An Information Broadcasting System with Infrared Data Communication Protocol

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Abstract: - This paper presents an information broadcasting system for portable information terminates with Infrared devices, such as PDA or handheld PC. To realize information broadcasting service by infrared optical media, we developed a new Infrared data communication protocol and a new infrared optical transceiver that can cover a much large area than normal IrDA device. We also designed a data management module and contents data structure for receiving data and accessing the data saved in PDA. In this paper, we will describe the protocol in detail and the information broadcasting system outlines. Based on the experiment results, a large service area and long communication distance can be guaranteed with the presented infrared communication protocol and enhanced infrared optical transceiver, and this may allow many PDA users obtain the service at the same time. An experimental broadcasting system was implemented for confirming the performance of the protocol and the system.

Keyword: - Infrared optical, IrDA, Communication protocol, PDA, Broadcasting, Palm OS

1. Introduction

Recent years, there has been an increasing trend toward miniature, light weight and high performance for the information portable terminals, such as PDA and handheld computers. Therefore, such increase in using of these devices has led to a desire for more wireless data connectivity, and it may be very important to provide the users with various medium for their various needs. There are basically two methods available for wireless data communication: radio and Infrared optical. Radio has become popular because it provides a high level of mobility. However, the radio spectrum is heavily congested and is strictly controlled by regulation especially in urban area. Also radio transmission required significant power consumption and the components for radio connection can be relatively expensive. In contrast, Infrared optical provides a limited range, but the Infrared spectrum is totally unregulated and can potentially provide very high data rates. Infrared optical components are both inexpensive and provide low power consumption. A comparison of radio and optical Infrared wireless strengths and weaknesses is presented in Table 1.

In 1993 the Infrared Data Association (IrDA), initially a working group of IT industry partners fronted by IBM, Hewlett-Packard and Sharp, set about establishing a standard for low-cost serial infrared communication. The resulting protocol set, IrDA 1.1 provides directed point-to-point...
communication with data rate up to 115.2Kbps, or 4Mbps with a high speed hardware extension. Devices such as digital cameras, mobile phones and PDAs can communicate each other using Infrared optical in addition to the traditional applications of file transfer and printing. The heart of the IrDA protocol is the IrLAP data link layer, which supports only point-to-point communication.

Recently, radio LAN services have been spread rapidly in many hotspots area and office building environment for its high data rates and wide service area covered. Almost all of PDAs products have a built-in Infrared interface that supports IrDA 1.1 or IrDA1.2. If the PDA users want to use such radio wireless connection to obtain information from Internet, they have to expend more to add some radio communication modules. Using radio module may reduce the battery time greatly, and this may be a fatal weakness for mobile device users who want to use the device for a longer time. When a lot of users access the network at the same time, it may bring a severe traffic congestion problem.

Because of increasing demand from more and more PDA users who want to obtain various information, we present a new information broadcasting system by means of Infrared optical. The aim of the system presented is to provide most PDA users a new style communication media, by which the PDA users may obtain the information for their business, travel, shopping and entertainments. PDA is not a receiver only, user can search the information that he is interested in from the received information by PDA’s communication ability. To obtain the service provided by the system, what the PDA users should do is only installing the application software in their devices, and they do not need to pay more for increase other module. It is expected that the new style information broadcasting service will expand the usages of PDA. Figure 1 shows a scene of usage of the system. To implement the information broadcasting system, there are two main technical problems that have to be solved. One is the communication protocol, another is the data architecture for saving and managing the contents data received by PDA. For the first one problem, there is an standard infrared communication protocol IrDA 1.1 supported by most PDA Infrared device, which supports only point-to-point communication. For the second problem, an efficient data architecture is necessary to access and reserve the contents data received by PDA terminal.

