Development of remote video monitoring system based on TCP/IP

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***Abstract*—This paper introduces a design of remote video monitoring system based on S3C6410 processor .The system adopts the V4L2 programming interface collect external camera video data, using the CPU internal hardware encoder for H.264 to code compression, by means of the Live555 third party open source library for video stream transmission through the RTSP protocol, using RTSP protocol player supported by VLC. The system has low bandwidth consumption, fast compression speed, low CPU occupancy rate, less heat, stable operation etc. Because this system adopts the standard RTSP protocol, it can use a variety of general player to broadcast live, has the advantages of convenient installation, simple using method and other characteristics. This system is suitable for indoor household use of real-time monitoring.**

Key words—S3C6410, H.264, V4L2, RTSP, Live555

I. INTRODUCTION

With the popularization and development of modern enterprise and the system of residential area in our country, and the deepening information construction of enterprise and community, various enterprises and community, especially large and medium-sized enterprises and residential areas has accelerated the construction of information network platform. Enterprise, community is gradually to focus on using the Internet and computers to deal with large amounts of data about management, production, sales, logistics, after-sales service and other important link.

In the community, in order to effectively protect the community's property and the safety of staff, guard against all kinds of invasion in the greatest degree, improve the response speed of processing various emergencies, to provide a good working environment for the security guard, ensure the safety of the community .according to the actual monitoring needs of community users, it usually will be install cameras in the surrounding area, warehouses, computer room, parking and other key parts.

In the modern enterprise, in order to ensure the efficient and orderly production order, normal and safe operation of the equipment, the production of material storage supply safety and enterprise overall management; In the door, warehouse, computer room, power distribution room, workshop, parking and other target, security department needs to implement the real-time and all-weather video monitoring.

The market of video monitoring system is expanding, and the market demands for its function that is tend to be diversified, intelligent, remote, and sophisticated. However, the traditional first and second generation of video monitoring system is based on the analog image transmission. it has some disadvantages, such as complex and messy routing, high cost, short transmission distance, difficult data processing operation; The third generation of video monitoring system has achieved the transmission of IP networks, but it's front-end equipment whose function is single and management system relatively simple, the video compression is often not ideal, often occupy large broadband video transmission, video streaming using a non-standard protocol, and remote image only confined to the local area network transmission, so it is difficult to complete expanding and increasingly complex functional requirements of the monitoring network currently, it severely restricts the remote monitoring, remote access control management and other applications.

In order to solve the above problem, the needs of new generation of remote video monitoring system become increasingly urgent; Embedded video surveillance has become a trend in video monitoring at home and abroad, now embedded devices, especially mobile audio and video equipment, it compared with previous years has been greatly developed, and the performance also has been greatly improved, but the performance and the processing ability of the processor is still very limited, for video codec, it need external encoder or implemented by software, so it can't satisfy the needs of the development of video surveillance.

H.264 is a new generation of digital video coding standard developed by the ITU-T and ISO / IEC together, as the world's most advanced video coding standard currently, it has the characteristics of high compression ratio, low code rate, and low bandwidth requirements. This paper adopts S3C6410 processor set of Samsung that is combined by the ARM11 kernel and H.264 hardware encoder, not only has high computing capability, but also use hardware to decode, so it is very good to meet the current problems on video decoding in embedded system, and suitable for different network transmission of video data .Because the data stream

use the standard RTSP protocol, it can use the general universal player to broadcast live, as long as the network conditions permit, not bound by distance ,and therefore it has a certain practical value.

II. THE OVERALL DESIGN OF THE SYSTEM

The video monitoring system is mainly composed of three parts that video acquisition sending terminal, network and PC is responsible for video playback. The terminal is a development board using S3C6410 embedded processor, and use embedded Linux operating system, is convenient of the user's various operating and the exploitation of application software. The application through the V4l2 interface to collect the video data in the development board external camera, the video through hardware encoder compressed and zip up RTSP protocol by the Live555 library. Then through network send to a PC that can receive network, running the Windows/Linux operating system that can install player supported by RTSP protocol in the PC machine, is responsible for receiving transmitted data in terminal, and decoding, display and playback. The following is the system design diagram.

