Realizing robust and secure IoT services with microservices

Miyagoshi Kazuki[1], Shimojo Shinji[2]
1:Graduate School of Information Science and Technology, Osaka-University 2:Cybermedia Center, Osaka-University

Introduction

In recent years, in our country, where energy resources are precious, the need and importance of effective use of electricity have been increasing. In addition, there is an increasing need and importance not only for energy saving but also for power saving to control maximum demand. Air conditioners (AC), which account for a large portion of the total energy saving of home appliances, are one of the most promising devices for achieving energy saving.

On the other hand, in recent years, smart homes get attention, and IoT devices such as cameras and temperature sensors, which are capable of retrieving data from the Internet are rapidly spreading toward smart homes. From these sensors, it is possible to grasp the distribution of people in a room or a building, and minute changes in movement and temperature. Through the collection and analysis of data from these IoT devices, attempts are being made to improve the operational efficiency and functionality of ACs and to reduce energy consumption and improve comfort[1].

AC Control

In this research, we will collect and analyze data from IoT devices in real time, and develop a platform for optimal control of ACs on Kubanetes as a mesh of microservices. The aim is to build a robust system that can cope with security and load imbalances. As an IoT device, multiple temperature sensors are installed in a room, and information such as temperature and outdoor temperature is collected in each place of the room. Based on the collected data, the optimum set temperature, air flow, and wind direction are instructed to the AC. By performing this control in real time, a comfortable space is always provided to the user.

The overall configuration is shown in Fig. 1. Temperature information from the temperature sensor is collected using fluentd and stored in the database using elasticsearch. Based on this information, the optimum set temperature for AC is analyzed, and the analysis results are fed back to a Nature Remo to control AC. As PoC, two types of AC control using sensors were realized as follows.

