Infrared Signboard

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Abstract

The infrared signboard system lets consumers receive digital information (such as URLs and email addresses) from a signboard at a distance. It uses infrared communication technology originally developed for remote control devices to achieve a reasonable communication range and low equipment cost.

1. Introduction

As the information society has advanced, there have been discussions about objects that transmit information directly without human control [1]. In the real world, there are many objects that might want to send messages to persons. We studied the model in which signboards communicate with persons as "object-to-person" communication.

These days, advertising signboards in trains or on walls often include printed Web or e-mail addresses for the company or product. However, consumers must write them down or memorize them and later input them into an Internet access terminal, which is troublesome and inconvenient. What is needed is a means of easily acquiring such information from signboards in a directly usable form.

To solve this problem, some systems use mobile phones with built-in digital cameras, which are available now [2]. They can get information from advertisements directly by capturing a two-dimensional barcode and processing the image or by acquiring digital data from text in advertisements using image recognition technology. These systems require the user to move close to the signboard, so they are suitable for advertisement media that the user can take away (e.g., magazines and newspapers) and a system that needs authentication. They are not suitable for street signboards or advertisements in trains. The communication range can be extended by using wireless communication devices, such as Bluetooth or a wireless LAN, but such equipment is expensive. Inexpensive equipment is one of the important factors in enabling a system to become popular because, in the case of advertising, its effect depends on the number of consumers that can make good use of it. Therefore, the equipment cost should be as low as possible.

We studied wireless technologies to find a way to expand the communication range using inexpensive devices. In this paper, we describe our infrared signboard, which features a large communication range, signal multiplexing, and inexpensive equipment as a result of using infrared communication technologies originally developed for remote control systems.

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2. Proposed system

2.1 System configuration

The infrared signboard consists of the signboard and its peripheral equipment (**Fig. 1**). The signboard equipment can i) receive a request signal transmitted from a user terminal to a signboard indicating that the user wants to receive information from the signboard and ii) transmit the requested information. The user terminal can transmit the request signal and receive the desired information. If the user terminal is connected to a network (for example by wireless Internet access), the consumer can access an online web site within moments of seeing the signboard.

2.2 Communication media

There are several choices for the wireless communication media to use between the signboard equipment and user terminals. To expand the communica-

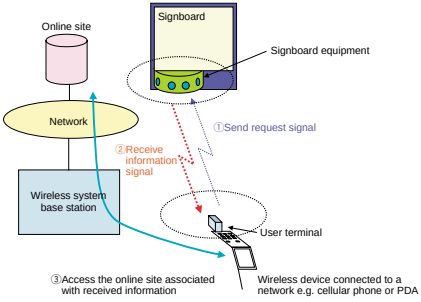


Fig. 1. System configuration.

tion range, we could use radio systems such as wireless LAN or Bluetooth [3], [4], but these would make the system construction cost high. To keep the cost low, we might use wireless tags [5], but if the user terminal is to receive information from the signboard anytime, it must incorporate a receiver, which makes the terminal expensive. Moreover, to avoid interference with nearby radio devices, the user terminal and the signboard equipment should control the directivity of the radio waves and the carrier frequency.

To achieve a reasonable communication range at a low system cost, we chose a remote control system based on infrared communication technology. The communication direction is controlled optically. There are several existing systems using infrared such as IrDA (infrared data association) [6], infrared wireless LAN, and remote control devices for consumer audio/visual equipment. In our intended application, the transmitted information is text strings (e.g., email addresses and Web addresses (URLs: uniform resource locators)), so the system does not need broadband communication. The bandwidth of infrared wireless LAN and IrDA systems is more than enough, but their power consumption is very large. Therefore, we chose to use a remote control infrared communication system that offers devices at low cost with low power consumption. **Table 1** compares various communication media.

One problem with infrared remote control systems is their low data transmission rate: only a few hundred bits per second because they are designed to transmit very little data. We want to transmit no less than 256 characters in 1 s to give our system good usability, so we need to raise the bit rate to several thousand bits per second. We achieved high-speed communication in our system by redesigning the transmitted codes

Table 1. Comparison of communication media.

System	Media	Communication range	Speed	Battery life	Directivity	System cost using commercial equipment
Wireless LAN	Radio	Several hundred meters	Up to 11 Mbit/s (IEEE802.11b)	Several hours	Depends on antenna characteristics	Several hundred dollars
Bluetooth	Radio	Up to 10 m (Class 1)	Up to 1 Mbit/s	A few days	Depends on antenna characteristics	Several hundred dollars
Wireless active tag	Radio	A few tens of meters	Several hundred bit/s	A few years	Depends on antenna characteristics	Several hundred dollars
IrDA	Infrared	1 m	Up to 4 Mbit/s	A few months	Optically tunable	Under 100 dollars
Remote control	Infrared	Several meters	Several hundred bit/s	A few years	Optically tunable	Under 50 dollars

and enhancing the modulation speed.

There are two choices for the communication scheme between the signboard equipment and user terminals: one-way communication in which the signboard broadcasts information periodically or two-way communication in which it transmits information upon receiving a request signal from a user terminal. Since signboards will not always be set up in places where electrical sockets are available, we must consider the maintenance of batteries to keep the proposed system running. Thus, the power consumption of the signboard equipment is an important issue. The two-way communication scheme uses less power.

2.3 Multiplexing scheme

A signboard is usually set up in plain view so as many people as possible can see it. Consequently, the signboard equipment must transmit its information to many people simultaneously. Therefore, we gave our system a multiplexing function. There are several kinds of multiple access schemes among radio systems for multiplexing user terminals at the base station, such as FDMA (frequency division multiple access), TDMA (time division multiple access), and CDMA (code division multiple access). These schemes can achieve effective multiplexing but the equipment tends to be expensive. The infrared communication scheme for remote control devices does not use any access control scheme to keep the cost low. In our system, we use a simple multiple access scheme that divides the communication space by controlling the directivity of the infrared beam, as shown in **Figs. 2** and **3**. The signboard equipment is

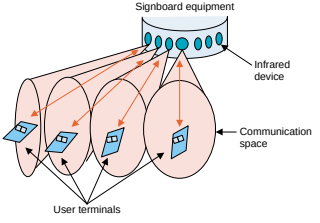


Fig. 2. Multiplexing scheme.

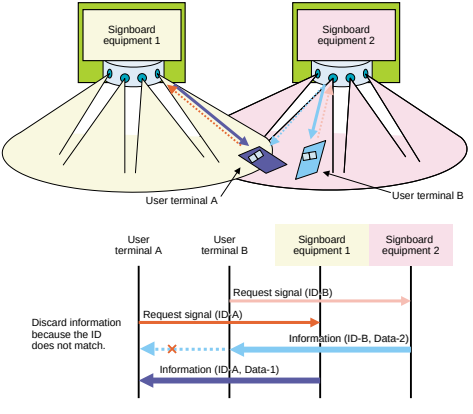


Fig. 3. Communication concept.

equipped with infrared devices that have limited directivity. The communication space in front of the signboards is covered by mounting these devices in a semicircle. If they were mounted in a hemispheroid, they could cover not only the horizontal space but also the vertical space. The proposed scheme provides two-way communication by equalizing the directivity of the transmitting and receiving devices. The user terminal's address is included in the request signal and the information signal to avoid interference with other devices in the neighborhood. A given user terminal receives only information signals containing its own address.

3. Development

3.1 Signboard equipment

The signboard equipment we developed is shown in **Fig. 4**. It has 11 pairs of infrared devices, set up 15 degrees apart. Each pair consists of an infrared transmitter and receiver that cover the same communication space. The transmitter is located directly below the receiver. The signboard equipment stores letter strings associated with the signboard and supports both one-way and two-way communication. In the case of two-way communication, after a request signal from the user terminal has been received, the transmitter located directly below the receiver sends the information signal together with the terminal's address to the user terminal. Also, when the signboard equipment selects one-way communication, it can transmit information with a broadcast address at certain intervals. The uplink and downlink communication speeds are different in the two-way communication mode. The request signal (uplink) uses very little data because it consists only of the terminal address, so we chose a slow modulation speed scheme for the uplink to reduce the power consumption of the receiver at the signboard equipment.

3.2 User terminals

Two examples of user terminal configurations are shown in **Fig. 5**. We developed small external devices (user terminals) that can connect to two popular types of mobile communication devices having built-in interfaces: a PDA (personal digital assistant) and a cellular phone (PDC: personal digital cellular). Both devices were designed as external devices because they are prototype models. However, they have few parts, so if our system becomes popular, the user terminal hardware could be incorporated into future ver-

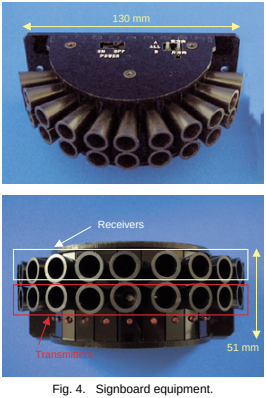
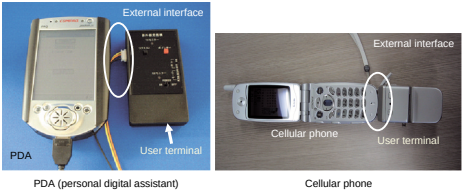


Fig. 4. Signboard equipment.



PDA (personal digital assistant) Cellular phone

Fig. 5. Examples of user terminals.

sions of such mobile devices.

The user terminal has a laser pointer to indicate the direction in which the infrared radiation is being emitted. If users see the light of another laser pointer on the signboard, they recognize that someone else nearby is also receiving information, so the laser pointer provides an anti-collision function in the proposed system. The user terminal stores a specific address associated with the connected device and sends this address when it transmits a request signal. When the user terminal receives information from the signboard, it checks the address in the received information. If the address matches the user terminal's address, it forwards the received information to the connected network device (wireless PDA or cellular phone) via the external interface. Therefore, the user can get useful information without having to manually input it. Also the user terminal supports both communication schemes provided by the signboard equipment. We experimentally confirmed that the communication distance was up to 10 m.

4. Conclusion

Our infrared signboard system lets a consumer get useful information easily from a signboard. We developed the signboard equipment and the user terminal. To ensure inexpensive devices and a reasonable communication range between the signboard and consumer we used infrared as a wireless medium and the infrared communication technology designed for remote control devices as the communication scheme. We developed a multiplexing communication system by mounting several infrared devices. The user terminal we developed can forward received information to another device directly because it has an external interface to connect to network devices such as wireless PDAs or cellular phones. We experimentally confirmed that the communication distance is up to 10 m. This system lets consumers connect to an online site associated with a signboard without inputting text strings and without getting close to the signboard.

References

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