Proceedings of the 5th WSEAS International Conference on Signal Processing, Istanbul, Turkey, May 27-29, 2006 (pp255-260)

An Innovative Video Phone System in DHCP and Firewall Network Environment

BING-FEI WU, CHAO-JUNG CHEN, and HSIN-YUAN PENG
Department of Electrical and Control Engineering
National Chiao Tung University
1001 Ta Hsueh Road, Hsinchu
Taiwan, R. O. C.
http://cssp.cn.nctu.edu.tw/

Abstract: - In the decade, the video phones have brought the intense interests for its service. However, the limited network bandwidth, the unfriendly operations like IP dialing, and the dynamic host configuration protocol, DHCP, environment bound the development. An innovative video phone system, IVPS, based on a creative data transmission architecture has been presented in the paper, especially the advantage of operating in the DHCP and firewall environment. Moreover, IVPS retains the traditional dialing way with telephone number and downward capability with the recent analog telephone. Therefore, the users can enjoy IVPS in their familiar operations.

Key-Words: - DHCP, video phone, Firewall, telephone.

1 Introduction

Recently, the video phone systems have brought the extreme interests for their services, since the analog telephone system could not satisfy the eager communication demands [1]. Users expect a video phone to transmit their emotions clearly and warmly to their friends or families. The PC-based video phone system has been first presented in [1], which is realized under Integrated Services Digital Network, ISDN. H.32x protocol which includes H.26x is widely used in the recent video phones [2-5]. The video and the voice bit streams are transmitted together through the Ethernet at the same time. That is, the Ethernet bandwidth is shared by video and voice. The delay and the intermittence of video and voice are unable to be avoided. Furthermore, the approach of IP dialing is not friendly for users because they can not always understand their current IP address in the dynamic host configuration protocol, DHCP, network environment which normally exists in the home asymmetric digital subscriber line, ADSL, connection. Most users do not know their IP address because it is not fixed, and it will change dynamically. Therefore, when the users want to communicate with each other via video phones, they don't know what to dial. The video phones manufactured by Leadtek can partially solve this problem by using Gatekeeper [6]. To use this service, the users must register their phone numbers in advance, and then set up various items in the video phone system. Moreover, if the users want to use both traditional telephone and video phone, they have to prepare two different phones. With these serious disadvantages, the video phone system now is too complex to use.

Lately, the internet virus problems are growing rapidly, so the software or hardware firewalls are commonly adopted by the users. The video phone systems now can establish the connection through the firewall if and only if the firewall revokes some specific blocking internet ports. In this situation, when someone listens to these ports on purpose, the private video and voice data will be stolen away.

In the proposed innovative video phone system, IVPS, video and voice were sent or received in different ways. Two channels, Public Switched Telephone Network, PSTN, and Ethernet were established when the video phone call is originated. A revolutionary hand shaking processes, RHSP, are embedded to IVPS with the dual tone multi-frequency, DTMF, signal to handle the IP address transmission work in DHCP environment. DTMF uses two tones to represent a numeral, and the frequencies were chosen to avoid harmonics. Table 1 shows the relationship between the numerals and the frequencies. Since the recent analog telephones also use DTMF to transmit the phone number, IVPS owns the downward capability.

The home appliances now should not have only one function. IVPS also can be am embedded home surveillance system because IVPS also has a camera to capture the real-time images. If the users have to leave home, they can put the camera to the place

which is concerned. When they are at offices or other places, IVPS near them can be used to establish the connection with IVPS at home. Therefore, IVPS is not only a video phone system, but also a home surveillance system that can protect the users' properties.

The main contribution of IVPS is that it adopts dual-channel connection which can effectively provide higher Ethernet bandwidth for transmitting the video bit stream than traditional video phones. Moreover, IVPS can easily establish the connection even in dynamic IP address and firewall network environment. Furthermore, IVPS has rich functionalities since it can be a home surveillance system by monitoring both video and voice.

The rest of this paper is organized as follows. Section 2 shows the overview of IVPS. Section 3 presents the architecture and processes of IVPS. Section 4 depicts the results of implementation and Section 5 draws conclusions.