<table>
<thead>
<tr>
<th></th>
<th>Infrared</th>
<th>Radio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Power consumption</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Cost</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Spectrum restriction</td>
<td>Physical properties</td>
<td>Regulation, congestion</td>
</tr>
<tr>
<td>Pass through barrier</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Main noise sources</td>
<td>Ambient light</td>
<td>Other users, Electrical equipment</td>
</tr>
</tbody>
</table>

Table 1. Comparison of Wireless Infrared and Radio communications

Figure 1  Example of the Information Broadcasting System
2. System Summary
The information broadcasting system with infrared optical provides a one-way style data communication from a infrared transceiver to PDAs terminals. In this section, we give an overview of the information broadcasting system. The system components are shown in Figure 2. The PDA terminals receive the contents data from the infrared transceiver and save the contents in a form of database records. The transceiver is controlled by a infrared control unit that will control the infrared optical device to send contents data. If necessary, there may be a sensor in the control unit, which collect the accessing condition that may be useful for the contents distribution supervision in the contents server and contents providers. The control unit is connected to the contents server with Ethernet or radio wireless network. The contents server will supervise the contents for broadcasting, and send contents broadcasting schedule or command to the control unit of the infrared transceivers. For example, sending a contents distribution schedule to a specified transceiver control unit, sending a command to change the condition of a specified transceiver or collecting the accessing condition of each transceiver. The contents providers prepare or modify the contents and send them to the contents server by Internet.

The information broadcasting system employs two communication media: Infrared and Internet. The Infrared is used for packets from the interred optical transceiver to PDA terminals. An Ethernet is used to make connection between the infrared optical transceiver control units, the contents server and the contents providers with TCP/IP protocol. For the contents server and the infrared transceiver units are connected by Ethernet, the system administrator can access them from any machine that is available connecting to access internet. Therefore the supervision of the system is much easy to realize and should be efficient.

In order to allow more users to receive the information from the transceiver, we have designed a new Infrared optical transceiver, which can send out stronger (satisfying the safety standards) infrared optical and cover a larger area and distance required by system specifications. In our experiment device, we modified a Palm based PDA and designed a signal amplifier to amplify the current to drive an array of infrared LED. It supports a data rate up to 115kb within 5 meters.

3. Infrared Communications Protocol
The protocol stack of IrDA 1.1 is shown in Figure 3. There are three mandatory layers in the IrDA protocol stack; the physical layer, the LrLAP layer, and the LrLMP (Infrared Link management Protocol) layer. The latter consists of the LM-MUX (Link Management Multiplexer), which provides multiple application channel access to a link, and the LM-IAS which provides a database of supported services which can be interrogated by a device establishing a link. Optional components include TinyTP, a credit based transport control protocol; IrCOMM a serial cable link emulator; IrLAN a network interface component; and IrOBEX, an object exchange

![Figure 2  BIR Information Broadcasting System Components](image-url)
component. The IrDA physical layer provides the hardware for optical transmission and detection and signal modulation and encoding. An important aspect of the IrDA link that needs to be taken into account is that the link is half-duplex, i.e. the station can not send and receive at the same time. This is due significant cross-talk between the transmitter and receiver, which generally will incur some saturation latency. IrDA protocol is a Peer to Peer style half-duplex communication, and a communications link must be established before data communication.

Because much more than one user may receive the contents data from one infrared transceiver at the same time and in the same receiving area, it is obvious that the standard IrDA communication protocol mentioned above can not be used for data distribution in the infrared information broadcasting system.

The main aim of the system is to essentially provide a data broadcast service without link establishing operation. As shown in Figure 4, a new infrared communication protocol named as BIr (Broadcasting Infrared) is developed by modifying the standard IrDA communication protocol. In the protocol BIr, the IrDA physical layer that is machine related is reserved without any changes, and a new IrLAP and TinyTp layer which support data broadcasting for both infrared optical transceiver unit (sending only) and PDA terminal (receiving only) are developed. The IrLAP layer in BIr includes device discovery, data sending, data receiving and error recovery. The IrLAP frame structure in BIr is shown in Figure 5.

Table 2  BIr Protocol Driver’s Functions

There are 9 Protocol driver functions available in BIr as shown in Table 2.
B1r protocol has following characteristics:

1) Any negotiation connection is not necessary for data transferring, therefore a data transferring can be realized even the receiving side is not near to the enhanced infrared optical transceiver unit.

2) Because the IrDA physical layer is reserved, a troublesome development for this layer is not necessary.

3) TinyTP and IrLAP are put together and only functions used for the information broadcasting are implemented, therefore the new TinyTP and IrLAP is much compact and will not consume much sources in PDA which may have much sources available as desktop PC or handheld PC.

4) If necessary, more powerful code correction algorithm such as BCH, may be used to achieve a better data transferring reliance.

Because the highest data rate implemented in IrDA 1.1 is 115200bps, the default data rate is set as 115200bps. In the future, if PDA maker can provide a higher data rate for their products, B1r can be upgraded to a higher data rate easily, for the B1r protocol does not depend on the physical layer.

