Electricity Fingerprint Analysis Technology for Monitoring Power Consumption and Usage Situations of Multiple Devices by Using One Sensor

KOUMOTO Shigeru, TOIZUMI Takahiro, SANEYOSHI Eisuke

Abstract

With regard to energy management, a meticulously applied monitoring of the power consumption situations of the target electrical devices leads to promoting reduced and efficient use of energy, while at the same time comfort, convenience and productivity in life and work styles are maintained. This paper describes the electricity fingerprint technology developed by NEC that aims at the simple visualization of the power consumption of individual electrical devices. Also discussed are an actual case of application and the expected future deployment of appropriate services.

Keywords

electricity fingerprint, visualization of power consumption, HEMS, BEMS

1. Introduction

Energy management technology aimed at the efficient, waste-free utilization of electrical power is attracting attention as a suitable countermeasure for dealing with global warming and the rise of energy prices. R&D and practical implementation of this technology is currently becoming very active. In conducting energy management, a meticulously applied monitoring information of the power usage may acquire better understanding among users regarding saving power, which will lead to the efficient energy usage; for example, reducing the chance of use of devices with high power consumptions.

This paper describes the electricity fingerprint analysis technology developed by NEC as an effective means of visualizing the power consumption of each electrical device.

2. Features and Expected Effects of Electricity Fingerprint Analysis Technology

At present, the power consumption in houses and offices are identified mainly by visualizing the total value using "Smart Meters" or sensors on the power distributor. To identify the power consumption of an individual home appliance or OA device, it is necessary to install a power metering sensor on each appliance or device.

In contrast, the electricity fingerprint analysis technology can monitor the power consumptions of multiple devices by installing a single sensor on the power distributor.

Fig. 1 shows an outline of the electricity fingerprint analysis technology. With this technology, a current transformer (CT) is connected to the main power line on the power distributor and the waveform of the current flowing through the main power line (temporary current waveform of one cycle of the 50 or 60 Hz current). The current waveform in the main line at this time is one that synthesizes the current waveforms of all of the electrical appliances that are consuming current that are connected to the main line via circuit breakers.

The current waveform of each device has characteristic features depending on the device, as shown in **Fig. 2**. We call the current waveform inherent in each device the 'electricity fingerprint' by way of analogy to the human fingerprint.

The electricity fingerprint analysis technology esti-

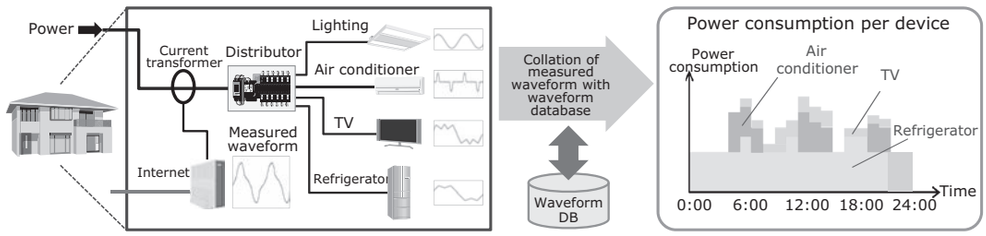

Fig. 1 Outline of the electricity fingerprint analysis technology.

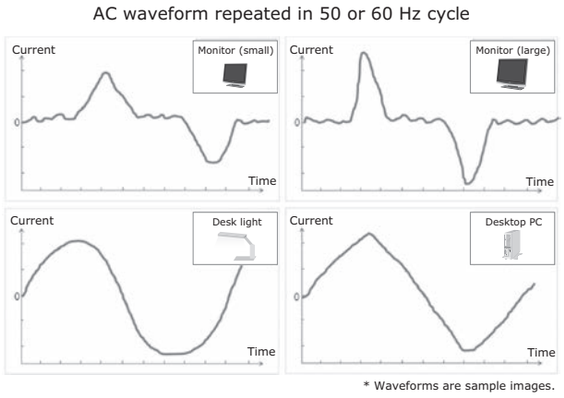

Fig. 2 Current waveform inherent in each device (Electricity fingerprint).

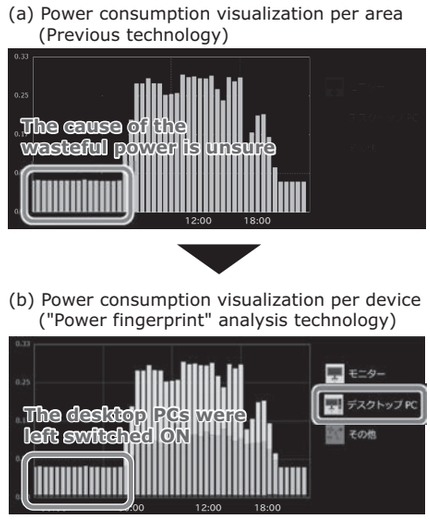

Fig. 3 An actual case of the application of energy-saving measures in the office.

mates the power consumption of each device by analyzing the synthesized current waveform measured on the main line with referring to the waveform database that stores the current waveform (electricity fingerprint) information of each device using the electricity fingerprint analysis engine.

