Development of an Electronic Ordering and Payment System with Embedded Devices

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Abstract

In this paper, we propose an electronic ordering and payment system with embedded devices to improve a conventional manned ordering and payment method using a POS system for quick and easy ordering and payment. Embedded devices as thin clients of the proposed system can be placed on each table, and a user can choose a menu and can check his payment from the screen easily. After a user completes an order, the ordering message is transferred to server for preparing the chosen menu at a shop counter or a cooking place in a restaurant. The proposed system also provides various multimedia contents such as advertising information to users during wait time. Finally we successfully verified the feasibility and the effectiveness of the proposed system by conducting an experiment of ordering and payment checking with several embedded client systems connected to a server system. The proposed system can be applied to an unmanned ticketing or dispenser system, an information kiosk and a guidance robot.

Keywords: *Embedded System, Electronic Ordering and Payment, Window CE, Server-Client Programming*

1. Introduction

With the development of information communication industry, existing appliances or electronic products go beyond simply performing their features to develop into information electronic appliances and embedded systems. These embedded systems ask for progressive features such as portability, wireless communication, power consumption, user interface and security, *etc.*, and their operating systems are efficiently designed to use limited resources efficiently and to exhibit high performance even in complex environments [1].

Embedded systems including home appliances such as DVD players, MP3 players, camcorders, digital cameras, refrigerators and washing machines, *etc.*, and elevators, aircraft, medical equipment, automobile, plant control and communication equipment are all easily seen around us. Embedded system is going to be used as human-machine interface apart from the application to the current specific areas.

Operating systems for embedded system currently used include Windows CE, Linux and Android. Windows CE [2], the operating system used in this paper has the following six strengths: First, it was designed in an open architecture that can be used for a variety of equipment; Second, it supports 32-bit, multitasking and multi-thread; Third, it supports various kinds of communication equipment such as infrared port, serial port, USB, 1394 and 802.11, *etc.*; Fourth, Windows CE consists of more than 60 components, which can form an

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OS appropriately combined for hardware; Fifth, it supports various processors and Win32 and API; and Sixth, it provides with integrated development environment.

Thus, this study aims to develop an electronic ordering and payment system based on an embedded system using Windows CE OS. Currently, at fast food stores or restaurants, customers make orders by calling with a bell and talking to the employee. In this way, sometimes there are mistakes, so this system reduces the inconvenience of having to ask the staff about order menus and prevents them from the inconveniences in advance.

With the proposed system, customers make orders and payments while sitting at their seats and can use various multimedia contents. In addition, the developed system can be applied to unmanned ticketing or dispenser system, information kiosk, or various guidance robots [3].

2. Overview of Electronic Ordering and Payment System

Generally, a person goes to a place where there is an order POS system, makes an order, and receives a bill when he goes to a shop or a restaurant. This method shows a phenomenon in which there is a delay when people request for orders at the same time except for the first person ordering.

To solve this problem, this study uses an embedded electronic ordering system. In the embedded board, when a user enters order information through a touch screen, the order information is sent to the server computer exclusively for ordering and the employee check it out. On the tables, each client embedded board is arranged which is connected to the server computer.

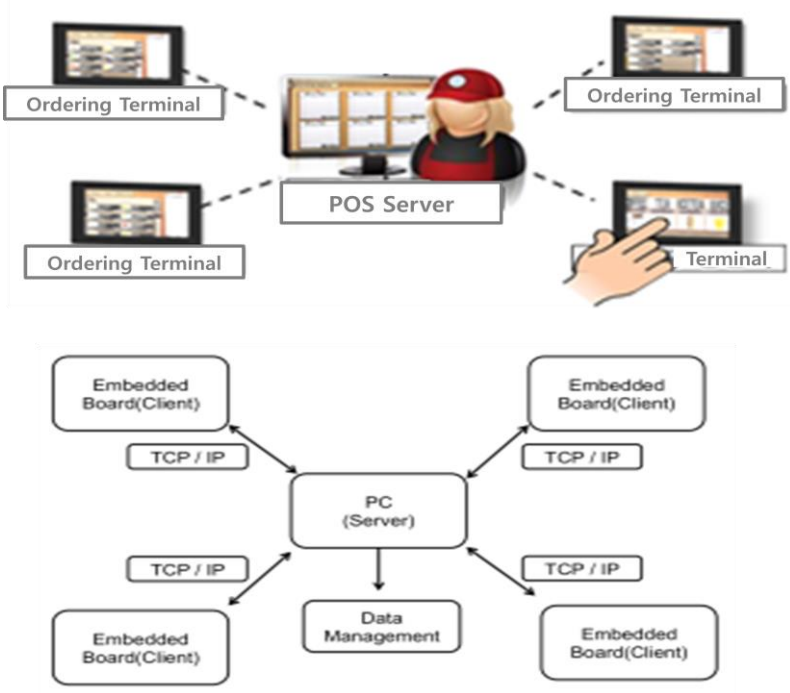

Figure 1. Overview of Unmanned Ordering and Payment System and its Hardware Structure using Embedded Devices

In this study, multiple client embedded boards are connected to one server computer using a client/server system The client embedded board carries out ordering and payment through the connection with the server, and in addition, various contents such as music video, books of the month, and advertising, *etc*., can be used by the transmission/reception of data through the server computer. Figure 1 shows an overview of the proposed unmanned ordering and payment system and its hardware structure using embedded devices.

3. Payment System and Multimedia Contents Retrieval

In this research, servers and multiple clients can be connected through the networks in TCP/IP Ethernet mode, where order list of each client can be checked. Each client transmits order lists and payment lists through the network to the server in a wireless network [3].

3.1. Payment system using Open-API

OpenPay API is a new concept payment system in a form of Web 2.0. Its relevant payment module is merged in to the bill. There is no need to move to a new web page or to show a pop-up for payment. Figure 2 shows an overview of the OpenPay API payment system.

Simultaneously with pressing the payment button, in the current order sheet page, the payment module is embedded in real time, and without need of building a separate ActiveX installation and the bank system, in any Internet available environment, it provides input window for each payment means for the user to make payment conveniently.

The stability of all information coming and going in payment through OpenPay API payment window has been secured through HTTPS communication, so it can be used conveniently. This study plans to apply a payment service using the OpenPay API payment system.

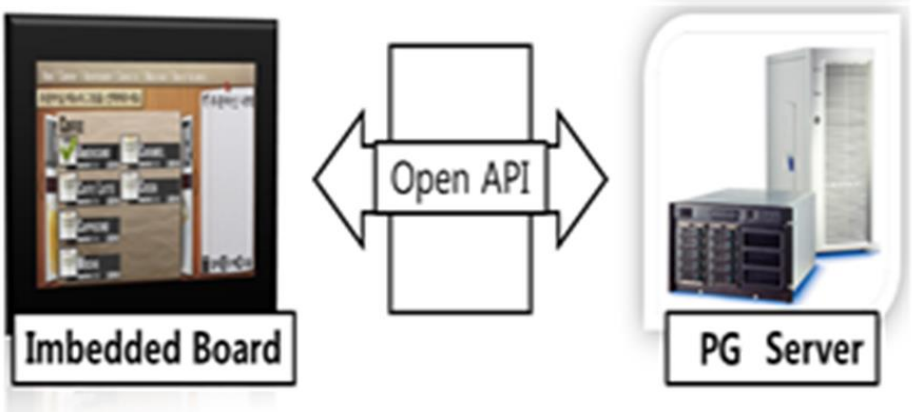

Figure 2. OpenPay API Payment System

3.2. Multimedia contents Retrieval on Embedded Device for Entertainment

Using the Internet environment, the latest music videos in You Tube can be viewed, and if the books of the month menu is opened, the books of the month list provided from the professional books web-site for the relevant month can be viewed, and if the relevant book is selected, its brief synopsis can be read as shown in Figure 3. In addition, there is an advertising menu, so various companies can promote themselves to the users of the electronic ordering system through the embedded board.