4. Information Broadcasting Method

Suppose that the infrared optical transceiver unit will broadcast N contents repetitively, and \( S_i \) (\( 1 \leq i \leq N \)) is size of ith content in byte. The broadcasting can be shown in Figure 6. The user with PDA terminal can receive the data sending by the infrared optical transceiver while turning the PDA infrared interface to the transceiver. If there is no transferring error happened, the minimum receiving time \( T_{all} \) to obtain all information can be calculated by

\[
T_{all} = \sum_{i=1}^{N} \frac{S_i}{V}
\]

where \( V \) is the average transferring time.

It may spend more time to receive all contents correctly, if there is any heavy disturbance around the service area. If user miss one content, he has to wait for another cycle to receive the contents again. Sometimes there may be a little error in the contents he received, but he has to discard all of the content and replace it by a new one. Of course, it is very inefficient for a large content. To reduce the receiving time as short as possible, a large content will be divided into several data frames that have smaller size compared with the content itself. The user may re-receive several frames of the content instead of the whole content, therefore it will cost less time after sending contents with frame unit. With this approach, if there is a un-recovery error while receiving one content, what we should do is re-receiving the frame that did not be received correctly only. Figure 7 gives an example of data frame and broadcasting under several cases. The case I shows a perfect condition, PDA user receives all contents A, B, and C, without any error happened. In case II, the user did not receive all of the contents, during receiving, some frames were missed. To obtain all contents, the user had to re-receive the missed frames again in next transferring cycle. In case III, during receiving the contents, there is a
renovation in the some contents, therefore, the user will re-receive the content again, and replace the old one with new one. In application layer, there is also contents management module, which provides user powerful functions for accessing the preserved contents, such as searching contents by key words, sorting them by category, deleting old or unnecessary contents. The data structure for contents saving in PDA is defined as shown in Table 3. There are three data blocks in this structure, general index information block, content text data block and image data block. In the general index information black, the first item and the second item are used for contents sorting and searching, the highest bit of the third item is used prohibition or permission data deletion. (1: prohibition data deletion; 0: permission data deletion). The forth item will indicate how many pictures in this contents, and the fifth item gives the offset for referring position of images data. The content text data block contains the text data including some command for font or text style or picture position. Based on the method and approach mentioned above, we implement the information system in a Palm based PDAs. Figure 8 shows some layout of the application in Palm based PDA.

<table>
<thead>
<tr>
<th>Size (byte)</th>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Category ID</td>
<td>Indicating category ID</td>
</tr>
<tr>
<td>4</td>
<td>Create date</td>
<td>Content making date</td>
</tr>
<tr>
<td>1</td>
<td>Attributes</td>
<td>Indicating condition such as reserve or delete</td>
</tr>
<tr>
<td>1</td>
<td>Picture numbers</td>
<td>Total picture numbers in the content</td>
</tr>
<tr>
<td>4</td>
<td>1st picture data offset</td>
<td>The offset from the head of data block for the 1st picture</td>
</tr>
<tr>
<td>2</td>
<td>1st picture size</td>
<td>The size of 1st picture</td>
</tr>
<tr>
<td>…</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>2</td>
<td>n-th picture size</td>
<td>The size of n-th picture</td>
</tr>
<tr>
<td>LT</td>
<td>Text data</td>
<td>Data of text including command for style</td>
</tr>
<tr>
<td>L1</td>
<td>1st picture data</td>
<td>Image data for 1st picture</td>
</tr>
<tr>
<td>…</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>Ln</td>
<td>n-th picture size</td>
<td>Image data for n-th picture</td>
</tr>
</tbody>
</table>

Table 3  Data Structure for Bir Contents

Conclusions
To provide a new service for rapidly increased PDA users, we present a new style information broadcasting system by means of infrared optical media. In our system, a new Bir protocol was developed and used for data transferring. Because of adopting an efficient data frame, an efficient data transfer may be achieved. A contents management approach and a data structure also develop for the contents service. For the data receiving is implemented by using the build-in infrared optical device in most PDA, so the user can obtain the
service without paying more. This information broadcasting service may be expected to provide PDA users various services in hotspots area, such as train station, shopping maul, airport and exhibition etc. In our future research, by modifying the data structure and management approach, a voice or video streaming service may be available with upgrade of infrared optical physical layer.

References: