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Design of 3G net monitor system based on DaVinci technology
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Abstract

Outdoor remote surveillance is very difficult, and the wireless video surveillance needs high real time, but has large amount of computation and the limited available bandwidth. In order to solve the above problems proposed the 3G net monitor system solutions based on DaVinci technology. The program needs low cost, has superior performance and can be work outdoor. In the field of mobile video surveillance has the widespread application prospect.

1. Introduction

The third generation intelligent monitor system after simulation surveillance and digital surveillance has gradually become one of the most important technical means in modern testing and control for its real-time, image and true vision of monitor. One main point of the monitor system is the web-based network monitor. While the 100 meters network in distance and limits of the network wiring, the net monitor system is used mainly in the room and floor, so it is unable to do anything for the external environment monitoring. Nowadays the rapid development of 3G network and its successful use in the wireless internet and video call have showed its especial performance in the wireless transmission. But about its use in monitoring area the domestic field is in the blank. In order to solve the above problems we proposed the network surveillance system based on 3G wireless net. The system integrates the most advanced video compression techniques, the embedded techniques and network technology, can provide the most convenient real-time video surveillance for the users.

2. System Architecture

The 3G Net monitor system uses high-speed dicaryon TMS320DM6446 chip + Embedded Linux Operating System + H.264 Compression Algorithm, and it can meet the requirements of large amount of data computation, high real time and convenient network transmission. The system architecture has shown in figure 1 including the front-end video capture, the network transmission and the web server.

Fig.1 System Diagram

2.1. Front-end video capture processing equipment

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¹ Fund Projects: Projects Funded by Inner Mongolia Autonomous Region Natural Science Foundation (200508010811); Projects Funded by Higher Education (NJzy08009); Projects Funded by 211 Innovative Talent.

It uses the TMS320DM6446 chip and peripheral equipment to design embedded monitor system, this system can realize the video data capture, compression, storage and transmission. The video compression algorithm uses H.264 and the standard carries forward merits of video encoder H.263 and MPEG1/2/4, it has the higher rate of data compression and is more appropriate for the transmission with the limited bandwidth wireless network such as 3G.

2.2. Network Transmission

The data network bandwidth and chip rate is much higher than CDMA 2000 and TD—SCDMA by using the latest 3G WCDMA technology. The network reliability is higher and the data transfer rate also becomes faster.

2.3. Web Server

The design uses Web Server-Boa which supports the CGI technology, in order to realize data package and transmit them to the internet in the way of streaming media through the web server. It can process the data inputted through client browser using the CGI standard to compose extended program and accomplish interaction between client and server, and can also realize the dynamic web technology.

3. System Hardware Design

This system only requires to perform the hardware design for front-end video capture terminal, the design is centered for the TMS320DM6446 which is a new generation video processing chip of the TI company. The TMS320DM6446 have the binuclear architecture of ARM and DSP, the ARM uses the ARM926EJ-S kernel, its main frequency reaches 297MHz; the DSP uses C64x+ kernel, its main frequency reaches 594MHz, and the number of instructions reaches 4752MIPS[1]. It can completely meet the requirements of real-time video processing and heavy computation. The system mainly includes the microprocessor, the video capture module, the 3G wireless module, the PTZ control module and so on; and also includes some other necessary modules, such as the clock management, the DDR2 memory, the Flash and so on. Figure 2 is the front-end system structure diagram. The following describe the designs of the main function modules in detail.

3.1. Video Capture Module

The video capture chip in this design uses the MT9T001 CMOS digital image sensor chip which is from Micron company[2]. The chip supports the QXGA(2048*1536) format of three million pixels, the maximum data rate can reach 48MPS, the ADC resolution on the chip is 10bit, it can capture dynamic video and single frame image. In addition, the video processing front-end (VPFE) which is the internal integration of TMS320DM6446 provides peripheral interfaces of general images with the external image sensor, the video decoder, etc, it is used to receive the images which are put out from the external image sensor or the video decoder. The VPFE is composed of the CCD Controller, the Preview Engine, the Columnar Statistical Chart Module, the Automatic Exposure/the Automatic White Balance/the Automatic Gain Control H3A and the Scaling Module Resizer, etc[3]. The MT9T001 and TMS320DM6446 can be connected directly, without other decoder chips. Figure 3 is the interfaces connection diagram.

3.2. PTZ control module

PTZ stands for the omni-directional (from top to bottom, left and right) movement of the cradle head and the lens zoom, zoom control. PTZ control mainly by RS485 + PELCO-P protocol + PTZ decoder to achieve, according to PELCO-P protocol format, send the appropriate command and control front-movement.
There are three UART controllers within the TMS320DM6446, this design uses UART1 for RS485 communication interface, the baud rate sets to 4800bps. The PELCO-P protocol as shown in Table 1\(^4\).

Where, the STX is always 0xA0H; address code is the monitoring system logical address number, its address range 0x00H ～ 0x1FH; command bits 1,2 stand for the main control system switches to achieve a focal length control action; data bits 1, 2, respectively, stands for the horizontal, vertical speed; ETX is always 0xAFH; verification code is the XOR value of the Byte1 to Byte5.