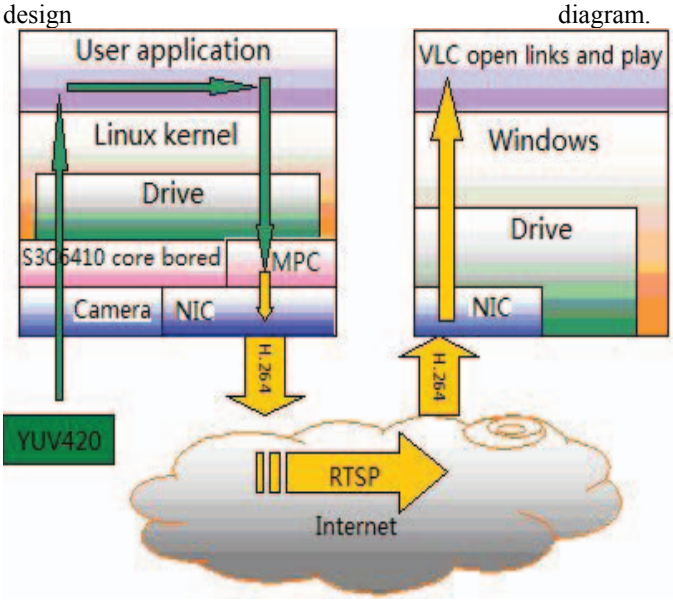

Fig. 1. The system design diagram

It be seen from the diagram, the YUV420 format of image data collected by the development board, the program immediately sent data to the hardware encoder (MFC), [4] then the data is sent to the network through the RTSP protocol, and in the Windows, VLC open RTSP links, accepting data and start playing.

III. THE HARDWARE DESIGN OF THE SYSTEM

Because the design is based on the embedded Linux development, the applications running on the operating system, the hardware design has large scale, it has complex manufacture and has already been very mature, so the market is flooded with development board based on S3C6410, there is no hardware design work, only need to buy development board.

The system adopts the OK6410 development board of Guangzhou Feiling Technology as the hardware platform, it uses the ARM11 processor S3C6410 product by South Korea's Samsung, with 256MB DDR and 2GB NANDFLASH memory, the system has the characteristics of small volume, low power consumption, and strong capability of processing, it can loading and running embedded Linux operating system. The following is the structure chart of the hardware terminal.

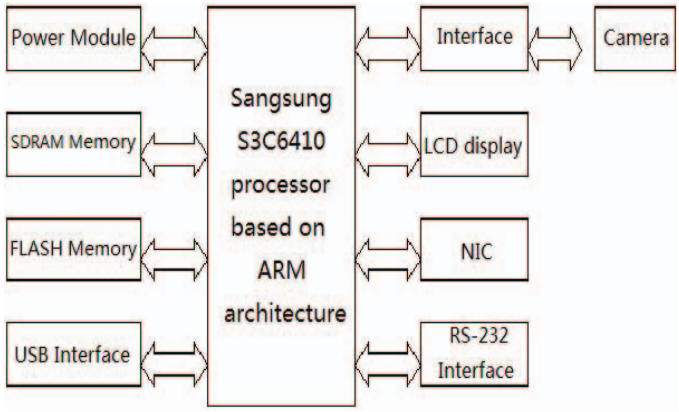

Fig. 2. 6410 development board hardware structure chart

IV. THE SOFTWARE DESIGN OF THE SYSTEM

A. *The overall design of software*

The software design of the system can be divided into the establishment of software platform and the design of application, building the system software platform in accordance with OK6410 manual steps can perform the establishment of boot loader, the kernel and file system in separately. The application software design can be divided into 3 parts, respectively is video collection, H.264 data coding of video and the network transmission of video work.

Video acquisition use V4L2 API interface in Linux. In the operations of the camera, the key steps are the open of camera driving, the parameters of equipment setting, memory mapping, and the copy of camera equipment memory data.

Video coding use Samsung API to drive the hardware encoding unit of the S3C6410 to achieve it, in calling these API, [1] the key steps are the open of encoder driving ,the parameters of equipment setting, acquiring the entry address of encoder, copying the data to the encoder, start up code, obtaining the target data address and size etc.

Video transmission uses the RTSP protocol, with the aid of the third party libraries Live555 to complete it. Live555 adopted object-oriented C++ programming and using this library, the key step is to inherit the two basic classes. [2]

The above three parts contact each other closely, the design of software block diagram as shown below:

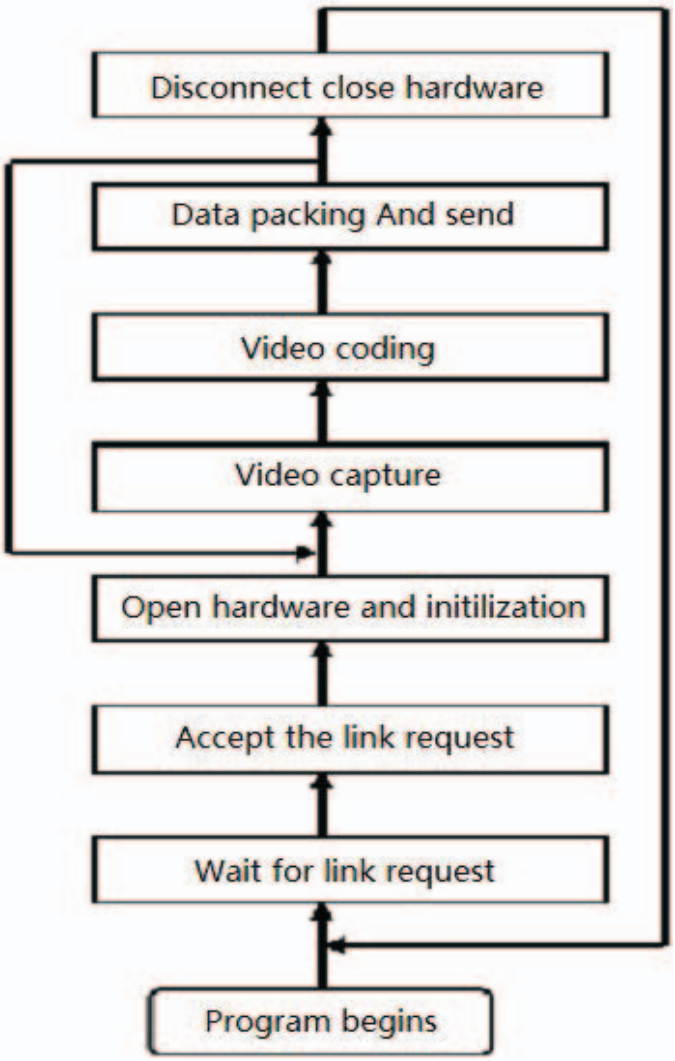

Fig. 3. Software design block diagram

B. Software design of video acquisition

1) *Video capture workflow:*Because in the H.264 hardware compression, the input of video stream format must be YUV420 format, so it must be collected to the format of video in the development board, in the initialization of hardware parameters, it has used Linux camera V4l2 programming interface,[3] not only we need to set the resolution, but also we need to set a good sample format, in order to ensure the sampling rate, I adopted the way of equipment memory map directly to the copy of frame data. By means of Memory mapping avoid frequent data copying between user memory and kernel memory, accelerate the speed of data read, improve the efficiency of the program. In Linux system, using V4L2 for video capture process as shown below:

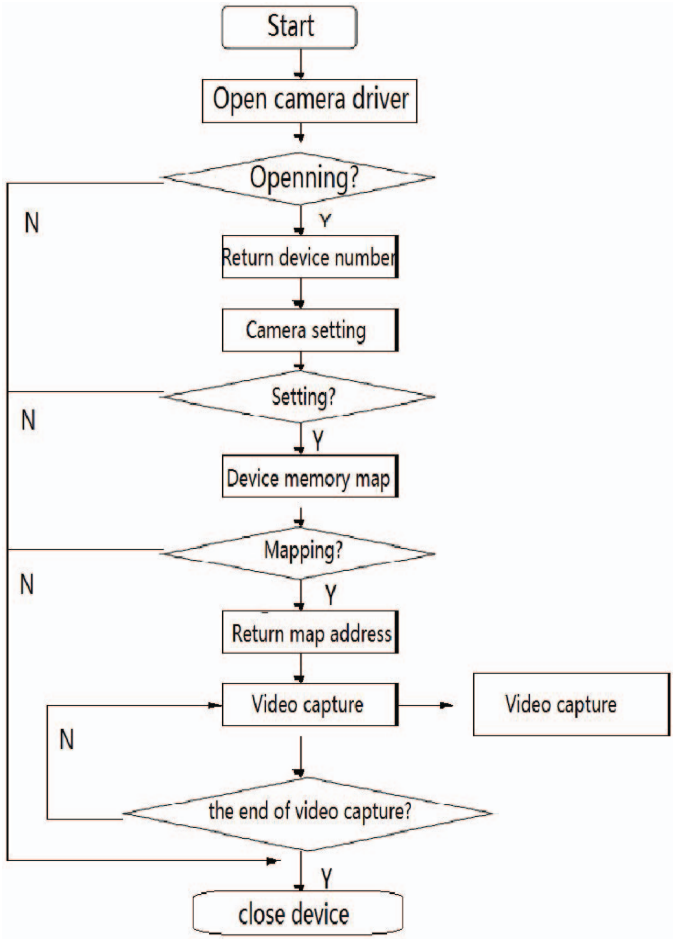

Fig. 4. YUV420 image acquisition flowchart

2) The key code of video capture process:

a) Open the function of camera driver: This function is according the driver name in the way of reading and writing non-blocking to open the drive, and then return the driving device to the integer variable that pointer "FD" pointing to. In this function, it is called "dev" parameter to "/dev/video0".

b) Set the camera parameter function: This function is based on the camera driver device number that set the width and height of image. Image format is YUV420.

c) Close the camera driver function: This function is according the mapping pointer of the camera to release memory mapping, and then according the driving device number to off camera driver.