Figure 3. Menu screen of Music Video Clips and Books of the month

4. Development of Electronic Ordering System using Embedded Devices

In Window CE 6.0 environment with a convenient embedded system, an ordering and payment system is integrated and implemented. In other words, software implemented in a general PC is developed so as to be compatible with the embedded system. In addition, the source code of the part where the video processing speed gets slower than PC in the embedded system is optimized. Figure 4 shows the embedded device and the table 1 shows the specification of the embedded board including ARM1179JZF and wireless LAN which is used in this research [4].

Figure 4. Embedded Board IEC667

Table 1. Specification of Embedded Board

Item	Specs.
CPU	32Bit RISC ARM1179JZF - 667MHz
Memory	256Mbytes Mobile DDR2, 128Mbytes NAND Flash
Ethernet	SMSC LAN9220 10/100Mbps
WLAN	USB Type Wireless Lan
USB	USB 1.1 Host, USB 2.0 OTG
LCD	8Inch TFT, Resolution: 800×600, 4:3

4.1. Network Protocol for Electronic Ordering and Payment System

This system generates the sockets of the server and the client using TCP/IP socket function. The server defines the properties of the sockets using port, address and other necessary

information for electronic ordering and payment system. The sequence of server and client communication is shown in Figure 5.

The server creates a listening socket to receive the client's connection, and the client's connection is made through the listening socket. The server receives connections from the client, brings the first connection from the queue in which unprocessed connections are waiting and generates a newly connected socket.

The client attempts connections to the server by calling Connect, and if the server side calls Accept, then the server generated a gang socket, and using the generated gang socket, it communicates with the client. The client transmits messages to the server, and the server receives the messages from the client. The client closes the socket if the message transfer to the server is completed. The server closes the socket if it receives EOF (End Of File) from the server.

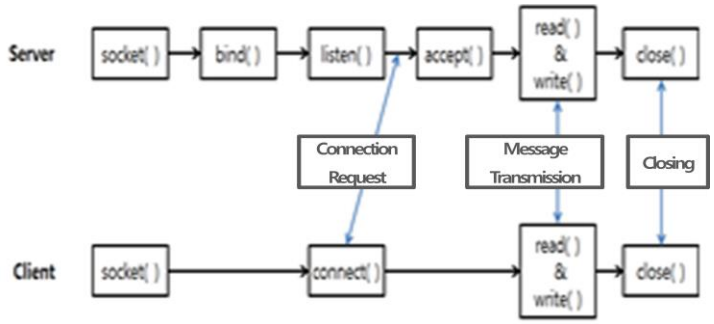

Figure 5. Sequence of Server and Client Communication

4.2. User Interface of POS Server and Ordering Terminal

A user interface of a server and a terminal program for ordering is composed using Window CE. 6 The server consists of 6 tables to receive data from the ordering terminal, and the terminal program for ordering consists of menu buttons, order list, payment, delete, call, advertising and various multimedia contents. Figure 6 shows the screen of POS server UI (User Interface) and Figure 7 shows the screen of ordering terminal UI.

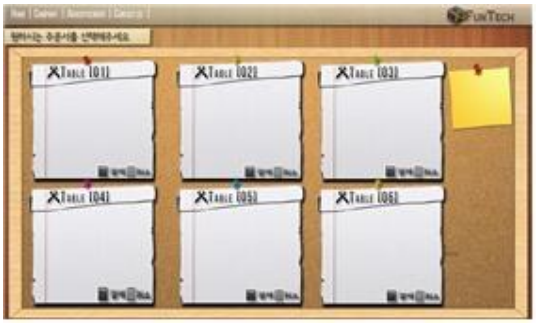

Figure 6. Screen of POS Server UI

Figure 7. Screen of Ordering **Terminal UI**

5. Experimental Results

The developed electronic ordering and payment system has been successfully demonstrated after configuring one POS server and four ordering terminals using embedded devices. In the ordering terminal using embedded device, a user can click on a menu button he or she wants among 4 buttons of Coffee, Tea, Iced Tea and Juice. Figure 8 shows the screen where one clicks on a menu button that he wants.