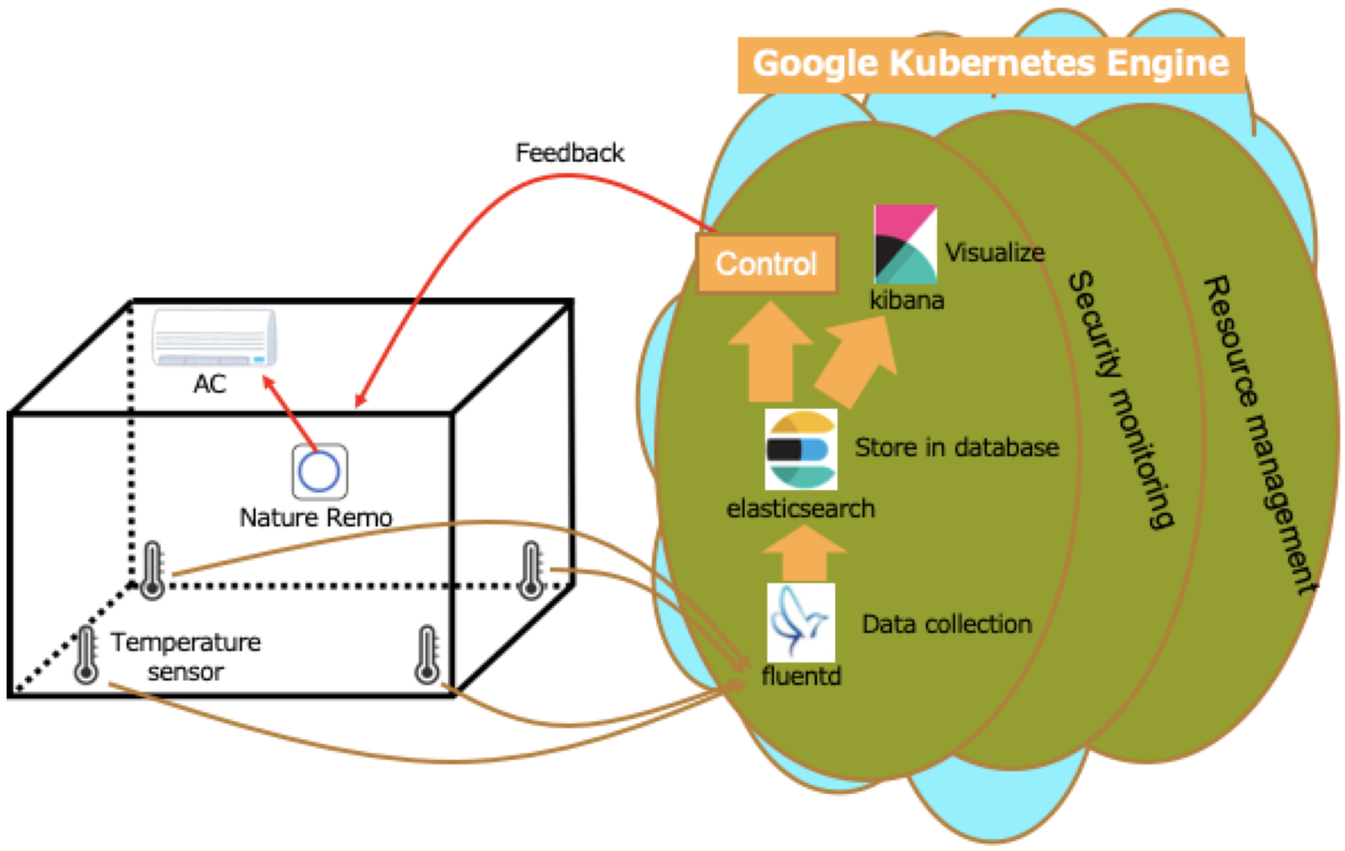


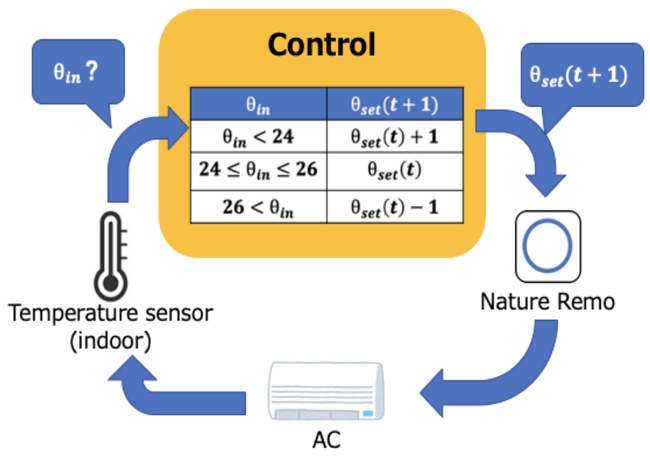
Fig1. Overall configuration of the microservice

Control 1

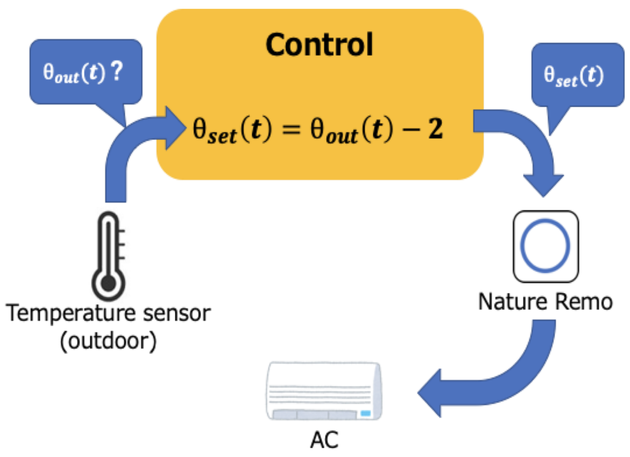
The control which maintains the temperature of the place where the human actually exists is considered. In the control of the AC itself, the temperature is controlled based on the values of the temperature sensor installed in the AC near the ceiling, so the temperature sensed by the AC differs from the temperature sensed near the human. Therefore, by controlling the AC in real time based on the value of the temperature sensor installed on the table, the temperature in the place where the person is is kept constant.

Control 2

Control to keep the difference between the value of the ambient temperature and that of the room temperature is considered. Room temperature varies with ambient temperature. Therefore, the difference between the outside air temperature and the room temperature is controlled so as to be constant at all times to improve the comfort.



Control 1. To maintain the temperature where there are people



Control 2. To maintain the difference between outside temperature and room temperature

Fig2. Two types of AC Controls

Evaluation

For evaluation, two temperature controls was performed every 10 minutes, and the values of the temperature sensor and the set temperature were recorded. Each control was performed over a one day period, and the temperature value in every 10 minutes was obtained from elasticsearch database. The blue line on the right graph indicates the temperature set to the AC, and the orange line indicates the value of the temperature sensor.

