IMPLEMENTATION OF EMBEDDED BLUETOOTH DATA BROADCAST SYSTEM

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Abstract

Enhance Data Rate (EDR) in Bluetooth 2.0 specifications provide condition for Bluetooth multi-point communication. Aiming at application requirements of Bluetooth technique in wireless communication, Embedded Bluetooth Information Broadcast System (EBIBS) based on ARM9 microprocessor S3C2440 was designed and implemented. The system runs on ARM-Linux operation system and achieves single point transmission, multi-point transmission and information update based on Bluetooth 2.0 specifications. BlueZ protocol stacks and object exchange (OBEX) were utilized to complete multi-point transmission. Device driver technique was used to switch core functions and retransmission mechanism to ensure reliability of information broadcast. The system has been verified at broad-level and practical application. The result was also provided.

Index Terms*: *ARM, Bluetooth, embedded, information broadcast

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1. INTRODUCTION

Bluetooth is an open standard for wireless data and voice communication. As a short-range wireless communications technology standard, Bluetooth technology has been widely applied in wireless communication field as personal communications devices, wireless network communication and various transmission systems for its advantages of low cost, low power, small size and etc. The intelligent and multimedia trend integrates embedded computer system and wireless communication application has become increasingly clear, both wide-area mobile communications and short-range communication technology have played a pivotal role in information society. Embedded Bluetooth application that integrates embedded technology and Bluetooth communication is one of development directions currently and future. Traditional Bluetooth communication based on 1.0 specification only supports unicast.

As Bluetooth technology develops, the Bluetooth 2.0 specifications add EDR technique to improve throughput of Bluetooth data transmission and provide condition for multicast communication. In the current data communication researches about Bluetooth 2.0 specifications, the general Bluetooth data communication system and wireless intelligent home gateway are based on unicast not considering information broadcast functions. According to 2.0 specification and combining with TDD technique, the paper implemented Bluetooth information broadcast system and completed multipoint transmission and network communication among Bluetooth devices.

Information broadcast and information update with Bluetooth provides broad development space for advertisement and other industries related to information publish The paper is organized as follows. In section 2, we give system functions as well as software and hardware architecture. The specific implement of information broadcast function is conducted in section 3. Section 4 introduces implement of information update. The test on information broadcast and information update is carried out in section 5 and section 6 concludes our work.

2. Device FUNCTIONS, ARCHITECTURE

2.1 Device Overall Framework

The designed EBIBS mainly complete two functions, namely information broadcast and information update .The information broadcast completes the task that sends information to multiple Bluetooth devices around EBIBS at the same time, mainly including information unicast and multicast. Information update achieves network communication between EBIBS and PC. It completes seamless connections between Bluetooth and TCP/IP. Users are permitted to access file system via FTP, so the EBIBS can timely update information based on user requirement, which greatly improve system operability. The architecture of EBIBS is shown in Fig. 1. In addition, user interaction interface was designed. The USB host in interface improves system scalability and portability.

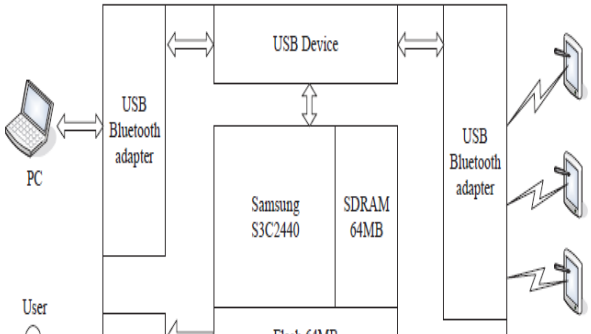

Fig-1.EBIBS architecture

2.2 Device Hardware Framework

The EBIBS is based on ARM hardware development platform and uses Samsung S3C2440 as core processor. The micro-processor constitutes core embedded system with 64MB SDRAM and 64M Flash. It runs ARM-Linux-2.6.12core operation system, where Bluetooth bus-system is configured to provide driver for USE Bluetooth adapter. As core communication component, Bluetooth adapter connects to USB device interface. LED and key constitute hardware part of user interaction interface. The system is easy to extend function and migration system. Developers can download operation system core and upper applications to SDRAM or Flash via USB Host interface and debug applications with RS-232 serial port.

