Wearable Internet Appliances and Their Applications

Osamu Ebina
Norio Owada
Yoshinobu Ohinata
Kimihiko Adachi
Masahito Fukushima

OVERVIEW: Based on the idea that new value can be offered to users if the high-resolution, large-screen information display capability of desk-top personal computers could be achieved in a size suitable for portable devices, Hitachi, Ltd. has recently developed a portable information appliance which employs a head-mount display that has recently been made practical. That appliance has been given the name "Wearable Internet Appliance" (WIA). For both industrial and consumer uses, a variety of applications that had been difficult to implement are now made possible by the WIA. The key words are "anytime, anywhere" and "viewing while doing something else." For industrial uses, improvement in work efficiency and accuracy can be expected by the real-time, high quality displaying of manuals, maintenance and service information, etc. For consumer uses, the portability of high-quality visual information will allow access to the Internet "anytime, anywhere" and "viewing while doing something else," without requiring a conventional large personal computer.

INTRODUCTION

THE surging popularity of cell phones and general access to Internet services through the addition of browser capabilities has opened up a new dimension for portable information devices and their uses.

In this environment, what might be the next product that customers find value in? We believe that a portable, high-resolution, large-screen display is one such device. Here, we describe a portable Internet appliance, the Wearable Internet Appliance (WIA), which employs a head-mount display that is portable, yet provides a large, high-resolution image.

Fig. 1— The Wearable Internet Appliance Developed by Hitachi. The WIA consists of a control unit, a head-mount display and a pointing device.

THE LATENT DEMAND FOR PORTABLE INFORMATION APPLIANCES

For portable information devices such as cell phones and various types of portable information appliances, etc., nearly all of the display devices have a direct-view panel (mostly of the LCD type).

For direct-view panels, the size and resolution of the panel itself is restricted by the size of the device on which it is mounted. From the standpoint of users, on the other hand, there is a need for a display having the same screen size and resolution of desk-top personal computers in a device that can be carried around. The materials to be viewed include, for example, ordinary web pages that are designed to be viewed with personal computers (particularly when photographs or diagrams are included), as well as maps, building and plumbing diagrams, etc.

Direct-view panels in sizes of 15 inches or larger are now common, but those are mainly used with desk-top systems. For use as portable units, the power required for attaining high image quality and brightness is a problem, in addition to the size and weight.

One way to overcome these problems is to use HMD (head-mount display), a display device which has recently been made practical.

Fig. 2—The External Appearance of the HMD and How It Is Worn.
The HMD consists of a display unit and a frame just like eyeglasses.

THE WEARABLE INTERNET APPLIANCE

The WIA that Hitachi has developed is an Internet appliance that employs an HMD to satisfy the need for both portability and high-resolution display with a large screen (see Fig. 1).

The WIA has the following features:
(1) Internet or intranet sites can be displayed at full size anytime, anywhere.
(2) Additional flash memory through CompactFlash* interface allows substantial off-line content storage as well.
(3) Screen display capabilities like those of a notebook computer are realized with a device the size and weight of a PDA (personal digital assistant).
(4) Hands-free operation (the user does not have to hold the display).
(5) Instant-on operation by diskless design.
(6) Flexible connectivity to peripheral devices is achieved by use of the CompactFlash Type II interface and a USB (universal serial bus) interface.

Display

The main features of the HMD that is used for the WIA are listed below:
(1) Monocular viewing
(2) See-through display (The display is superimposed over the user's view of the outside world.)
(3) A 13-inch image is projected at a distance of 60 cm from the eye.
(4) SVGA resolution (800 dots wide by 600 dots high)
(5) 18-bit color depth (about 260 thousand colors)
(6) Highly stable and safe forehead-supported eyeglass-style mounting that can be put in place by a touch (see Fig. 2)
(7) Switchable viewing set-up between right and left eye
(8) Wearable with eyeglasses or a helmet
(9) Weighs less than 80 g (without cable).