Table. 1. The relationship between the numerals and the frequencies.

Frequency (Hz)	1209	1336	1477	1633
697	1	2	3	A
770	4	5	6	B
852	7	8	9	C
941	0	*	#	D

2 System Overview

As shown in Fig. 1, an x86-based embedded platform is applied in IVPS. The DTMF module plays a key role for the IP address transmission. It translates the numeral to dual tone signal so that the data exchange will be processed.

Concerning about the software, the Linux 2.4.20 kernel is built. The H.263 codec is applied in IVPS for video compression.

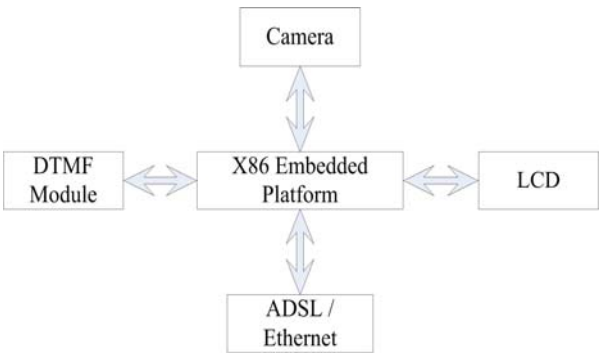


Fig. 1. The x86-based video phone hardware architecture of IVPS.

3 System Architecture and Processes

In this section, the development of the innovative connection method which can successfully solve the linking problem in DHCP and firewall network environment will be described. Furthermore, the design and implementation of the DTMF modules that can be the bridge between IVPS and the physical telephone line are presented.

3.1 Transmission Architecture

In IVPS, video and voice data are sent or received in different ways. Two channels, PSTN and Ethernet were established when the video phone call originated. The voice trunk passes through the PSTN and the video bit stream goes through the Ethernet, as shown in Fig. 2. In addition, the smooth voice has also retained in IVPS because the voice is the most important human sense in phone calls. The voice quality of traditional telephone is preserved. Since voice won't occupy the bandwidth of Ethernet any more, the saved bandwidth can fully support the better video streaming.

The traditional dialing way of the telephone number is more familiar to most people so that the IP dialing was a strange operation. Under this architecture, users can keep the telephone number dialing in IVPS, rather than the recent systems which are with the IP dialing.

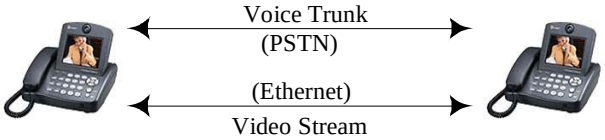


Fig. 2. The transmission architecture of IVPS.

3.2 Revolutionary Handshaking Processes

The DHCP network environment exists in almost all of home today, especially in Taiwan. The IP addresses are always different after each reconnection. In the general case, the call originator doesn't know the IP address of their video phone at the beginning of the operation. To solve this problem, RHSP is integrated to IVPS with applying the DTMF signals. As shown in Fig. 3, the call originator's IP address will be sent to the call terminator by DTMF signals to build the Ethernet connection for video bit stream transformation if it receives the video phone definition codes, "#A", from the call terminator.

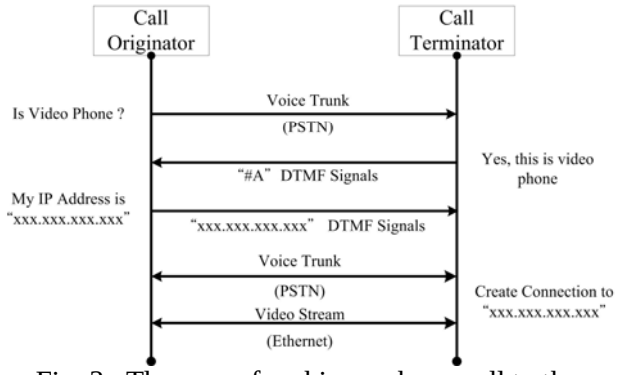


Fig. 3. The case of making a phone call to the terminator.

