プロジェクト名：　人間ー環境系における人間の感覚予測のための
次世代センサーネットワーク技術に関する研究

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1. Abstract

This study addresses a method for using many unspecified sensors on a sensor netowork, including information about unspecified sensors available on the internet to obtain useful information at a given time and place. Here, we describe a method for predicting the behavior of a system involving the thermal sensation of human subjects by using unspecified sensors organized into a certain sensor network. However, the problem dealt with here is not confined to the formation of a sensor network from many sensor nodes, but extends to the problem of how each node discovers and uses only the effective sensors out of a vast quantity of sensors.

In this study, we utilize a dynamically changing neural network for predicting the system behavior. As an example case, the thermal sensation of the subjects is predicted by using unspecified temperature sensors, humidity sensors, and global temperature sensors. We place a large number of sensors and subjects in an indoor environment, and conduct an experiment where the sensor readings and the thermal sensation of the subjects are associated. Finally, the experimental results are shown, where unspecified sensors are chosen properly and used for predicting the desired value.

2. Acquisition of human's thermal sensation

In this paper, the air-conditioning system in an office is used as an example, as shown in Fig. 1. In this system, 21 temperature sensors are located indoors, where two sensors are located at the outlets of the two air-conditioners, and the remaining sensors are located above the desks of the occupants. The sensors are self-organized in a dynamical manner by peer-to-peer connections using our original software running on the PCs. The connection is unstable, and its state changes frequently.

In order to acquire the level of thermal sensation of the subjects, we implement specific software which the occupants use to express the level of their thermal sensation. The software simultaneously acquires the values of the sensors and the level of thermal sensation of the subjects. Every 15 minutes, the software uses a dialog box to inquire about the occupant's level of thermal sensation and thermal comfort as well as any request for a change in the temperature.

3. Predicting the thermal sensation

In order to predict the behavior of the system, we used a self-organized neural network (Fig.2). Here, the behavior corresponded to the thermal sensation of the occupants. The neural network was dynamically organized on the basis of correlations with the thermal sensation of the occupants and many other values in the sensor network, and the structure of the neural network was updated cyclically. Also, when it became impossible to use a certain part of the information which is present in the sensor network, the structure of the neural network was updated.

Figure 3 shows three indoor temperature changes and the thermal sensation of three occupants. The part is selected from the data measured over two weeks, where the figure represents the temperature changes over the span of about 3.5 days. In this case, the changes in the temperature show the same tendency. However, the respective thermal sensations obtained from three occupants show tendencies which are completely different from the tendencies of other occupants. As these fluctuations originate from individual differences, these values are not easily

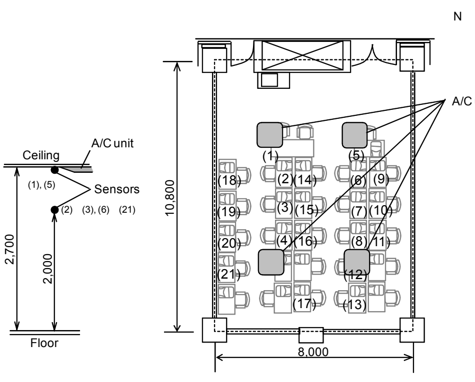

Fig. 1 Experimental environment

acquirable with a sensor.

We assume that particular values correspond to particular situations. A value can be estimated by using sensor values which have a strong correlation with the target value. Generally, the present value is estimated from the present state and the past state. A simple method in this respect is the method of calculating the correlation coefficient for every section by dividing it by the time. According to the correlation coefficient, we can select some parts of measurement values which are used for teaching neural network.

4. Experiment

The experiment is conducted in the environment above mentioned. Using our software, 20 subjects notify the network of the level of their thermal comfort, their thermal sensation, and their request with respect to temperature every 15 minutes. The experiment is conducted continuously over two weeks.

The software calculates the correlation coefficients, constructs a dynamical neural network, and trains the neural network in the background. Using the constructed neural network, it is possible to predict the thermal sensation. Figure 4 shows the experimental results. In the upper figure, the solid line expresses the report of a single occupant, where the circles represent the prediction of thermal sensation. The lower figure shows a plot of several indoor temperature changes. The sensation as reported by the subject and the predicted thermal sensation are in good agreement.

5. References

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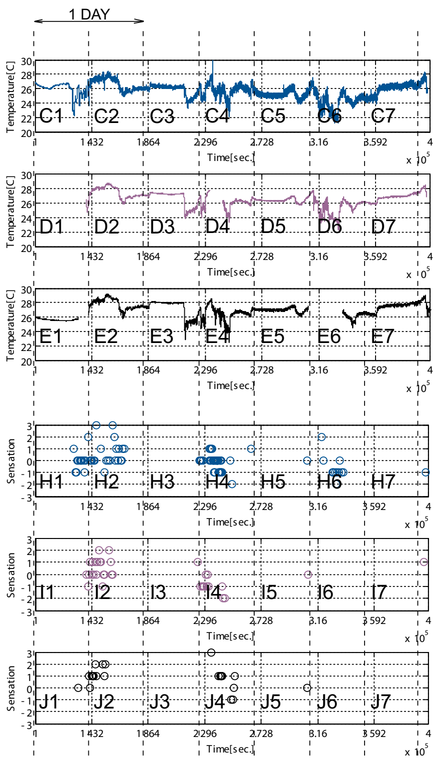

Fig. 3 Indoor temperature and level of thermal comfort

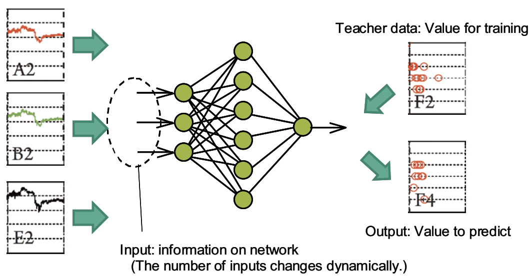

Fig. 2 A dynamically changing neural network

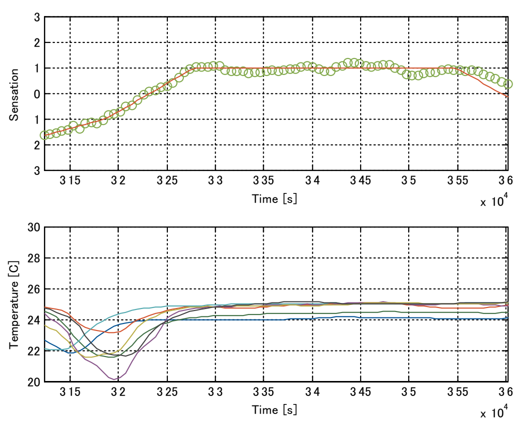

Fig. 4 Experimental result