Toward Human-oriented Home

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OVERVIEW: Human-oriented technologies for the home are widely seen in the user interface designs of home appliances. The current emphasis is on automating function settings and improving the ease-of-use of individual products by providing intuitive operation. For the future, interactive environments that link people, devices, and systems will be implemented by utilizing the growing potential for collecting extensive information from the surroundings through the greater diversity of sensors and other information technology devices, the spread of high-speed network services based primarily on wireless communications, and the improved data processing capabilities of back office information systems.

INTRODUCTION

THE interaction between electronics technology and the spaces in which people live their lives is largely mediated via home appliances. Human-oriented technology for the home, which centers on home appliances, started with ergonomic design and other approaches that dealt with the shape of the product and now extends into improving the appliance's operation through software-based control. Thanks to a growing range of sensor technologies, the spread of high-speed wireless networks, and developments in data analysis techniques, we can now look forward not only to simpler operation of individual devices but also to improvements in comfort and safety throughout the home environment achieved through the interoperation of the devices located in our living spaces.

This article considers human-oriented technology in the home by focusing on home appliances, and describes the expansion of human-oriented services through information exchange between devices and the utilization of "ambient information."

HUMAN-ORIENTED HOMES CENTERED ON HOME APPLIANCES

Development of current human-oriented technology for home appliances at Hitachi is carried out at Hitachi's Mechanical Engineering Research Laboratory with a focus on making products easier for people to use. It is now possible for users to control the operation of products through the use of sensors by using manual menu settings.

Smart Cooking Features by Weight Sensors of Combined Microwave and Oven

These microwave ovens perform "custom home-style heating" by memorizing the weight of the user's dish and then subtracting this weight when heating to calculate the net food weight automatically so that the food can be heated by the optimum amount.

Microwave control technology

Hitachi is working on increasing the sensitivity of the sensors used to measure the weight and location of food in the oven, and on developing functions to set the weight of the dish and any individual preferences

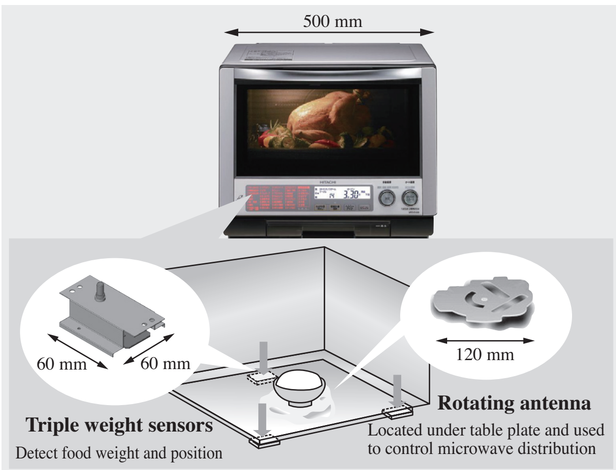

Fig. 1—Sensor Technology Used in Ovens.
The "custom home-style heating" function controls the distribution of microwaves based on information obtained from weight sensors.

and then adjust the heating time accordingly. These functions use a microwave control method based on triple weight sensors that position three different weight sensors inside the oven and can measure both the weight of the food and its position in the oven.

Hitachi has also developed a "custom home-style heating" function that measures the weight of commonly used bowls, plates, cups, and other containers and stores the data for later use. By calculating the net weight of the food, this function can perform optimum heating control and coordinate the five different heating modes (microwave, oven, grill, superheated steam, and steam) to cook the food in accordance with the user's preferences (see Fig. 1).

Energy-saving control technology

The annual power consumption for oven heating was reduced to 11.8 kWh (4.2 kWh less than the previous model year) by improving the control sequence for the heater and fan and adopting a heating chamber with a four-layer insulated structure based on sample data measured from actual user cooking. Also, the cause of uneven heating was identified by analysis of microwave distribution in the heating chamber and the control of microwaves improved to reduce the annual power consumption for microwave heating to 55 kWh (5.5 kWh less than the previous Hitachi model). These improvements resulted in an annual power consumption of 66.8 kWh/y[*1].

Mist Humidifying Stainless Clean SHIROKUMA-KUN Room Air Conditioner

Energy-saving control technology

This air conditioner features a new function that uses infrared sensors to automatically operate the air conditioner in an energy-efficient way. If the remote control is used to select "Eco" mode, the air conditioner uses an infrared sensor (called the "Eco-sensor") to detect where people are (rooms are monitored in nine separate areas), their level of activity, and the humidity in the room. Air conditioner operation is made more efficient by using local control. Compared to normal operation, energy savings of up to 25%[*2 *4] for heating and 20%[*2 *4] for cooling are possible. By using the sensor to detect where people are and combining "Eco" mode with the "Directed air flow/Deflected Air flow" mode for automatically controlling the blower direction, the blower direction can be controlled based on the detected level of activity of the people in the room. Compared to normal operation, energy savings of up to 35%[*3 *4] are possible if the "Directed air flow" and "Eco" modes are combined for cooling (see Fig. 2).