IVPS will detect that whether the terminator is the compatible video phone system or not. Fig. 4 shows the case of making a phone call to a traditional telephone. No matter what kind of the terminator is, the originator retains consistent in dialing the telephone numbers. The phone call will also be established as that between two traditional telephones.

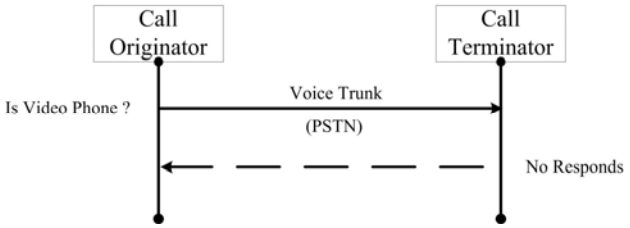


Fig. 4. The case of making a phone call to the traditional telephone terminator.

3.3 The DTMF Modules

The DTMF modules are responsible for transmitting and receiving the data through the PSTN line. In the call originator, the floating IP address and the control signals are transmitted to the call terminator via the DTMF modules which includes an 8051 microcontroller, DTMF receiver, DTMF generator and ring detection circuits. The 8051 microcontroller will control the DTMF receiver and the generator. Moreover, it will communicate with IVPS by RS232. The relationship between IVPS and the DTMF modules is illustrated in Fig. 5, and the overall block diagram of the DTMF module is shown in Fig. 6. Since the IP address is composed of the numbers from 0 to 9, it can transmit and receive by the DTMF modules.

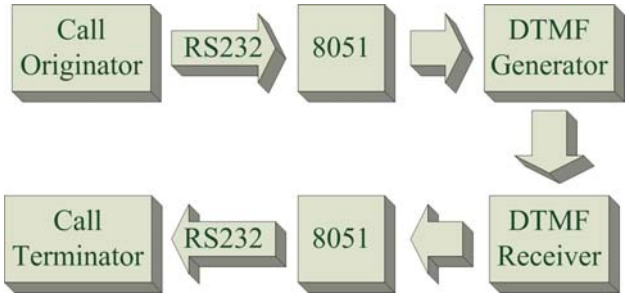


Fig. 5. The relationship between IVPS and the DTMF modules.

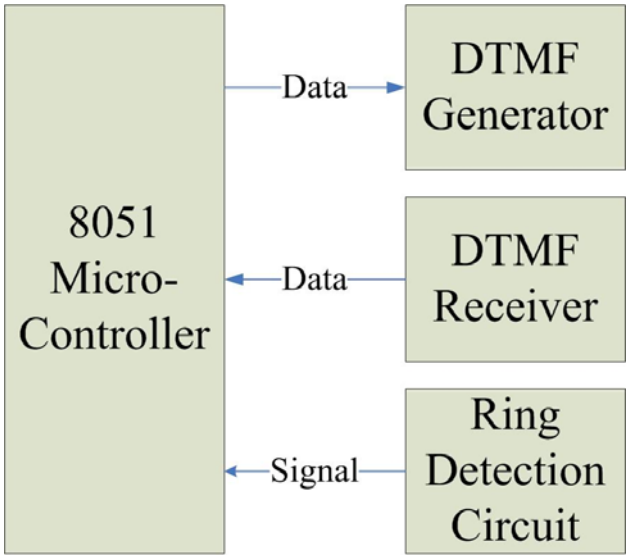


Fig. 6. The overall block diagram of the DTMF module.

3.3.1 DTMF Generator

The IC HT9200A is a serial mode tone generator, and the 8051 microcontroller will input the data at the corresponding timing which is illustrated in Fig. 7 with the stop code, 1111 [7]. After the signals are transmitted, the IC will generate the consonant DTMF signals. Fig. 8 illustrates the circuit diagram.

