Domestic Electricity Consumption Visualized as Flowing Tap Water to Raise the Feeling of Waste

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Abstract. In this study we visualize electricity consumption as flowing tap water in order to encourage people to save electricity by raising the feeling of waste. To save electricity, the mainstream is to present its consumption and quick feedback. Additionally we try to evoke the feeling of waste using flowing tap water. We build a prototype system to convert the amount of electricity being consumed into that of flowing tap water. Finally it is shown that the flow rate of tap water changes according to the amount of electricity consumption.

Keywords: Flowing tap water · Electricity consumption · Peripheral information · Ambient display

1 Introduction

After the Kyoto Protocol was negotiated in 1997 and coming into force in 2005, eco-friendly products and energy-saving household appliances started to be manufactured and gradually replaced the old ones in our homes to reduce greenhouse gas emissions. In 2011 there was the catastrophic event of East Japan earthquake, so we were all urgently required for further reduction of electricity consumption due to suspension of nuclear power plants across Japan for security check. This period turned to be a good opportunity to look deep into the way of daily use of electricity.

The mainstream to save electricity is believed to present its consumption in graph, which will be available as a part of Home Energy Management System (HEMS). This makes it easier to specifically find out what time and which room much electricity is consumed. To save electricity, it is also emphasized that quick feedback of the consumption is very important because it helps the residents to connect between the current consumption and the appliances being used. Although HEMS provides electricity consumption in graph, it is displayed on a screen, so it seems to be more effective to direct the consumption to the residents

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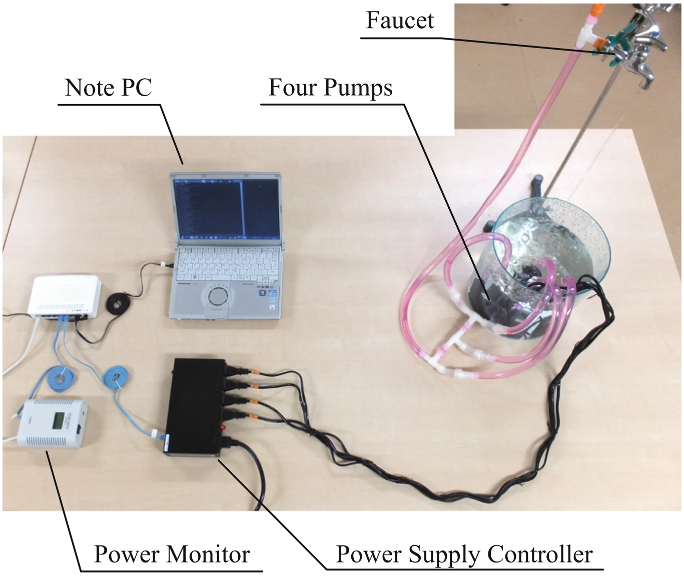

Fig. 1. Our prototype system.

in some other form. In this study, we take an approach of presenting electricity consumption as peripheral information.

Peripheral information is usually out of the focus of users' attention and does not interrupt their current work. When people are working on computers, for example, they will realize that it starts raining without their work interrupted when they hear the sound of raindrops hitting the ground, roof or the window. They may also realize that a near coffee shop opens because the beautiful smell of coffee comes up in the room. The peripheral information of the sound of raindrops and the smell of coffee does not interrupt their current work but it conveys much of what is going on around them.

In a HCI area, ambient displays were invented to provide peripheral information [1]. There are several studies to encourage people to improve their behaviors by introducing ambient displays in their life space. Rodríguez et al. [2] proposed a system for safe driving. Driving behavior of a driver is monitored and shown through a small mirror-hanging accessory, so the driver can realize his/her behavior but the driving is not interrupted. Hong et al. [3] built a flower-shaped physical avatar to provide feedback of how good/bad a user's posture is. When the user is slouching over a computer, for example, the avatar changes its posture and color to warn about his/her bad posture. Gustafsson et al. [4] made cords specially designed to illuminate depending on the amount of electricity being consumed.

The last study of Gustafsson et al. [4] is very relevant to ours. While cords illuminate to show electricity consumption in their study, we use flowing tap water. When people see flowing tap water with no intention of use, they cer-

Table 1. Conversion of electricity consumption into Pump#.

Electricity Consumption (Watt)	Pump# to work
Less than 100	No pumps
100 - 400	Pump1
401 - 700	Pump2
701 - 1000	Pump3
More than 1000	Pump4

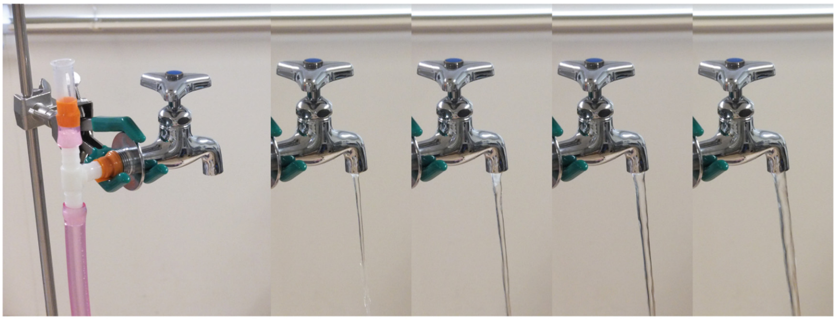

Fig. 2. Flowing tap water at four levels of flow rate. No pumps are working in (a). Pump1 to 4 are working in (b) to (e), respectively. Pump1 sucks the least water while Pump4 does the most.

tainly feel wasteful. As for electricity, they hardly feel it even though they know that standby electricity is being consumed all the time. We visualize domestic electricity being consumed as flowing tap water in order to let them feel wasteful as well as visualize the flowing electricity.