2.3 Device. Software Framework

Software framework can be divided into two main modules, namely information broadcast module and information update module. The information broadcast module can be further divided into three sub-modules: information management module, device query module and information transform module. Information management module is responsible for sorting information so that user can send it in specific order. The device query module uses Service Discovery Protocol (SDP) to obtain information of surrounding Bluetooth devices service and automatically filter remote device with object push service as discovery objects. As core module, information transform module complete information broadcasting. LED driver and key driver are added into system to provide low level software support for user interaction functions. The software framework of EBIBS is shown in Fig. 2.

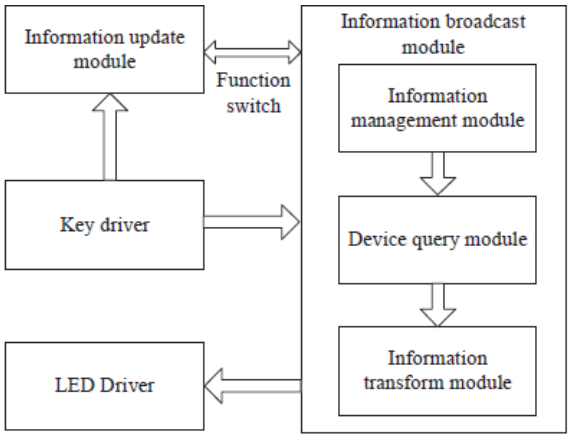

Fig-2. Device software framework

Information broadcast module and information update module are designed according to official Bluetooth protocol BlueZ and OBEX, where BlueZ includes two parts of core library bluez-libs and bluez-utils utility. The latter provide developers with tools support for upper-level applications.OBEX protocol is realized by OpenOBEX application function library. Therefore, the design firstly implements migration from BlueZ and OpenOBEX to ARM9 hardware platform system and then achieves other functions. LED and key driver are designed according to embedded character-driven technology.

3. DATA BROADCAST IMPLEMENT

3.3 Unicast Implement

As information unicast basis of information broadcast, it is also the core of design. The system firstly complete file transmission process in single point mode. The process is based on OBEX protocol and uses OPENOBEX function library achieves object push on some remote device. OPENOBEX function library completes session layer operation and corresponding object model description of OBEX protocol. Fig. 3 shows complete process of object push.

(1) OBEX-INIT() function is used to initiate OBEX entity,including initiate transform type, socket description, maximum size of send packet and maximum size of receive packet and then return a entity handle.

(2)Store target Bluetooth device address, object push service channel number and information file name to corresponding local variables.

(3)Call BtOBEX_TransportConnect() function establish transmission connection. The function firstly initiate transmission attributes of local and remote OBEX entities and then call socket () system function to create local socket. The bind () function is used to bind socket and process and connect()

function is used to connect local device socket and remote socket. Finally return connect () system call. If the return value is 0, it indicates the connection is successful.

(4)Broadcast system send connect request to remote device. It firstly call OBEX-Object New () function to create a send request object and then call OBEX-Client () to write request into local device, and then send it out. At this moment, broadcast system calls OBEX-Handle Input () function to wait fro response signal of remote device. The function call select () and register socket between broadcast system and remote device so that system can listen to events on the socket. After remote device responds, the function will read and process received data, otherwise the function will block. If returned event variable is OBEX_RSP_SUCCESS, it says that remote device respond successfully.

(5)Send file object to remote device. Firstly, build_object_from_file () function is used to create file object. The function will access related file information about file content, size and send the Object out. Then it waits for response from remote device.

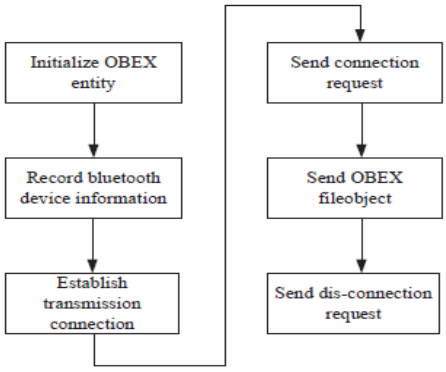

Fig-3. Object push protocol implements process

(6)Send disconnect request to remote device. As same to send connect request, after remote device successfully respond, it disconnects .With the above process, system completes once file object transmission with object device. In case of information broadcast, the process is called recycled to complete file transmission.