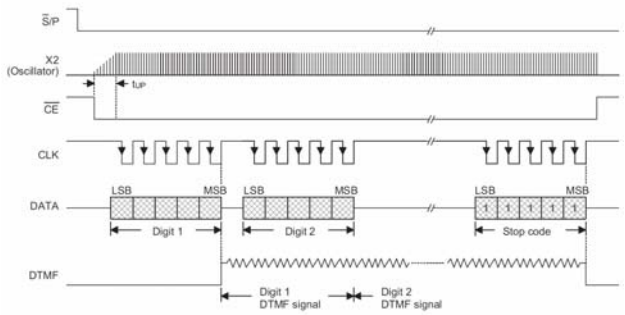


Fig. 7. The timing diagram of HT9200A.

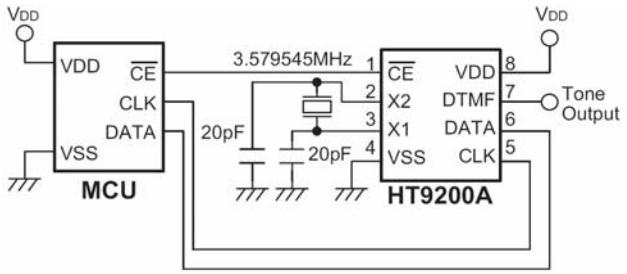


Fig. 8. The circuit diagram of HT9200A.

3.3.2 DTMF Receiver

The IC HT9170B is used to detect the signals which are generated by pressing the buttons on the telephone [8]. After receiving the data, the IC will decode them into binary numbers in the form of four bits, and then the IP address can be recognized. Fig. 9 shows the circuit diagram.

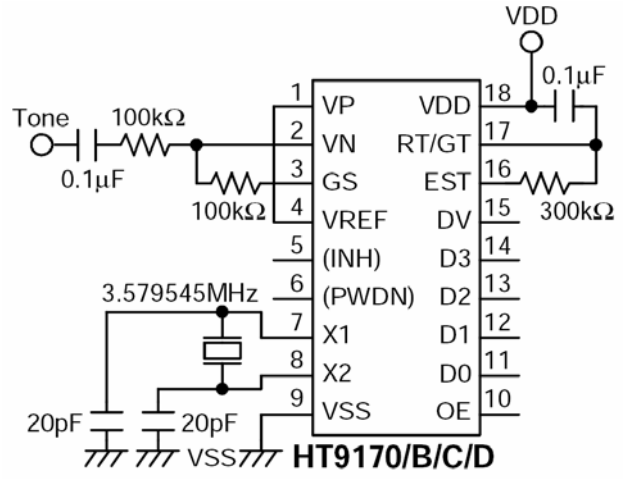


Fig. 9. The circuit diagram of HT9170B.

3.4 Ring Detection Circuit

Since IVPS can also be a home surveillance system, it should be able to set in the automatically pick-up mode. As shown in Fig. 10, when the telephone ring comes, the 110V, 20Hz sine wave will appear between the x1 and x2 which are connected to the telephone lines. During the positive period of the sine wave, the PC817 diode is conducted, so the output is at the low level [9]. On the other hand, during the negative period, the output is at the high level. Therefore, the output is a 5V peak to peak periodical square signal, and it is input into the IC 74LS14 which is used for buffering to stabilize the output. Based on the circuit design, a ring tone will generate 15 to 20 square waves. In Fig. 10, T0 is connected to the timer interrupt of the microcontroller, and the firmware will count the number of the square waves. When the number is exceeded, IVPS will start to operate automatically.

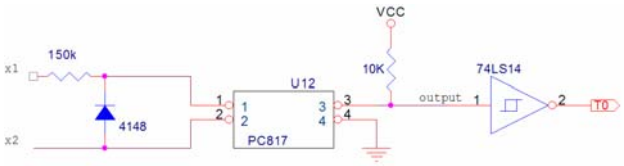


Fig. 10. The circuit diagram of the ring detector.

3.5 Connection Through Firewall

For the traditional video phone systems, the firewall will be a critical problem because it will block the connection from outside. If a particular port is opened for communication, the security of the system will drop. IVPS can solve this serious problem effectively by using the DTMF modules. When the call originator dial the phone number of the call terminator, the connection via PSTN will be established. The call originator will request the firewall to open a dynamic port for transmission, and then deliver the port number to the call terminator by the DTMF modules. Therefore, the call terminator can access the host through the firewall, and the security of the system will not crash since the port is dynamically opened. Fig. 11 is the flowchart of transmission through the firewall.