The rest of this manuscript is organized as follows. In Sect. 2, it is explained the way how electricity consumption is visualized as flowing tap water. Then our prototype system is demonstrated in Sect. 3. Finally we give concluding remarks in Sect. 4.

2 Electricity Consumption as Flowing Tap Water

Figure 1 shows our prototype system that comprises a power monitor (EGM801 manufactured by Miyakawa Electric Works Ltd.), a power supply controller (IP Power 9258 T manufactured by Aviosys International Inc.), four pumps and a note PC. The power monitor is connected to a fuse box and measures electricity being consumed by the household. After that the measured data is sent to a program running on the note PC then the program determines which pump to work as shown in Table 1. Each of the four pumps or Pump1 to 4 is previously adjusted to suck up water at one of four levels of flow rate. Pump1 sucks the

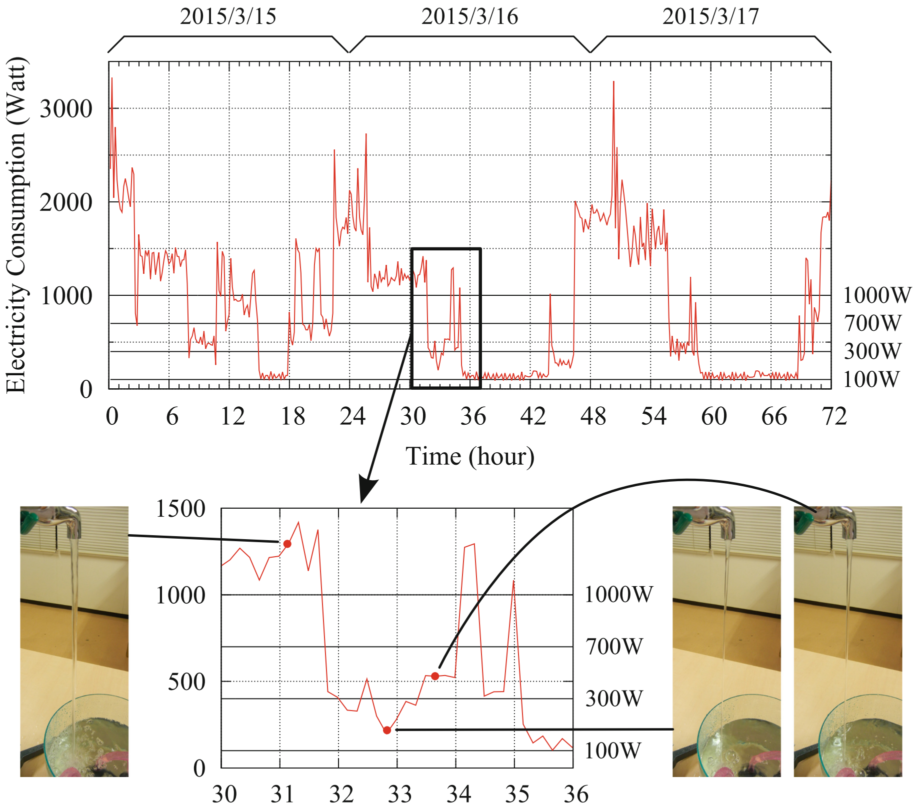

Fig. 3. Electricity consumption by a family for three days.

least water while Pump4 does the most (Fig. 2). These pumps are connected to the outlets of the power supply controller, and each of the outlets can be turned on/off separately by the program. Finally the program sends a signal to the power supply controller to turn on/off the pumps based on Table 1.

3 Experiment

We conducted an experiment in a research laboratory to make sure our prototype system works. First a family was asked to connect the power monitor to the fuse box of their home and measure the electricity consumption for three days. After the data was obtained, it was brought in the laboratory and reproduced on the note PC in order to simulate the electricity consumption of the home.

Figure 3 shows the measured electricity consumption. A part of the graph indicated by a rectangle is enlarged and shown below. Our prototype system was run based on the electricity consumption of Fig. 3. Three photos beside the enlarged graph show the flowing tap water at the three points of time. As a result, it was confirmed that the flow rate of the tap water changed according to the amount of electricity being consumed.

4 Conclusions

In this study we visualized electricity consumption as flowing tap water in order to encourage people to save electricity by raising the feeling of waste. In the experiment, it was shown that the flow rate of tap water changed according to the amount of electricity consumption.

We are now planning to conduct a field study to find out the effectiveness in practical situations. Before the field study, the pumps and tubes should be hidden so that our system looks like a common faucet and becomes a part of homes. This will be helpful because people usually feel more wasteful seeing flowing tap water than just circulating one.

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