# Image information acquisition and transmission system Based on DSP

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**Abstract.**This paper mainly puts forward an experiental method about video data collection, coding compression and data communication based on DSP technology. It is mainly about the video coding method of the Tms320vc5402 chip software and the design and application of its peripheral hardware system.

## Introduction

Digital signal processor [1] , as a new device, is accompanied by microelectronics, development of digital signal processing and computer technology. The purpose of the digital signal processing is to measure and filter the continuous analog signaling to the real world. Therefore, before the digital information processing, analog-digital converter should be used to realize the shift from analog signal to digital signal. Whereas digital-analog converter can realize the oppisite. The appearance of DSP chip can be a more effective solution for processing digital signals. It can complete a variety of digital information processing specifically and its internal structure and processing algorithms can effectively improve the ability of digital signal processing, and also promote the development of science and technology and electronic technology.

## Descriptions of system hardware

TMS320VC5402 [2], designated a digital signal processor (hereinafter called 5402) is a Harvard framework updated by technology, which has an address bus and three data buses. It has highly parallel dedicated hardware logic, peripherals as well as extra chip arithmetic logic unit (ALU). 5402 also uses control mechanisms to manage interrupts, repeated operation and function calls. Storage uses CY7C104lV33 chip. The flow chart of the system can be shown in figure1:

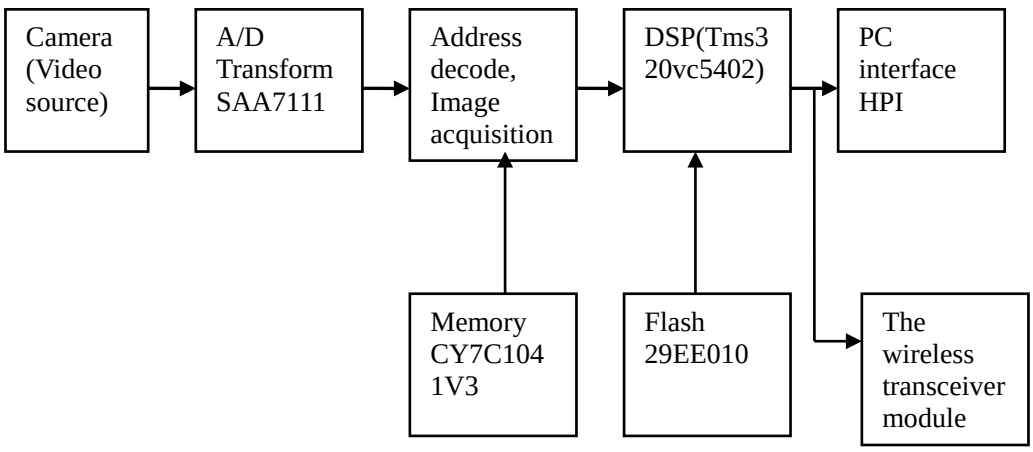


Fig.1. Flow chart of the system

 

## DSP- JPEG Coding

This section mainly discusses the working principle of JPEG and JPEG program written in C and then transplanted it into the DSP chip to implement. This system's JPEG coding is to be realized using the discrete cosine transform algorithm, and the following is a brief discussion of JPEG coding.

### Two-Dimensional discrete cosine transforms

In 1974, KRRao and N.Ahmed, T.Natarajan proposed the discrete cosine transform. For a two-dimensional matrix multiplication M*N pixel block, The DCT (Discrete Cosine Transform D) is defined as [3]:

$$F(u,v)=c(u)c(v)\frac{2}{N}\sum_{x=0}^{N-1}\sum_{y=0}^{N-1}f(x,y)\cos\left(\frac{2x+1}{2N}u\pi\right)\cos\left(\frac{2y+1}{2N}v\pi\right) \quad (1)$$

$$c(u)=c(v)=\begin{cases}\frac{1}{\sqrt{2}} & u=0,v=0\\ 1 & others\end{cases}$$

Where, $x,y,u,v=0,1,\cdots,N-1$

Two-dimensional inverse discrete cosine transforms formula is:

$$f(x,y)=\frac{2}{N}\sum_{u=0}^{N-1}\sum_{v=0}^{N-1}c(u)c(v)F(u,v)\cos\left(\frac{2x+1}{2N}u\pi\right)\cos\left(\frac{2y+1}{2N}v\pi\right) \quad (2)$$

$$c(u)=c(v)=\begin{cases}\frac{1}{\sqrt{2}} & u=0,v=0\\ 1 & others\end{cases}$$

Where $x,y,u,v=0,1,\cdots,N-1$

JPEG uses 8*8 sub-blocks size as a two-dimensional discrete cosine transform. In the encoder input according to a certain order divided original image into a 8*8 sub-blocks, the value of sub-blocks between -27 to 27-1 .Cosine transform can be obtained 64 transform coefficients. Conversion formula is:

$$F(u,v)=\frac{1}{4}c(u)c(v)\sum_{x=0}^{7}\sum_{y=0}^{7}f(x,y)\cos\left(\frac{2x+1}{16}u\pi\right)\cos\left(\frac{2y+1}{16}v\pi\right) \quad (3)$$

where $x,y,u,v=0,1,\cdots,7$ 。 $c(u)=c(v)=\begin{cases}\frac{1}{\sqrt{2}} & u=0,v=0\\ 1 & others\end{cases}$

### DCT coefficient quantization

After the DCT conversion of image information, it is necessary to quantize the frequency coefficients, and its main function is to reduce non-zero coefficient and increases the zero coefficient which can increase the compression ratio, also being the reason of the image quality deterioration. DCT for image compression coding algorithm can be shown in Figure 2:

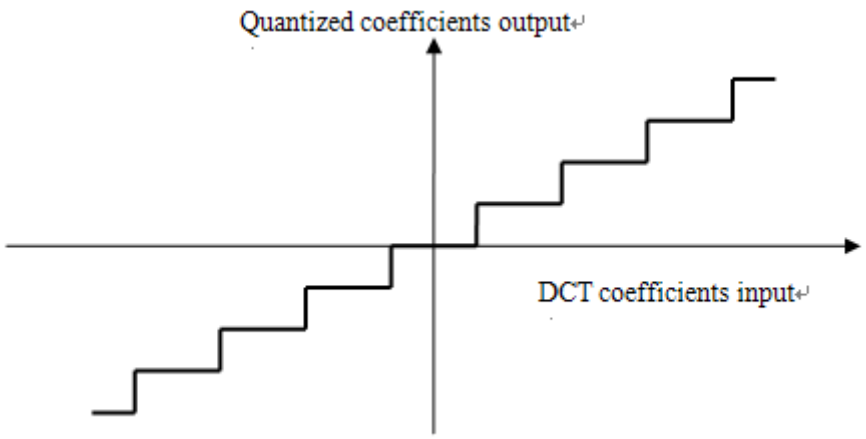


Fig.2. uniform quantize

**Arrangement of quantized coefficients**

After DCT conversion , the low frequency components gathered in the upper left corner, and F (0,0) ( the first row and first column of data ) shows the DC coefficient (DC), representing the average of 8*8 block. It should be independently coded. Both the immediately 8*8 DC coefficient difference is extremely small, so we can use DPCM (differential encoding) to deal with it. It is possible to improve the compression ratio, which can be understood as: on the next sub-block DC coefficient is encoded using the difference value .The other 63 sub-blocks of 8 *8 coefficients is alternating (AC), according to the line programming method. The quantized coefficients regroup, arranging zero in accordance with the Z word choreography to pave the way for a quick scan program.

After the DCT conversion, the quantized coefficients is scanned by the read, shaped as Z. We can see the 8*8 square as a 1*64 one-dimensional array, the low frequency components of the coefficient in front of the array. The arrangement of the quantized coefficients can be shown in Figure 3:

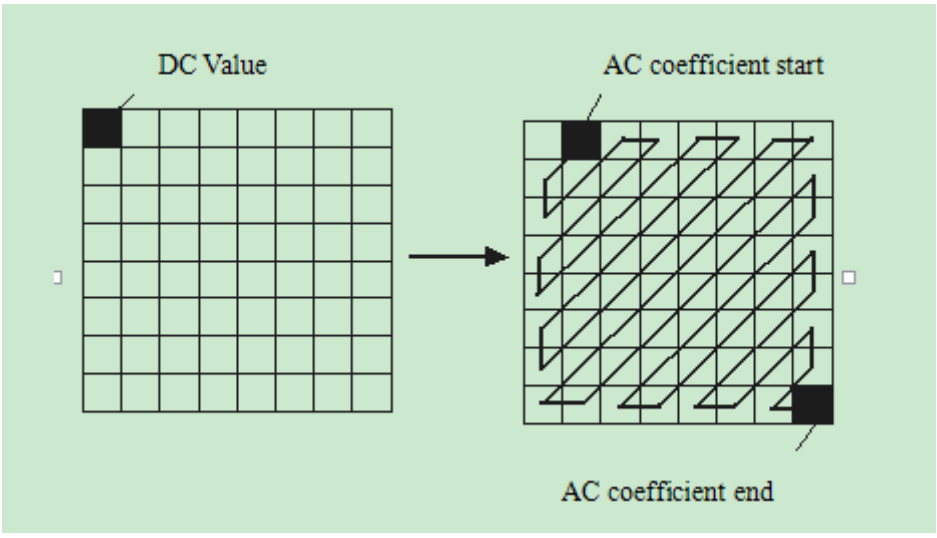


Fig.3. quantized DCT coefficients choreography

**The coding of AC coefficient**

The other 63 coefficients, except DC coefficient, of being shifted by DCT conversion are AC coefficients. The characteristics of AC coefficients after quantization are: There are many zeros in the coefficient, and many of them are continuous. According to such characteristics, the encoding of it can be implemented by run-length (RLE) coding.

**Composition of bit data stream**

After JPEG images shifted by DCT, there will produce a series of codes, and these codes have

generated image information after labeling and coding, which are expressed in the form of 01 code. In order to transport and storage easily, it is necessary to combine these information data in frames, and these datas are called JPEG bit stream.

**Implementation of JPEG based on DSP**

To make programming easy, with high portability and to improve the portability of software , C language is used in the system to programme JPEG encoding process , and then is transplanted to the DSP.

The above details present the algorithm of JPE. JPEG coding mainly has DCT conversion, quantization, coding and so on. The program flow is as follows:

(1) The degree of image files: the image file is read in buffer.

(2) Initialization information: required Huffman tables, table brightness, color tables and so on by initialization JPEG encoding.

(3) The block of source image file: block the read file in the buffer, and transform, quantizate and process entropy coding the DCT coding for the image block.

(4) Store and output files: store the processed fileinto the image bit stream.

**Image transmissions between DSP and PC**

This part mainly discusses the cable transmission between PC and DSP, namely, how to read the image information the PC storage file into the DSP's corresponding memory space.

The former chapters mainly discuss how DSP finishes the image compression to the collected and stored information. However, how to display the compressed image information on the PC. This chapter mainly illustrates some methods. There are some ways between DSP and computer transmission as followings:

(1) Realizing date transmission between DSP and computer using the HPI interface[4]

(2) Realizing date transmission between DSP and computer using the USB interface

(3) Realizing date transmission between DSP and computer using the IEEE1394 interface

Because of lack of consumption of hardware and software between the HPI interface of 5402 and a computer transmit information, it will not disturb the normal operation of the DSP program. In HPI communication mode, the computer completes the read and write of DSP memory by accessing the address and data registers.

PC will also provide a variety of parallel interface, including: SPP (standard parallel port), PS/2, EPP (Enhanced Parallel Interface) and so on. Among these interfaces, EPP enables data transmission stably, with speed. From the above factors, the system can complete the data transfer of DSP chip using the PC's EPP parallel port and HPI interface[5].

**Test results**

The system is used in access control systems, and the result achieves the expected requirements basically. When the system is powered, DSP loads the program into the Flash memory, and after loading, the 5402 chip can execute the program of memory. The Figure 4(a) image acquisition system and Figure4 (b) are the result of compressed 8 times in less than 30m of wireless transmission.

(a) Image acquisition system (b) Images after the wireless transmission

Fig.4 . Comparison Chart after the System Test Results

## Conclusions

This system not only solves the interface problem of DSP and external expansion device, but also solves the transplant problem in JPEG compression program of DSP. It mainly uses the SAA7111 as the image acquisition chips, and uses the address decoding technology to store the image information in the DSP's external memory. During the process of video image's compression and decoding, programming language and C language are used to improve the efficiency of image processing. In data communication between DSP and PC, the standard generic interface (HPI) is used due to its strong commonality. The wireless transceiver module (NRF401) is also used to complete the wireless transmission.


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