<table>
<thead>
<tr>
<th>Tab.1 PELCO-P Protocol Format</th>
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<tr>
<td>Byte1</td>
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<tr>
<td>STX</td>
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3.3. 3G communication module

To transmit video data through the mobile network, the design uses the SIM5218 modules produced by SIMCOM, a set of WCDMA / HSDPA / GSM / GPRS multi-functional 3G wireless communication module, it has small size and facilitates for integration; it works at temperature from minus twenty centi-degree to sixty-five centi-degree, suitable for outdoor work; downlink data rates up to 7.2Mbps, upstream rate up to 5.76 Mbps (maximum data throughput depends on the WCDMA 3G network support); it uses 3.2 ～ 4.4V single power supply, can directly use the TMS320DM6446 to supply the 3.3V power; it support sUSB2.0, can be directly connected with the processor, through the AT command control data and command transmission, can achieve network connectivity.

4. System Software Design

System software design consists of two parts: video display terminal and the video capture terminal. In which the main video display terminal can complete the loading of ActiveX controls and then achieve the Web page video display and the corresponding control. Video capture terminal is based on the DaVinci platform software development. The DaVinci platform produced by TI is a set of efficient digital video / audio component based on DSP / ARM. It contains a highly integrated Soc processing chip, optimized video / audio decoder and API interfaces, ARM / DSP integrated development environment CCS3.2 and necessary support services. The DSP uses DSP / BIOS to support the running of audio / video algorithms, the ARM uses Monta Vista Linux to support for the management of its peripherals\(^4,5\). DaVinci covers the complete structure of the underlying drivers and application API, so developers can not invest too much time to prepare the encoder and DSP programming, and then can short the product development cycles, reduce the development costs. Video capture software design flows to the modular according to the video frequency. It mainly contains the following five parts.

4.1. Linux Transplant

This design uses Linux2.6.10 Monta Vista Linux operating system kernel. The system has a small memory, high real-time, full hardware support, so can help the users constructing the target machine kernel, filing the systems and applying the programs. The transplantation mainly completes the compilation, initialization and the resource management of the hardware drivers, and renewing compilation of Monta Vista Linux Core in the cross-compilation build environment. Compiler uses arm_v5t_le-gcc. It’s necessary to configure and start NFS and TFTP server of host operating system for the convenience of on-line debugging embedded system.

4.2. Design of Web Server

Web server adopted Boa supporting CGI technology. Though small, it has fast response speed and high security. We need to set up Run-environment and parameter and list final profile Boa.conf in the /etc/boa directory in order to support CGI program and DaVinci platform. Designers can download Boa Source from http://www.boa.org and make compilation.

4.3. CGI Program

This design realized interaction between external extended program and Boa Web Server by CGI (Common gateway interface). CGI programs base on the client sending http protocol request and command trigger, then transfer client requests and command to Application Program. CGI program will return the result to the client when Application Program has
completed required operations. Its working mechanism is shown in figure 5.

![Fig.5 CGI Working Principle](image)

4.4. H.264 Codec

This is the key point of software design using H.264 codec possessing high compression ratio, wireless transmission of good fault tolerance, and realize video transmission in limited-bandwidth WCDMA. The design made a video image processing using TI height optimization H.264 encoder +Codec Engine decoding engine. H.264 algorithm consists of two parts: Video Coding Layer (VCL) and Network Abstraction Layer (NAL). VCL is the key compression representation of video, while NAL transforms video encoder expressed by VCL into video format suitable for specific network transmission or storage. Limited to the characteristic that network monitor system is real-time and wireless transmission video data, this design adopts RTP/IP activities belonging to network abstraction layer[6,7].

4.5. Data Transmission and Broadcast of Supervision Image

Using TCP/IP upper RTP/RTCP, transfer H.264 to RTP/IP Video Bit Stream to QuickTime player built-in Boa Web Server real-time web play. The way of inserting ActiveX controls is as follows:

```html
<OBJECT ID=Videownd width="736" height="592"
classid="clsid:02BF25D5—8C17—4B23—BC80—D3488ABDD"
codebase="http://www.apple.com/qtactivex/qtplugin.cab">
  ……
</OBJECT>
```

When the design of dynamic video web is ready, it need to be issued for outer net accessing by the browser. It is also important to note that IP address obtained by the 3G Web every time is dynamic, so it’s necessary to configure DDNS (Dynamic Domain Name Service) for the convenience of users.

5. Test

Setting up system platform coordinating MT9T001 cameras sensors and SIM5218 WCDMA module headed by DVEVM Digital Video estimation module supplied by TI, accomplish terminal design target of video acquisition. Look at camera video and antenna control by phone or PC browser to land domain name or dynamic IP address. Figure 6 shows real-time acquisition scene graph of network monitor system. At the present time, debugging based on 3G Net Control System has been done basically. Following we still need to optimize target board, Web Page and H.264 codec in order to realize production.

![Fig.6 Real-time acquisition scene graph](image)

6. Conclusion

In this article, we put forward and designed 3G Net Control System based on TMS320DM6446. The system has realized video view, simple antenna control and parameters setting, and it can be widely used in local monitoring including indoor and outside. With the prevalence of 3G network, the advance of embedded technology and optimization of video editing code algorithm, the system will supply high quality, low price remote surveillance for users. Also there is great market application prospect.

References