After all transmission tasks completed, information transmission parent process firstly determine whether all child process has exited. If so, enter into next round transmission, otherwise it will block operation and wait for other child process to exit. Each child-process will then create information push child-process. The process call object push function to complete transmission to some device. In the process to waiting for push, child-process query user key signal and respond.

In the waiting period, retransmission mechanism is initiated to determine reason of child-process exiting. If the reason is file transmission complete or user deny, send next information. If the connect is failed to establish for Bluetooth channel competition, re-initiate connect and the number should be no more than 5 times. In order to avoid frequently send information to same remote device, the system set transmission time interval of 10min in particularly. If system detects some device in 10min for the second time, it cancels transmission to the device. If it found the device after time interval, re-send information to the device.

3.2. Multicast Implement

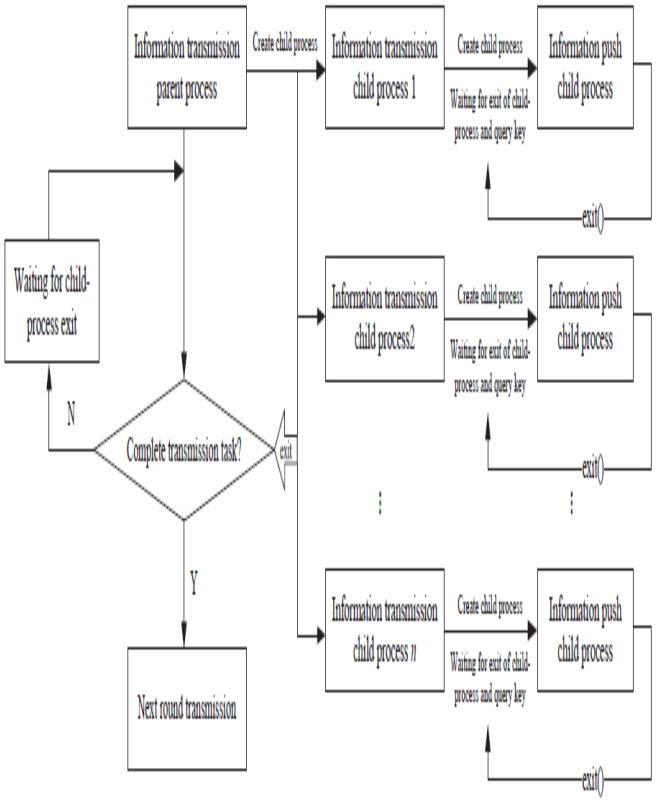

Fig-4. Multicast transmission flow

Multicast transmission uses TDD and EDR technologies in Bluetooth protocol to implement information transmission from system to multiple Bluetooth devices. Meanwhile, multiple process technique is used to reasonably manage multiple transmission processes, so that the information can be sent to remote device effectively and promptly. The TDD technique is used so that multiple devices can share a physical channel. Data is packet and sent in time division multiplexing manner. The EDR technology increases transmission bandwidth and transmission rate of Bluetooth data so as to improve information

multicast transmission efficiency. The multicast transmission process is shown in Fig. 4

Firstly, information transmission parent process creates child processes whose number is equal to that of Bluetooth devices. Each sub-process independently undertake task that send information to Bluetooth device so that information can be broadcasted to multiple devices.

4. DATA UPDATE IMPLEMENT

Information update function uses PAN technique to establish network communication between broadcast system and PC based on TCP/IP. In the Bluetooth network ,the client is called PAN or PANU, while server provides two kinds of services(Network Access Point) NAP and (Group Network)GN. In EBIBS, NAP is used for networking. There are only two devices in the network, namely PC and broadcast system. The role of PC is PANU and system is NAP, which acts as server.

Firstly, the system is in listening state. At this moment, Bluetooth software in PC is used to query NAP service of EBIBS and networking request is broadcasted. After system has listened connection request, it responds. After successful networking, broadcast system will automatically assign IP to PC and set its own address. If the IP of PC is set in same network segment with broadcast system, PC can immediately communicate with system via TCP/IP and update information in broadcast system through FTP.