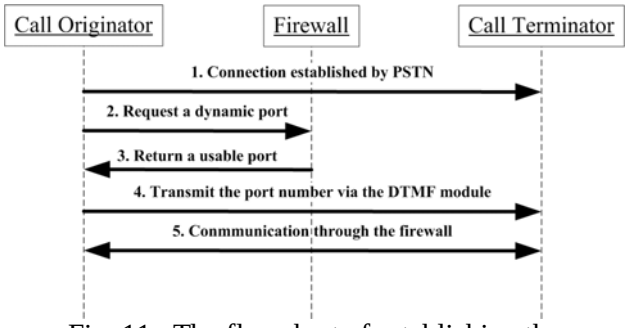
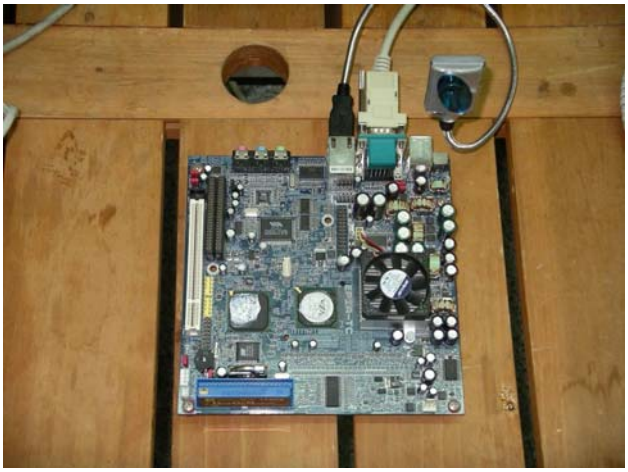


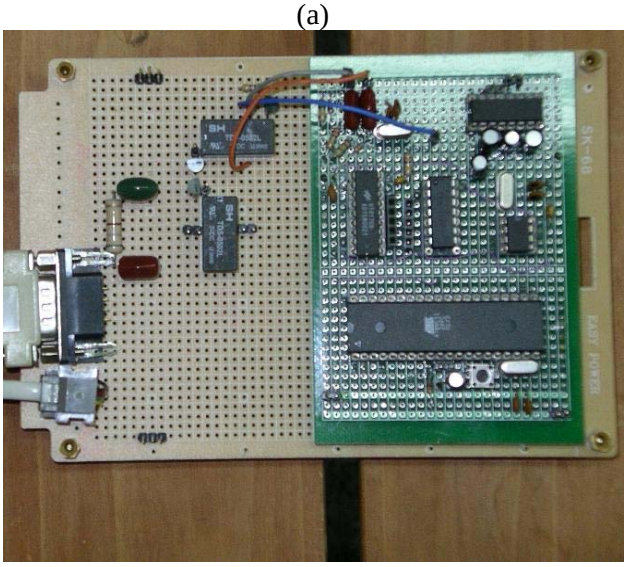
Fig. 11. The flowchart of establishing the connection through the firewall.

4 Experimental Results

The platform of IVPS is an X86 embedded one as shown in Fig. 12 (a), and Fig 12 (b) depicts the DTMF module. The GUIs of the originator and terminator sites are illustrated in Fig. 13. The dialed telephone number and the connected IP address are displayed in the fields above the frame grabbed from the other side.



(a)



(b)

Fig. 12. The components of IVPS. (a) the platform (b) the DTMF module

(a)

(b)

Fig. 13. The GUIs of IVPS. (a) Originator site (b) Terminator site

In order to distinguish IVPS from the other video phones and accentuate the advantages, the BVP8770 IP broadband videophone system manufactured by Leadtek is chosen for comparison. The necessary operations for establishing the connection of IVPS and BVP8770 in three different kind of network environment are described as following.

4.1 Firewall disabled, fixed IP

In this kind of network environment, both IVPS and BVP8770 are easy to use. The detailed operations are shown in Table 2.