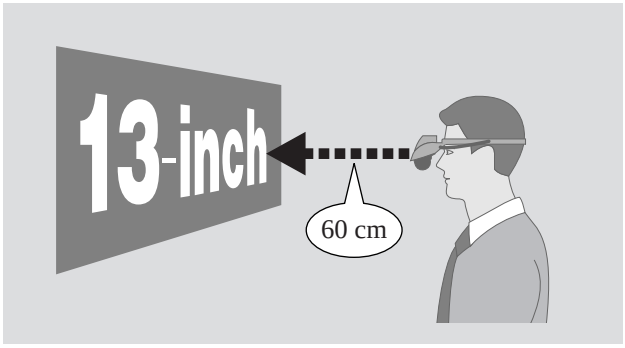

Fig. 3— The HMD Display.
A 13-inch screen can be viewed at a distance of 60 cm from the face.

HMDs and their trends

Of the various wearable display devices, the HMD refers to a display device that can be mounted on the head or face to offer both portability and hands-free operation. Recent years have seen the appearance of many display devices in which screen images produced by display elements of from 0.5 inches to 1 inch in size are enlarged by magnifying optics to present an image with a viewing angle of from 25 to 30 degrees. A view angle of 30 degrees is equivalent to a 13-inch display at a distance of 60 cm or a 64-inch display at 3 meters (see Fig. 3).

Even though the image size as seen by the user is large, the display element is actually small. If the magnifying optics can be made compact and light in weight, then the demand for a "portable device with large display images" can be met.

Head-mount displays for enjoying ordinary television and video have already been made practical by several companies. Although some displays have

*: CompactFlash is a trademark of SanDisk Corporation.

higher resolution to match the display capabilities of personal computers, they have limited application as displays for portable information appliances from the viewpoints of portability and low cost.

Practical HMDs such as these adopt liquid crystal panels that are illuminated from behind by fluorescent lamps, like the display panels of notebook computers. Most of these HMDs, moreover, use magnifying optics to enlarge the image for the display panel. Recently, however, a new device called the LCoS (Liquid Crystal on Silicon) micro-display has become practical. This device has realized a compact, lightweight, and low-cost HMD.

LCoS micro-display and LED illumination method

The LCoS is a device in which a liquid crystal panel is mounted directly on the liquid crystal driving circuit chip.

Since HMDs require only a small amount of light, and considering that small size is important, the three primary color LEDs (light emitting diodes) are used for illumination.

Mechanical structure of HMD

A certain kind of HMD was selected as the display for the WIA, noting its intended use as a portable information appliance requiring stability of mounting and safety.

(1) Use as a portable information appliance

For the enjoyment of video at home and other such uses in which the user is completely absorbed in the displayed content, it is best to have a binocular display that completely hides the outside world. If that kind of display is used in an environment where there is acceleration and vibration, such as in a train, however, the user may experience headache, motion sickness or other discomfort. To prevent such discomfort, the display should allow the user to see the outside world as well as the displayed content. (The binocular displays that are on the market are devised so as to allow the outside world to be seen as well.)

Because the keywords “anytime, anywhere” and “viewing while doing something else” should be achieved by WIA, a monocular, see-through display (i.e., the display image is superimposed on the outside world) was selected.

Also, an eyeglass-style mounting method was adopted so that the unit can be put on easily without affecting the user’s hairstyle.

(2) Stable mounting

Various mounting methods have been investigated, including the products of venture enterprises from various countries, but there are few products that fix the display securely in front of the eye, prevent slipping or vibration, and prevent the minute vibrations that hinder detailed display. The HMD employed for the WIA supports the display unit with a pad that is in direct contact with the forehead, so slippage, vibration or minute vibrations do not easily occur.

(3) Safety

The HMD used for the WIA has few parts that protrude from the head while being worn. Also, because the display unit is held by the forehead pad, it is supported by the pad against pressure from the front. Furthermore, because the display unit itself is flat where it comes in contact with the face and is larger than the eye socket, it cannot be pushed into the eye socket even in the worst case.

Controller

The specifications of the controller are listed below.

(1) OS (operating system): Windows* CE3.0

(2) CPU (central processing unit): The Hitachi SH-4 32 bit RISC (reduced instruction set computer) processor

(3) Interfaces

(a) Direct connection to HMD

(b) CompactFlash Type II

(c) USB × 1

(d) Stereo headphone jack

(4) Dimensions: 140 × 90 × 26 (mm)

(5) Mass: About 310 g

Pointing Device

A new optical pointing device that combines a blue LED and an image sensor was developed for the WIA. Tracing with a finger on the blue light sensor-window moves the pointer displayed by the HMD. The ability to use the device midair or when facing upwards is also considered to be important.

WIA APPLICATIONS

Because of the special features of the WIA, this device can be expected to find applications that have previously been difficult to implement in the following areas.

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*: Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

Industrial Uses

Systems for providing visual information to mobile workers

A model of an application system for industrial use is shown in Fig. 4. This system provides workers who are moving about with real-time online visual information by using the WIA together with a wireless LAN/PHS data communication card, etc.

This system can implement the following functions:
(1) A high-resolution display terminal system that can be used hands-free and outdoors
(2) Receiving and inputting real-time information on-site
(3) Displaying of centrally stored information (diagrams of premises, equipment explanations, etc.)
(4) Displaying of sensor data on diagrams of premises
(5) Displaying of monitor camera images
(6) The input of items that have already been inspected and the sending of that information to the Center
(7) Thin client (small and light in weight) implemented with a browser protocol

An example in which this model was applied in an electric power generation station is shown in Fig. 5, and an example of actual on-site use is shown in Fig. 6.

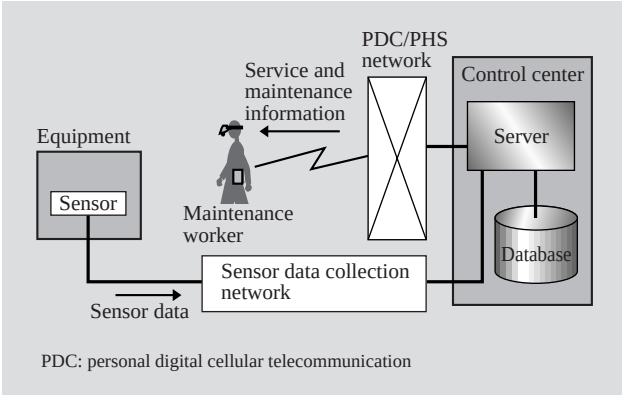

Fig. 4— Application System Model.
Sending service and maintenance information from a control center server to a maintenance worker who is wearing the WIA.

Off-line, large-volume text reader

High-speed off-line display of large-volume text in electronic format that can be carried around is also possible. This makes it possible to implement the following features:
(1) Reduction in weight and size by converting documents to an electronic format
(2) A compact, portable text reader with a large-screen display capability that can be used outdoors
(3) Reading text in any position, with both hands free (It is possible, for example, to use the device even while lying under machinery facing upwards.)
(4) The contents of the CompactFlash memory card can be updated easily by using an ordinary personal computer.

Use in special environments

The device can be used either on-line or off-line in special environments. One example is use in a clean