5. RESULT AND ANALYSIS

5.1. File Unicast Test

Take Bluetooth broadcast system as sender and mobile phone with Bluetooth service as receiver. Five times of file transmission were carried on a phone and file transmission time was recorded to compute average transmission rate. The result is shown in Table 1. All received image can be normally showed in the phone. Result shows that unicast performance is stable in case of different size and different format. The maximum rate is up to 19.7KBps, which can meet general Bluetooth communication requirements.

Table-1.File Unicast Test Results

File	File size/KB	Average transmission time/s	Average transmission rate/KBps
1.jpg	105	6.3	16.7
2.gif	223	11.7	19.1
3.jpg	339	18.7	18.1
4.bmp	469	24.1	19.5
5.jpg	575	29.2	19.7

5.2. File Multicast Test

The experiment is mainly used to test connect reliability and file transmission time.

(1) Compare connect success ratio before and after adding retransmission mechanism to show the importance of retransmission mechanism on improving reliability of multicast. The method to compute connection success rate is as follows:

Connection success rate = number of successful connections /(information number in each group□number of device) □ 100%.

Firstly, we tested connect success rate between test system and remote device before retransmission mechanism was added.Taking mobile phone as receiver client, the result is shown in Fig. 5. The results show that the connection success rate is only 53.33%, which cannot meet actual needs. Added retransmission mechanism, connect success rate is up to 100% in all cases. The connection reliability is significantly improved to meet practical application needs.

(2) Test multicast transmission time to illustrate role of TDD in practical transmission. Broadcast system sent a 200KB JPEG format image to all phones and number of phones increase from 1 to 5. The test result is shown in Fig. 6. Received image can all be normally showed on 5 phones, which indicates multicast transmission is stable and reliable and there is no packet loss. As phone number increases, transmission time also increase, which indicates that TDD reasonably packet data and transmission is reliable. In case of 5 phones, the average transmission rate is about 58.8KBps, which has been greatly improved compared with average transmission rate of unicast.

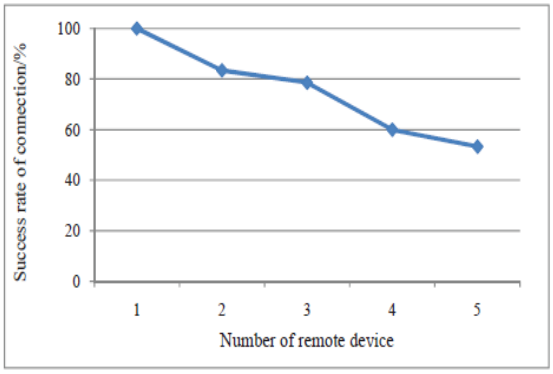

Chart-1: Test results of connection success rate

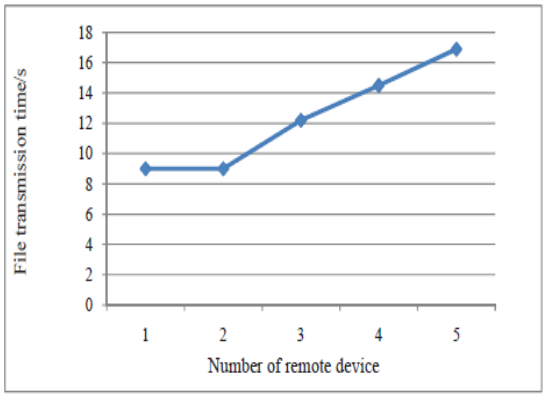

Chart-2: Test results of File transmission time

CONCLUSIONS

The paper implemented BlueZ protocol stack and OpenOBEX function library based on ARM-Linux with ARM hardware platform. The information broadcast and update function was achieved based on Bluetooth 2.0 protocol. The focus is on information unicast and multicast. The EBIBS is low cost, high reliability, real-time and can be flexibly extended. It also has good portability and interactive features. The program can be applied to variety municipal and public place propaganda system combining with multimedia technologies. It can also be used form publish of commercial advertisements, which has a good prospect.

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