Table. 2. The detailed operations

Systems	Operations
IVPS	1. Dial the phone number. 2. Watch and speak.
BVP8770	1. Dial the IP address. 2. Watch and speak.

4.2 Firewall disabled, Dynamic IP

The dynamic IP will cause the situation that both the call originator and the call terminator do not know the IP address of each other. For IVPS, the call originator still simply dial the phone number, and the IP address will be automatically transmitted to the call terminator via the DTMF modules. Therefore, the connection is quickly established. However, the communication between BVP8770s needs Gatekeeper for translating the phone number to the IP address. The required operations are presented in Table 3.

Table. 3. The required operations

Systems	Operations
IVPS	1. Dial phone number. 2. Watch and speak.
BVP8770	1. Register the IP address and the phone number in the Gatekeeper. 2. Set up the information of the Gatekeeper in BVP8770. 3. Dial phone number. 4. Watch and speak.

4.3 Firewall enabled, Dynamic IP

The hardware or software firewall will block all the connections from outside except for some particular ports which are opened by the users, like HTTP and FTP. Unfortunately, this network environment is the most general one in all over the world. If the video phone systems can not make the connection easier and have the private data safer, the customers will not buy the equipments. For IVPS, when the call originator dials the phone number, IVPS will request the firewall to open a dynamic port. Then, the IP address and the port number will be transmitted to the call terminator automatically. Nevertheless, BVP8770 must demand the firewall to open the specific TCP ports from 1720 to 1729 and from 7000 to 7009, and UDP ports from 8050 to 8054. Therefore, the hacker can steal the internet packets from these ports, and the private data will be disclosed. The complete operations are explained in Table 4.

Table. 4. The complete operations

Systems	Operations
IVPS	1. Dial phone number. 2. Watch and speak.
BVP8770	1. Request the firewall to open some specific ports. 2. Register the IP address and the phone number in the Gatekeeper. 3. Set up the information of the Gatekeeper in BVP8770. 4. Dial phone number. 5. Watch and speak.

5 Conclusions

IVPS has been successful implemented on the Linux platform with good video and voice quality, as shown in Fig. 14. Moreover, IVPS is suitable for applying in the DHCP and firewall network environment under the habitual dialing way. Furthermore, IVPS can be a trusty home surveillance system. With the innovative connection method which can solve the DHCP and the firewall problems, IVPS is a good video phone system and have downward compatibility with traditional analog telephones.

Fig. 14. The prototype of IVPS.

References:

[1] N. Sriskanthan, P.K.K. Loh, K.H. Lee, Y.C. Chan, "A Real-time PC-based Video Phone System on ISDN/LAN", *IEEE Trans. on Consumer Electronics*, Vol. 41, 1995, pp. 332-342.

[2] Den-Yuan Hsiau, Ja-Ling Wu, "Real-time PC-based Software Implementation of H.261 Video Codec", *IEEE Trans. on Consumer Electronics*, Vol. 43, 1997, pp. 1234-1244.

[3] H. Gharavi, "Pilot-assisted 16-lecel QAM for Wireless Video", *IEEE Trans. on Circuits and Systems for Video Technology*, Vol. 12, 2002, pp. 77-89.

[4] Chia-Wen Lin, Wen-Hao Wan, Ming-Ting Sun, Jeng-Neng Hwang, "Implementation of H.323 Multipoint Video Conference Systems with Personal Presence Control", *Proceedings of IEEE International Conference on Consumer Electronics*, 2000, pp. 108-109.

[5] Bhargava, B., "Adaptable software for communications in video conferencing", *Proceedings of IEEE Workshop on Application-Specific Software Engineering Technology*, 1998, pp. 8-13.

[6] Leadtek Research Inc., "The Datasheet of BVP8770", 2003.

[7] Holtek Semiconductor Inc., "The Datasheet of HT9200A/HT9200B, DTMF Generators", 2003.

[8] Holtek Semiconductor Inc., "The Datasheet of HT9170, DTMF Receiver", 1998.

[9] Sharp Co., "The Data Books of PC817 Series", 1995.