At the present time, we have already confirmed under our experimental conditions that a single CT (current transformer) sensor is capable of estimating the power consumptions of 15 appliances running simultaneously. With the single-phase three-wire power system used in general houses, the power consumptions of 30 appliances can be estimated by installing a single sensor on each of the R- and T-phases. The CT sensors used here are not special items but products that are readily available commercially may be used.

The electricity fingerprint analysis technology makes it possible to understand the power consumption and usage situations of electrical devices meticulously using a simple method while greatly reducing the cost and labor of installing the sensors compared to the previously applied technology. The acquired information can be used as the basis of proposing specific power-reduction solutions and thereby promoting the improved energy-saving behavior of the power consumers.

3. Application to the Energy Management of an Office Building

This section introduces a case in which our electricity fingerprint analysis technology was applied as an energy-saving measure for an office building.

In this particular case, an electricity fingerprint analysis system was built on the office floor of Bldg. No. 9 of the NEC Tamagawa Plant. It covers desktop PCs, monitors and notebook PCs which are installed at more than a hundred desks and also office automation equipment such as multifunction printers. Since a single distributor is used in the office for a number of equipment, multiple CTs were installed on the distributor panel.

Fig. 3(a) shows the change over time of the total power consumption measured by the CTs in the office area, per day. Although the graph indicates that wasteful power is consumed at night when nobody is in attendance, the visualization of total power consumption

per area from this perspective cannot lead to an understanding of the cause, even if it helps in the discovery of waste.

Fig. 3(b) shows the breakdown per device of the power consumption values shown in Fig. 3(a), which is achieved by employing the electricity fingerprint analysis technology. The graphs made it clear that the nighttime power consumption was because the desktop PCs were left switched ON. Based on this result, we held a workplace campaign and promoted the switching OFF of the desktop PCs before leaving the office. This resulted in successfully reducing the power consumed in the office.

As is evident in this case, the electricity fingerprint analysis technology makes it possible to effectively implement specific power saving measures by defining the causes of wasteful electricity usage, such as by the turning off of non-essential equipment.

4. Service Deployment of the "Power Fingerprint" Analysis Technology

The electricity fingerprint analysis technology is expected to contribute to energy saving by providing a per-device power consumption monitoring service for houses, office buildings, shops and factories.

In addition, we expect to predict, plan and control the energy supply/demand by visualizing acquired information or by using those information as a big data to be subjected to further analysis. This will then become possible to provide energy management services that can promote more efficient energy usage.

Furthermore, the accumulation and analysis of time-series power consumption data per device may expand the visualization targets. It is expected to visualize human behavior information such as presence and absence, as well for quantifying specific working behaviors (**Fig. 4**).

Consequently, it will be possible to provide services that will contribute to the security and safety of living and to a health-longevity society; watching services and lifestyle advices for households and the residents of apartments. It is also expected that the working situation in offices is visualized and is used to develop a work-style management service, which may support or manage the job performance of employees and may improve their overall work efficiencies.

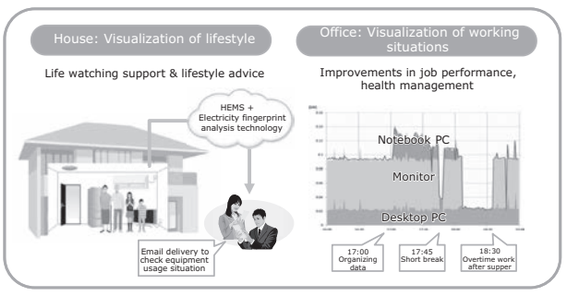

Fig. 4 Service deployment of electricity fingerprint analysis technology.

5. Conclusion

In the above, we presented the electricity fingerprint analysis technology that enables easily and meticulously applied monitoring of the power consumption and usage situations of electrical devices. The accumulation and analysis of the time-series power consumption data of each device is expected to visualize human behavior and business activity, and then to contribute to providing supportive human watching and improving work efficiency.

Authors' Profiles

KOUMOTO Shigeru
Principal Researcher
Smart Energy Research Laboratories

TOIZUMI Takahiro
Smart Energy Research Laboratories

SANEYOSHI Eisuke
Assistant Manager
Smart Energy Research Laboratories

Information about the NEC Technical Journal

Thank you for reading the paper.
If you are interested in the NEC Technical Journal, you can also read other papers on our website.

Link to NEC Technical Journal website

Japanese

English

Vol.10 No.1 Special Issue on NEC's Smart Energy Solutions Led by ICT
- Towards the Integration of ICT and Energy -

Vol.10 No.2
April 2016

Special Issue TOP