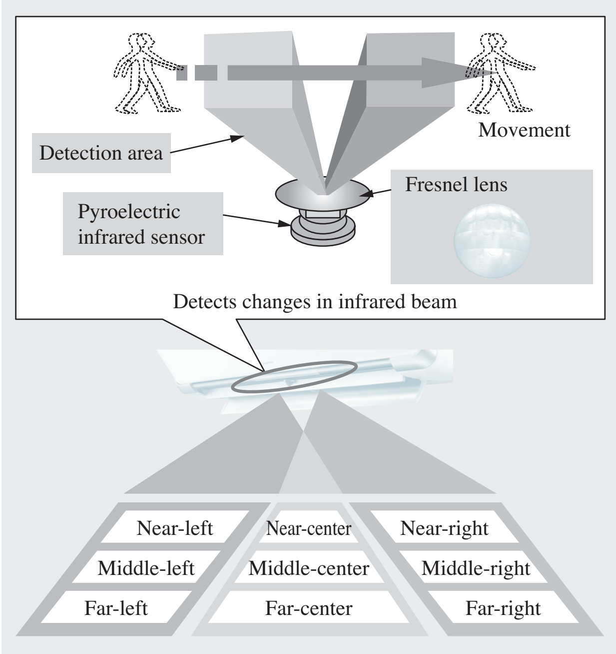

Fig. 2—Eco-sensor.
The "Eco-sensor" consists of two pyroelectric infrared sensors and works by dividing the living space up to monitor into nine areas. Energy savings and comfort can both be achieved by focusing air conditioning control on areas in which a person is present.

*1 As of May 20, 2008, for domestic microwave ovens (hot air recirculation types, excluding system kitchen models)

*2 Energy savings were measured for an RAS-S40Y2 in Hitachi's 22-m^2 environmental test room. The activity in heating mode consisted of exercise or housework such as vacuuming being performed at a distance of 3 m from the in-room unit. The activity in cooling mode consisted of reading performed at a distance of 3 m from the in-room unit. The conditions for heating were an external temperature of 2°C, temperature setting of 25°C, and blower speed set to automatic. The measured cumulative power consumption per hour under stable operation was 543 Wh in "Eco" mode, which compares with 725 Wh when "Eco" mode was not used. The room humidity at the time of measurement was 55%. The conditions for cooling were an external temperature of 35°C, temperature setting of 26°C, and blower speed set to automatic. The measured cumulative power consumption per hour under stable operation was 211 Wh in "Eco" mode, which compares with 265 Wh when "Eco" mode was not used. The room humidity at the time of measurement was 45%.

*3 Energy savings were measured for an RAS-S40Y2 in Hitachi's 22-m^2 environmental test room. The activity consisted of reading performed at a distance of 3 m from the in-room unit. The conditions were an external temperature of 35°C, temperature setting of 26°C, and blower speed set to automatic. The measured cumulative power consumption per hour under stable operation was 172 Wh using the "Eco" and "Directed Air Flow" modes, which compares with 265 Wh when "Eco" mode was not used. The room humidity at the time of measurement was 45%.

*4 These figures are based on conditions set by Hitachi and are different to the power consumption calculated based on JIS (Japanese Industrial Standards).

Enhancing comfort by improving factors other than temperature

A survey of user needs for room air conditioners conducted by Hitachi found growing interest in improvements to the home environment that related to aspects other than temperature control, including an increase in the number of users concerned about their skin getting dry when the cooling or heating function is operating. Hitachi developed an ion mist function for its air conditioners to respond to these needs and has been selling models that incorporate the function since 2007.

This function collects the moisture from the air sucked in by the in-room air conditioner unit then applies a high voltage to this moisture to generate tiny ionized water droplets with a diameter of 20 to 50 nm which are then expelled back into the room. The purpose is to enhance the comfort of the user's living space by improving skin moisture and enhancing the odor resistance and antimicrobial action of textiles such as curtains.

EXPANDING HUMAN-ORIENTED SERVICES THROUGH EXCHANGE OF INFORMATION BETWEEN DEVICES

Human-oriented technologies in current use are primarily implemented as standalone applications and limited to individual home appliances. However, by extending sensor technology and improving information storage and processing capabilities, it is possible to store details of the user's past usage, understand operating patterns, and similar. In the future, it is anticipated that progress will be made on developing systems and services in which the devices used in our living spaces work together based on accumulated information to configure functions and provide services in a way that is tailored to individual tastes.