C. Video encoding software design

1) *The workflow of video coding:* Until achieve the image acquisition of YUV420 In the camera, you can use the coding unit MFC of S3C6410 to the video data of YUV420 for H.264 compression. The coding unit MFC of S3C6410 has a high-performance function of video codec, supporting encoding and decoding of MPEG4,[5] H.263 and H.264. Multimedia application of user can call Samsung API to use the function of multimedia data that provide coding and

decoding by the S3C6410 multi-format encoder/ decoder. It can use the hardware circuit to complete, so the compression rate is fast, relative to the software compression, it is more suitable for the use of the embedded development platform. In the use of OK6410 development board,[6] it has the driven of H.264 hardware compression, and the specific location is "/dev/s3c-mfc". Hardware encoding process as shown below in the Linux system:

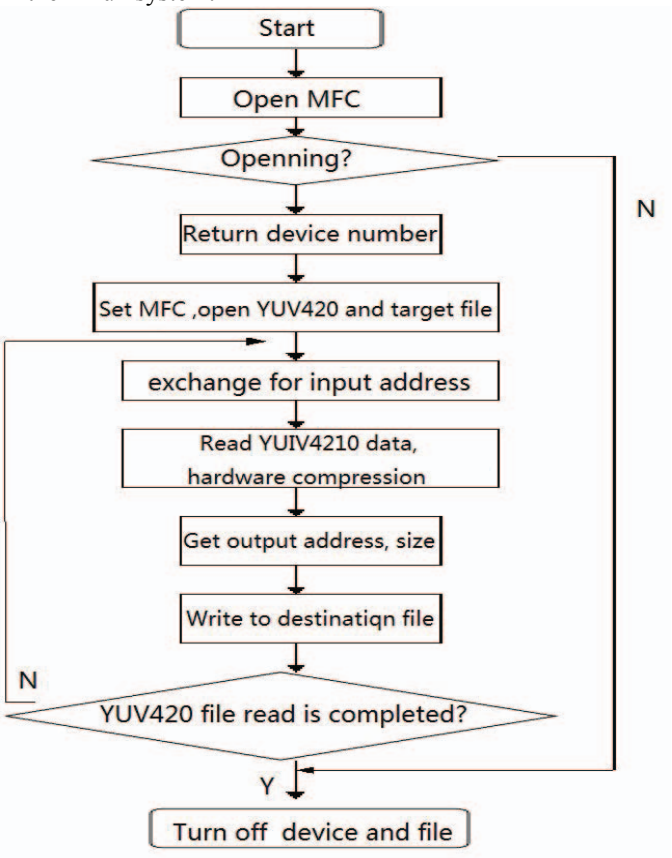

Fig. 5. H.264 hardware encoding flow chart

2) The key code of image acquisition process:

a) The open of MFC and initialization function: The function is to open the hardware encoder and set its width, height, frame rate parameters, etc.

b) H.264 hardware encoding function: This function is copy the original data to the encoder and to execute code, then return target data address and data length.

D. System integration

1) *The encapsulation of RTSP protocol：* Because the RTSP protocol implementation is more complex, this system uses the existing third-party open source library "Live555". RTSP protocol encapsulation not only plays the role of protocol implementation, but also the application integration in this step is completed, the following is the workflow of use Live555 to establish RTSP server.