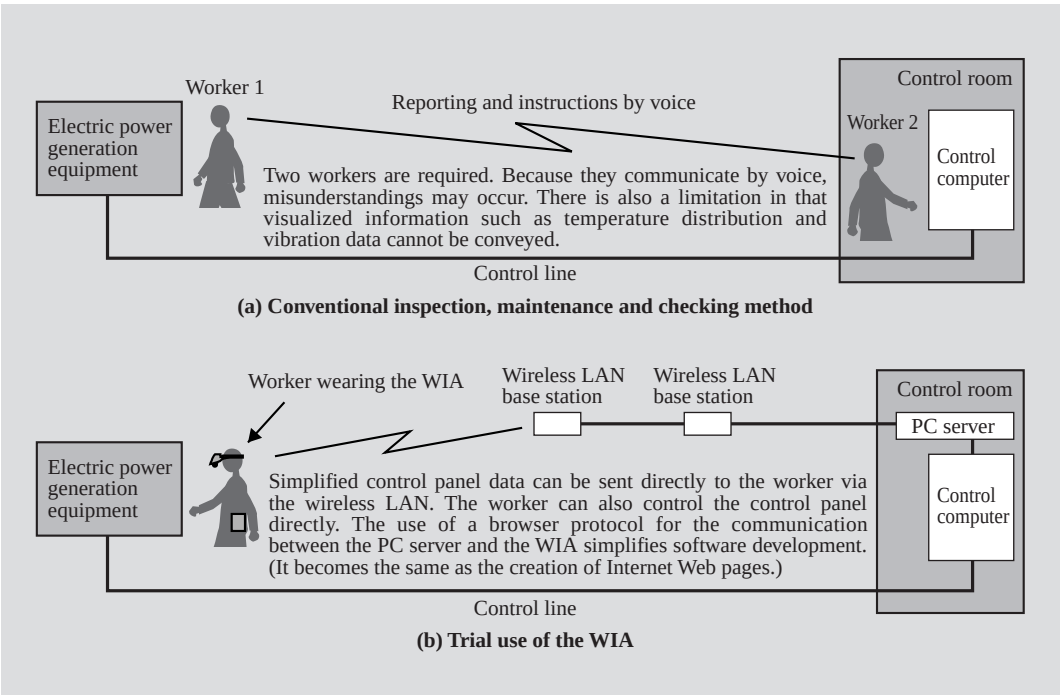

Fig. 5— Example of Application in an Electrical Power Plant. Conventionally, two workers are needed and voice communication is difficult in a noisy environment. By using the WIA, the work can be done properly by a single person.

Fig. 6— Example of Use on an Actual Site.
The worker is standing in front of the product that is being investigated and is referring to information that is displayed by the WIA while performing the work.

room or other such places where physical documents cannot be used or the entry of objects is restricted. Another example is maintenance work in nuclear power facilities where there are restrictions on objects being carried out.

Consumer Uses

As a consumer application, it is possible to implement "full-screen Internet access anytime, anywhere" by using the device together with a PHS data communication card, etc. The user can get, make use of and enjoy Internet information anywhere in the home, or even outside, rather than having to go to sit in front of a personal computer. It is said that Internet access at home is often done while watching television or while using the telephone. The device is also suitable for cases such as these.

Because hands-free operation is achieved by using the HMD, the device is also believed to be effective for the viewing of electronic books. It is lighter than physical books (only the pointing device is held in the hand), and reading is possible even on crowded public transportation vehicles. The HMD used by the WIA does not protrude from the back of the head or the side of the head and can therefore be used even while lying down. Because the WIA allows the user to read without having to support a book, it makes "hands-free bed reading" possible.

CONCLUSIONS

We have described the "Wearable Internet Appliance (WIA)" that has been developed by Hitachi, Ltd., and explored some of its applications. Although the HMD has so far been limited largely to games and entertainment applications, we believe that extending its application to industrial uses and to Internet access and other general consumer uses will open up a variety of new application areas.

Considering the keywords "anytime, anywhere" and "viewing while doing something else," there are still many unexplored areas in which the user may find value in using the WIA. Hitachi, Ltd. will strive to expand the application areas of the WIA and to implement new services in addition to developing industrial and consumer uses.

ABOUT THE AUTHORS

Osamu Ebina
Joined Hitachi, Ltd. in 1981, and now works at the Net-PDA Business Unit of the Business Strategies Division of the Mobile Information & Communication Appliance Division. He is currently engaged in WIA product planning, and can be reached by e-mail at oebina@cm.yokohama.hitachi.co.jp.

Norio Owada
Joined Hitachi, Ltd. in 1979, and now works at the Net-PDA Business Unit of the Business Strategies Division of the Mobile Information & Communication Appliance Division. He is currently engaged in WIA development, and can be reached by e-mail at oowada@cm.yokohama.hitachi.co.jp.

Yoshinobu Ohinata
Joined Hitachi, Ltd. in 1978, and now works at the Net-PDA Business Unit of the Business Strategies Division of the Mobile Information & Communication Appliance Division. He is engaged in business planning, and can be reached by e-mail at ohinata@dm.kaden.hitachi.co.jp.

Kimihiko Adachi
Joined Hitachi, Ltd. in 1990, and now works at the OEM Partnership Department of the Digital Media Systems Sales Division. He is currently engaged in WIA business development, and can be reached by e-mail at kadachi@dm.kaden.hitachi.co.jp.

Masahito Fukushima
Joined Hitachi, Ltd. in 1983, and now works at the Net-PDA Design Department of the Design Office of the Mobile Information & Communication Appliance Division. He is currently engaged in WIA development integration, and can be reached by e-mail at masahito-fukushima@em.tookai.hitachi.co.jp