If the user clicks on the menu button he or she wants, sub-menus for the top menu show up. On the sub-menus, the user can see the price and evaluation of the menu he or she wants, and through the order list, he or she can choose and cancel menus. On the sub-menus, price and taste evaluation, and order list can be checked.

Figure 8. Screen of Menu Selection using Ordering Terminal

The ordering menu finally sent from the ordering terminal shows up in a position for ordering terminal number and server table number while the server checks the ordering menu. Figure 9 shows the screen of contents ordered to the server.

A set of test between one server and multiple clients was carried out. Each ordering terminal tries to connect to the server, then if connection is success, then it sends the ordering data to the server once the order has been made.

When the data transmission/reception between the ordering terminal and the server was checked, there was no problem in the data transmission. However, the embedded system used in the ordering terminal did not have a fast processing speed unlike PC, so the delay time in the treatment process was longer than expected. This problem of the embedded system's processing speed was solved by correcting and simplifying the coding contents of the

program itself to minimize unnecessary calculations and coding it so as to bind the same job together to increase the speed.

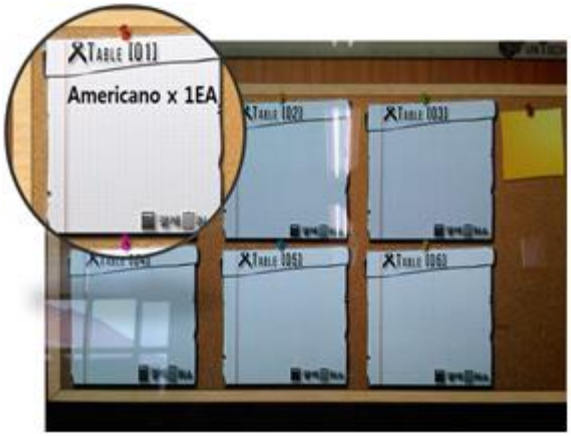

Figure 9. Screen of Notifying Selected Menu in POS Server

.NET Framework 2.0 and Windows CE 6.0 environment base had been very limited in the use of functions for general Visual Studio 2008 C#. This problem was solved by interpreting functions in existing coding and implementing them newly for Windows CE 6.0 [5].

We also need to deal with the performance optimization of embedded device. Since it has various multimedia contents as well as menu images, in executing in the embedded board, computation speed is relatively slow and there is a limitation of the memory size, so optimization was necessary.

A field test was also carried out in a cafe. During the service, the electronic ordering system corrected ordering message from ordering terminals in a real time as shown in Fig. 10. We verified the usability of the proposed server client system for electronic ordering and payment by conducting the field test as an on-site service experiment.

Figure 10. Field Test of Electronic Ordering and Payment System

6. Conclusion

This paper proposed an electronic ordering and payment system with embedded devices to improve a conventional manned ordering and payment method using a POS system for quick and easy ordering and payment. Embedded devices as thin ordering terminal clients can be placed on each table, and a user can choose a menu and can check his payment from the screen easily. After a user completes an order, the ordering message is transferred to server

for preparing the chosen menu at a shop counter or a cooking place in a restaurant. The proposed system also provides various multimedia contents such as advertising information to users during wait time.

An electronic ordering system is expected to be used at a restaurant or a pub where there are a lot of guests while few employees are working. However, there is a burden of having to install as many embedded boards as the number of tables in an early stage. This problem can be solved by connecting to a server through an application exclusively for smart devices changing the target from embedded boards to personal smart devices currently in wide use [6].

This paper developed a fast and efficient ordering and payment system that can be applied to an embedded system with relatively low specifications. For quick order and seamless data transmission, we optimized the developed server client program and the data between the server and the clients to stabilize the system. When not a single but a multiple transmission/reception from the server was checked by using 4 embedded boards, the data transmission was made well.

Finally we successfully verified the feasibility and the effectiveness of the proposed system by conducting an experiment of ordering and payment checking with several embedded client systems connected to a server system. The proposed system can be applied to unmanned ticketing or dispenser system, information kiosk, or various service robots.

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