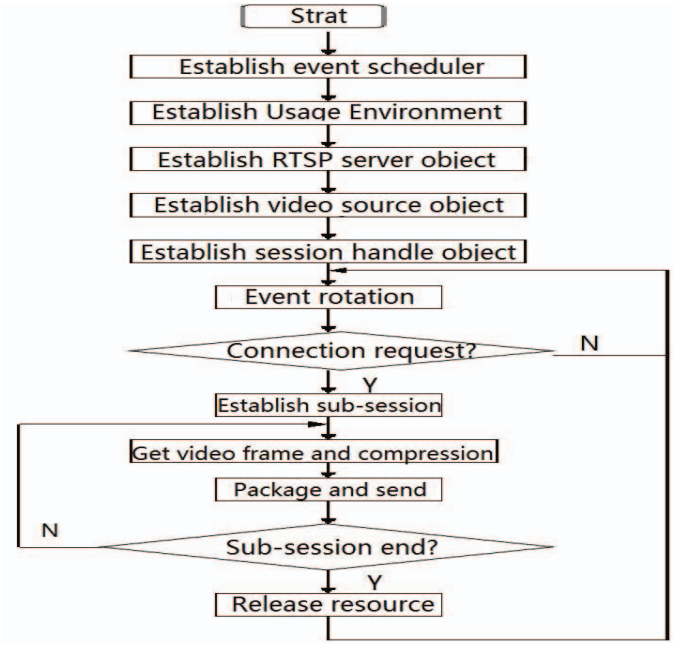

Fig. 6. The flow diagram establishment of the RTSP server

In the program, the most important step is to create a new class “Webcam On demand Media Sub session” inherits from “On Demand Server Media Sub session” to handle session task; a new “Webcam Frame Source” inherits from “Framed Source”, to generate image data.

2) The key code of the main function：

Main function is mainly to complete the following functions: New "Task Scheduler" and "Usage Environment" object for scheduling events, achieving the set of asynchronous read event handler and the output of error message; New "RTSP Server" object is used to build a RTSP server, it defines a “RTSP Client Session“ class in its internal for handling individual client sessions. In the creation process of "RTSP Server" object, we established the Socket (our Socket) to listen on port 1234 of TCP, [7] and then connect the processing function handles(RTSP Server: incoming Connection Handler) and socket handle to the task scheduler (task Scheduler); New "Server Media Session" class used to handle the session description, it contains more than one (audio or video) sub session description(Server Media Sub session).When the object set up, it bound to a "Usage Environment" object through its "add Sub session" method, and the new "Webcam On demand Media Sub session" object binding with Server Media Session; the object ”RSTP Server” through the "add Server Media Session" method to binding the "Server Media Session" with calling the "do Event Loop" method of "Task Scheduler" object . [8] The main program began to enter the main loop (do Event Loop) of the task scheduler, called function select clog in the main loop system, waiting for the network until RTSP client input (RTSP: //192.168.0.232: 1234 / webcam) to connecting the server, and select returns the corresponding socket, then according to a previously saved corresponding relationship, we can find the corresponding processed

function handler. Creating the “RTSP Client Session” in “Incoming Connection Handler”, [9] beginning to deal with the client session; when "Webcam Frame Source" was set up, we can call its constructor.

E. System testing

Connecting the software and hardware, we can get a complete system. And to test the function of the system, we can achieve the desired effect. Open the VLC in the Windows, then click the "media" menu, select "open network streaming" option, and open a RTSP connection in the pop-up window, as shown below:

Click the "play" button in the image above, then VLC can live RTSP video streaming. The following is the playback:

Fig. 7. VLC live screenshots

F. The conclusion

Observing the picture of VLC live in a more adequate light and under the condition of network flow, this scheme has good quality and smoothly playback that can clearly see the captured scene, it has reached the requirements of video monitoring level. Because the hardware encoder is integrated the internal of S3C6410, it has the very high compression calculation ability; if we use the more high-end cameras and appropriately increase the resolution, that we can achieve HD level quality.

The image of the system use VGA (640x480) level resolution, that sampling rate can reach 25 frames per second, but the fever of CMOS camera is more serious under the condition of the maximum sampling rate, considering the stability of the system, I set the sampling rate as 15 frames / sec. Confirmed by experiment, the network bandwidth is low (100KB/S), the system is running stable, in the long hours of operation, the program did not run out of truck , VLC is normal live in this setting; and looking the occupancy rate of resources in the development board, we found that the program runs almost does not take up CPU resources, and memory is also very stable, it shows the scheme is stable and reliable, and is more suitable for the application of video monitoring system.

Because this system uses a standard network protocol (RTSP), without distance limitations and not restricted by the player. As long as the player that supports RTSP protocols are installed on a PC and access to the network, we can view real-time monitoring screen at any place. And RTSP protocol itself has some security mechanisms for authentication, only the correct RTSP link can access the monitoring machine; thus we can ensure the data security and the privacy monitoring. The program used the general level development board that based on S3C6410,[10] it can easily be purchased, and the price is not expensive; Software using standard RTSP protocols, that has wide versatility and is more suitable for real-time monitoring of indoor home users.

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