Human-oriented Systems Utilizing Intuitive Interfaces and Interaction between Digital Home Appliances

Hitachi's Consumer Electronics Research Laboratory advocates the "super-concierge" concept for implementing features like simple device operation without needing to use a remote control, information searching, and system interoperation based on the growing information processing capabilities of digital home appliances and faster data communication environments, and is conducting research into the associated technologies.

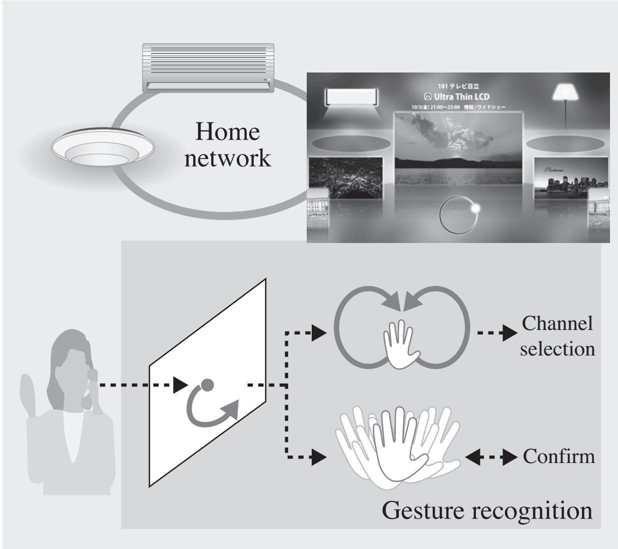

Fig. 3—Gesture-controlled Television.
This technology uses hand gestures to control digital televisions, air conditioners, lighting, and other home appliancess.

The "super-concierge" concept aims to improve user convenience by constructing an environment in which digital television, home servers, mobile phones and other portable devices, and sensors are linked together organically by a network. One example of this approach is the gesture-controlled television under development.

Gesture-controlled television uses an image sensor located in the set to control the television by detecting user hand movements in real time and identifying different types of gesture such as gestures for changing the channel or adjusting the volume. In the future, Hitachi believes we will be able to use televisions that incorporate intuitive interfaces like this one, not only to search for viewing content, but also to optimize the environment throughout our living spaces through integrated operation between home appliances and other equipment in the home such as air conditioning and lighting (see Fig. 3).

Development of Human-oriented Services through Interaction between Services and User Information

Hitachi is developing systems that provide users with health maintenance support by integrating public services with time series data on people's lifestyles and habits obtained by information technology devices. A health management support system developed by Hitachi's Central Research Laboratory uses information technology devices to collect, store, and analyze weight change data and

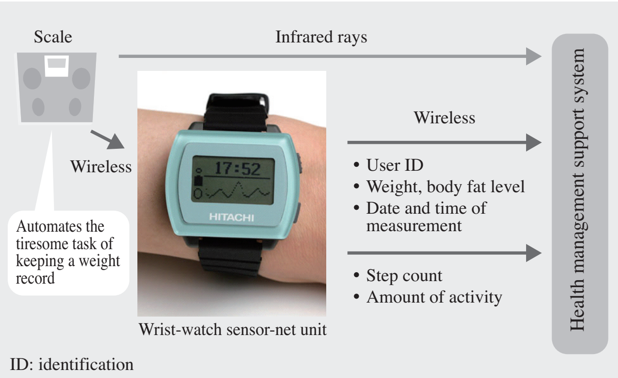

Fig. 4—Data Collection Using Information Technology Device.
Time series data can be collected from users conveniently by using a small information technology device and wireless communications.

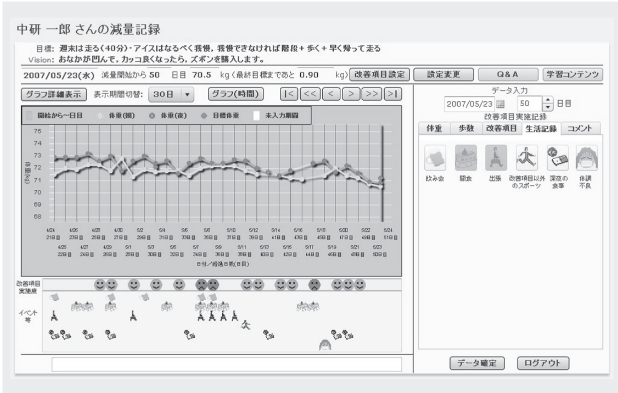

Fig. 5—Example Screen from Health Management Support System.
By linking the activity record (icons on bottom-left) to the weight change trend graph (top-left) and performing a correlation analysis, the user's characteristics and affinity with the lifestyle improvement program can be evaluated.

data from daily activity records from users who have set daily activity targets as part of a lifestyle improvement program.