Evaluation of Control 1

A case where the room temperature was controlled to be around 25 ° C. was compared with a case where the temperature set to the AC was kept at 25 ° C without any control. In the case of no control, the room temperature dropped to 23 ° C on the average, but in the case of control 1, the room temperature was maintained at around 25 ° C.

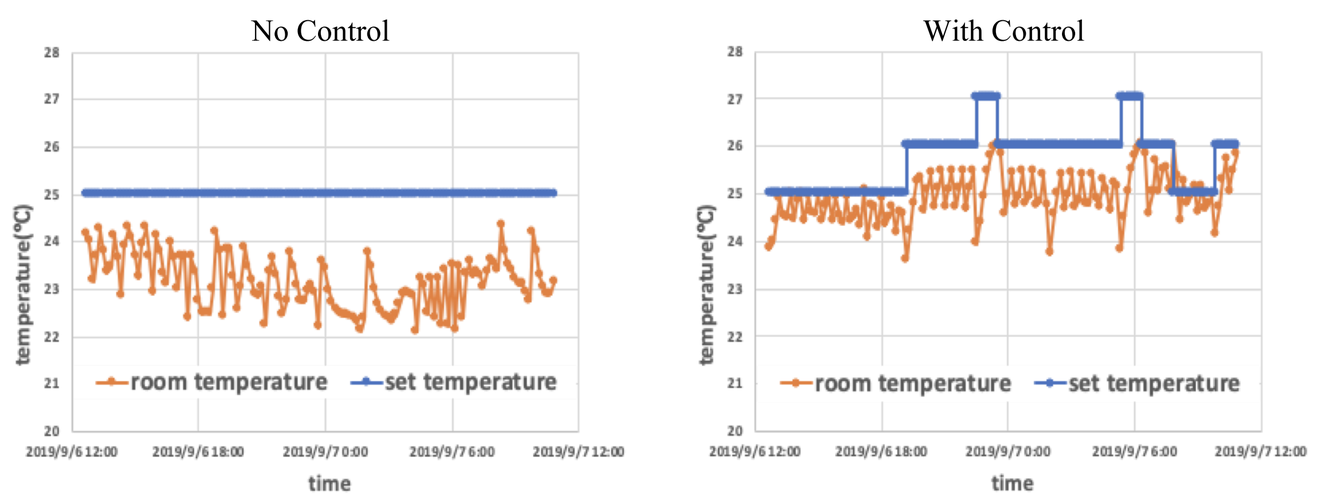


Fig3. Result of Evaluation of control 1

Evaluation of Control 2

The temperature set to the AC was controlled to change according to the outside air temperature. As the outside temperature was very high during the day, the upper limit temperature of the AC continued, but the difference between the outside temperature and the set temperature could be kept constant to some extent from evening to morning.

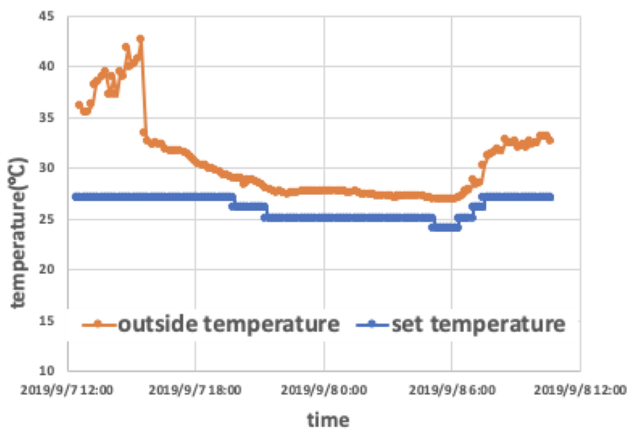


Fig4. Result of Evaluation of control 2

Reference

[1] M. Jain, “Energy Efficient Thermostats for Room Level Air Conditioning,” SmartObjects'18 in conjunction of CHI, pp.50–57, Apr. 2018.

Cybermedia Center
Osaka University

Contact: miyagoshi.kazuki@ais.cmc.osaka-u.ac.jp