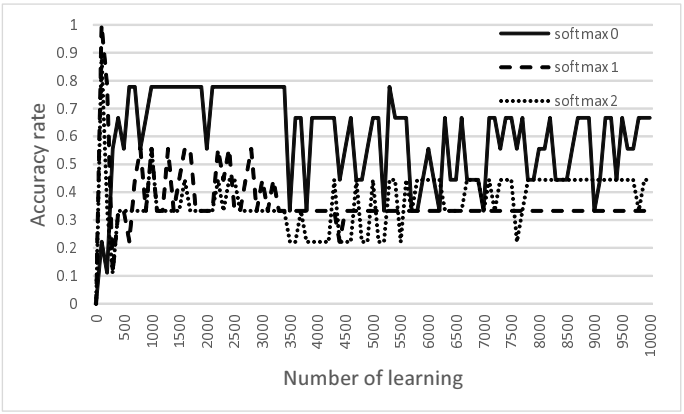

Fig. 4. Average accuracy rate for tumble postures.

accuracy rate of 9 test data (tumble images). An accuracy rate of the softmax0 is well and it is possible to obtain about 80% of accuracy rate in this instance. And variation occurs in the accuracy rate by the output layer.

IV. Conclusion

In this paper, we propose a method to grasp the situation of the people using the infrared array sensor in order to watch while considering the privacy of the elderly. And we show the results that accuracy rate of the posture determination is about 80%. In the future, we discuss accuracy improvement.

References

[1] Ministry of Health, Labour and Welfare, "Annual Health, Labour and Welfare Report", http://www.mhlw.go.jp/english/wp/wp-hw9/dl/summary.pdf, 2015.
[2] Shigeki Aoki and Masaki Onishi and Atsuhiro Kojima and Kunio Fukunaga, Detection of a Solitude Senior's Irregular States Based on Learning and Recognizing of Behavioral Patterns, IEEJ Transactions on Sensors and Micromachines, Vol.125, No.6, pp.259-265,2005.
[3] Panasonic, Infrared Array Sensor Grid-EYE, https://industrial.panasonic.com/ww/products/sensors/built-in-sensors/grid-eye