In the past, users would write and submit details of their activities and weight changes and receive guidance on how to improve their lifestyle from a nurse or other heath advisor. Because this information about activity and weight change is recorded after the fact, there are issues with the ease of data collection and how to ensure reliability because the process is time consuming and dependent on the user's memory.

In the Hitachi system, the activity record for each day is produced on a mobile phone and weight data is collected by two different methods. One method uses infrared communications via a PDA (personal digital assistant) and the other uses wireless communications to collect data from a scale and pedometer. This dramatically reduces the time lag between measurement and data recording (see Fig. 4).

Also, the health management support system performs modeling of the user's characteristics (ease or difficulty of weight loss) based on analysis of collected data so that aspects of the user's lifestyle can be broken down and evaluated appropriately under different lifestyle improvement programs. The health advisor can then reference the detailed time-series data obtained by the methods described above, including the person's daily activity record and weight changes, together with indicative information and offer specific and effective guidance via mobile phone, e-mail, or other means (see Fig. 5).

FROM CONVENIENCE TO SAFETY, SECURITY, AND COMFORT

— TURNING SOCIETY OF AMBIENT INFORMATION INTO REALITY

Human-oriented technology in the home is likely to become even more advanced as IT (information technology) becomes more deeply embedded in our surrounding environment. For example, it is possible to create living spaces that are safe, secure, and comfortable by automatically detecting people's preferences and emotions (people's environmental characteristics) through the collection and analysis of huge volumes of information from both public places and individual's living environments, and then using this to adjust and control our living environment.

The Hitachi Research Institute has proposed the importance of "ambient information" to realize a world that has achieved a safe, secure, and comfortable lifestyle and in which needs and potential problems can be ascertained by collecting and analyzing information from the home appliances and information technology devices located throughout the environments in which we live (see Fig. 6). The word "ambient" refers to something that surrounds and comforts us.

The utilization of ambient information envisages an interactive environment of people, devices, and information systems and is made up of (1) "broad-gathering functions" that monitor users by collecting huge volumes of information about their environments using sensors and other devices, (2) "intelligent computing functions" for analyzing

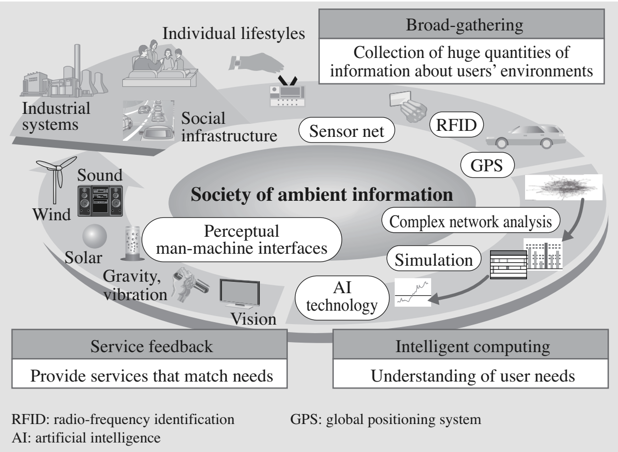

Fig. 6—Utilization of "Ambient Information."
Information technology devices and systems embedded in the environment will intimately watch over user's actions and support their activities.

and understanding user needs from the collected information, and (3) "service feedback functions" that provide services that match the analyzed user needs. To establish these three functions and get them to work together, it is important that we establish a cycle of "converting information into knowledge and using this to improve our environment."

In the utilization of ambient information, possible examples of how to create living spaces in which the act of living in these spaces in itself encourages good health might include having the air conditioning and lighting set up living areas based on factors such as the morning's weather and temperature so as to encourage morning exercise or family conversation, or making unobtrusive use of a display to remind us at the appropriate time of what medicines we need to take. These would involve the operation of functions that utilize the sensors and digital home appliances that are present in our living spaces to watch over users' lifestyles ("broad-gathering"), back office information systems that analyze information to identify user needs and adjust the environment to keep our bodies healthy ("intelligent computing"), and functions for making us sense information in accordance with our environmental adjustment plans so as not to make users feel any stress ("service feedback"). Currently, the Hitachi Research Institute is working on research and investigation aimed at implementing concepts suitable for specific tasks and applications.

CONCLUSIONS

This article has discussed human-oriented homes with a particular emphasis on home appliances, the expansion of human-oriented services based on exchange of information between devices, and the utilization of ambient information.

Technologies for interaction between people and information technology devices and systems, which are currently being developed separately for separate products, and organic interoperation with back office systems that analyze information based on aesthetics engineering will be important factors in further innovation in the field of human-oriented technology. Systems that use networks and sensors to watch over user property such as facilities, equipment, and other devices are currently in use or under development at Hitachi.

Hitachi intends to continue work on implementing pioneering applications that create safe, secure, and comfortable environments by extracting knowledge from the various types of information obtained by these systems.

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