Performance Test of Non-Intrusive Electric Appliances Load Monitoring System Using Harmonic Pattern Recognition

Background

Information on what and how electric appliances are used in households is important to evaluate the effectiveness of DSM (Demand Side Management), estimate potential demand, predict demand change, analyze primary factors for deterioration of load factor, build a careful seasonal and time-of-use rates system, provide various services to the customers, and so on. Up to now, we had to install a measuring equipment or a measuring sensor to each appliance inside in order to grasp usage of individual appliances in a household. It inevitably cost us much and was also troublesome to the residents of the household. In order to solve the problem, we invented a method to infer electricity consumption of individual electric appliances in a household from the harmonic pattern of current on a power feeder measured at the entrance of the household, as shown in Figure 1. We have been checking the fundamental effectiveness of the method by piling up some small-scale experiments. *1

Objectives

To make a measuring terminal that is applicable to a practical load survey for residential sector, fix a procedure for the survey, and evaluate inference accuracy of electricity consumption of individual electric appliances according to the procedure.

Principal Results

1. Measuring terminal

We made a measuring terminal, as shown in Figure 2, which can be used for a practical load survey for residential sector. We checked the expected performance by an operating test. A PHS (Personal Handyphone System) is used to control the terminal and retrieve the data.

2. Workflow of load survey

We determined a workflow of load survey as shown in Figure 3. A mechanism to infer electricity consumption (an inference model) is built and fixed by using the data representing the relation between harmonic pattern and electricity consumption of electric appliances, which are obtained by a short-term measurement.

3. Evaluation of inference performance in practical operation

In order to evaluate the inference performance in practical operation, the performance test was carried out at four real households, according to the procedure in Figure 3. The inference models built and fixed by using the short-term (three days) data showed a good performance for the long-term (several tens of days) unknown data. We confirmed that a difference between inferred electricity consumption and measured one is approximately below 20%.

Future Developments

An applicability of the method for commercial buildings will be evaluated.

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Reference

Y. Nakano, 2005, “Non-Intrusive Load Monitoring System - Part 5: Performance Test at Real Households -”, Technical Report R04019 (in Japanese)

*1 : Technical Report T98045, R99004, T00010, T01013, R01025, R01027, T02044 (in Japanese)

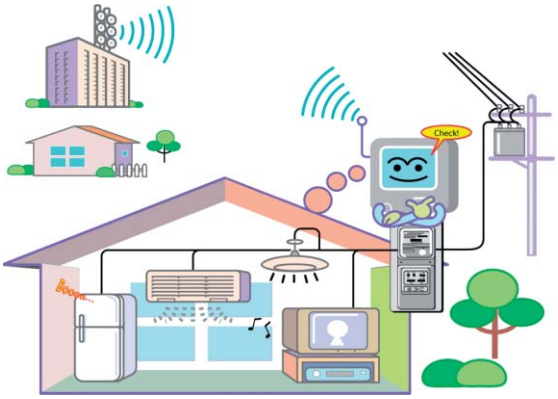

Fig.1 Non-intrusive electric appliances load monitoring system

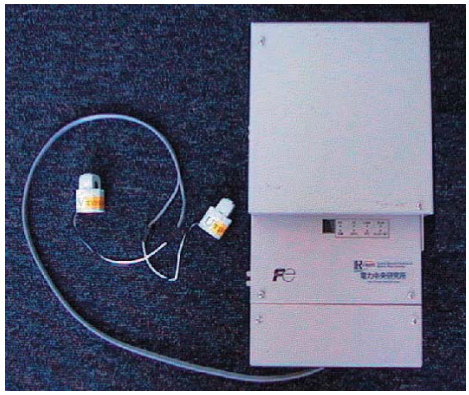

Fig.2 Measuring Terminal
290mm(H)×150mm(W)×85mm(D)

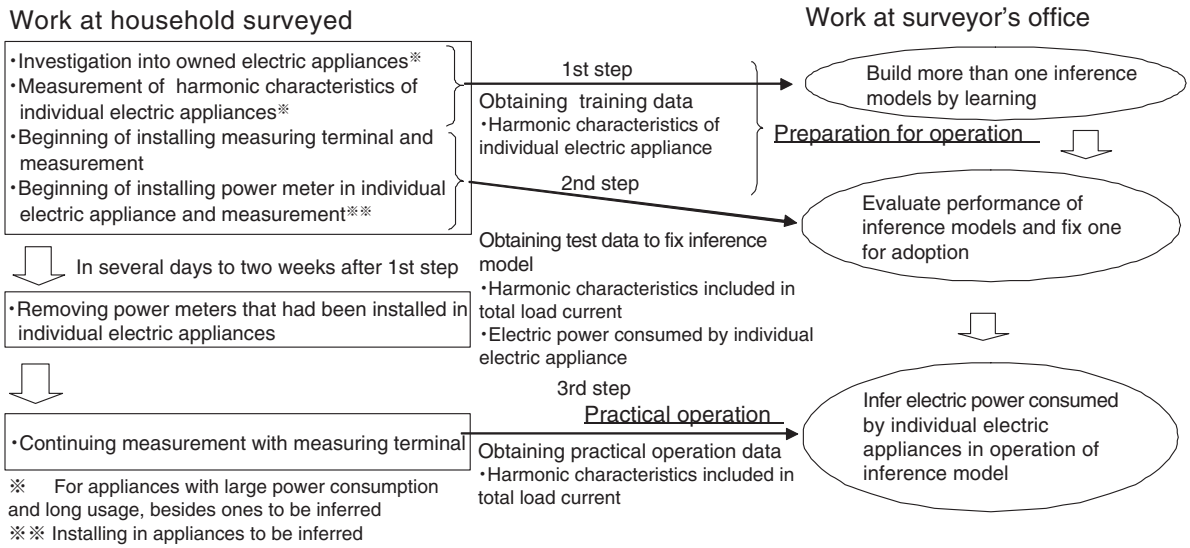

Fig.3 Workflow for load survey

Table1 Inference performance in practical operation

		Household A	Household B	Household C	Household D
Operation period		54 days	50 days	24 days	16 days
TV	Inferred Wh	30kWh [100%]	30kWh[150%]	26kWh [87%]	13kWh [130%]
	Measured Wh	30kWh	20kWh	30kWh	10kWh
	Measured On hrs.	186hrs.	196hrs.	190hrs.	86hrs.
Fridge	Inferred Wh	238kWh [97%]	146kWh [84%]	51kWh [100%]	28kWh [100%]
	Measured Wh	245kWh	173kWh	51kWh	28kWh
	Measured On hrs.	1,248hrs.	1,013hrs.	576hrs.	195hrs.
Air-conditioner	Inferred Wh	16kWh [80%]	157kWh [94%]	81kWh [92%]	10kWh [91%]
	Measured Wh	20kWh	167kWh	88kWh	11kWh
	Measured On hrs.	50hrs.	306hrs.	222hrs.	14hrs.

* The data period to build and fix the inference model is three days.
** [ ] : Percentage of measured for inferred