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# IMAGE ACQUISITION, COMPRESSION AND DECOMPRESSION USING ARM9

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**Abstract**: In market currently most of the image acquisition and compression system is based on DSP processor. This high cost, higher power consumable and large size system is not suitable for some applications. With advancement in embedded technology it is possible to build this system based on ARM processor. In this paper we have proposed a system using ARM9 processor. In this system we can use USB device through which image is acquired using USB camera. As memory capacity is significant issue in ARM processor, it is necessary to compress this image using suitable compression technique.

**Keywords**: ARM9, USB Camera, Display

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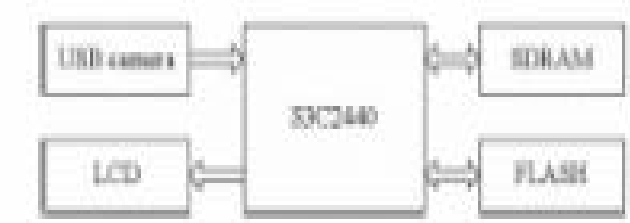
## INTRODUCTION

We have proposed S3C2440 along with embedded Linux. S3C2440 is being manufactured by Samsung and is a RISC microprocessor based on ARM920T.The maximum frequency can reach 533MHz. using USB camera, image is captured and image processing under the Linux operating system is introduced. Commonly used image compression technique is jpeg. The controller will save the image in jpg format. We are compressing and decompressing the images by using MINI 2440 board and Embedded Linux and display it on TFT touch screen display.

## I. SYSTEM ARCHITECTURE




In this system, the usb camera will capture the image and send it to s3c2440 microprocessor through USB device. The controller will save the image in jpg format then it is processed and sent to the LCD to display finally. The system's hardware architecture is as shown in Figure.

## II. S3C2440MICROCONTROLLR [4,5]

The S3C2440X is a 16/32-bit RISC microprocessor, which is designed to provide a cost effective, low-power capabilities, high performance Application Processor solution for mobile phones and general applications. To provide optimized H/W performance for the 2.5G & 3G communication services, the S3C2440X adopts 64/32-bit internal bus architecture. It also includes many powerful hardware accelerators for tasks such as motion video processing, audio processing, 2D graphics, display manipulation and scaling. An integrated Multi Format Codec (MFC) supports encoding and decoding of MPEG4/H.263/H.264 and decoding of VC1. To reduce total system cost and enhance overall functionality, the S3C2440X includes many hardware peripherals such as a Camera Interface, TFT 24-bit true color LCD controller, System Manager (power management & etc.), 4-channel UART, 32-channel DMA, 5-channel 32bit Timers with 2PWM output, General Purpose I/O Ports, I2S-Bus interface, I2C-BUS interface, USB Host, USB OTG Device operating at high speed (480Mbps), 3-channel SD/MMC Host Controller and PLLs for clock generation.

The Mini 2440 Single Board Computer is a high-performance controller board. It is designed based on the S3C2440 microcontroller, 256MByte DDR SDRAM, 1GByte NAND Flash, RTC, Audio

and net on board. It has integrated RS232, USB, Ethernet, Audio In/Out, Keyboard, LCD, CVBS, TV out, camera in, SD card and more other functions on board. So many hardware resources provided by the expansion board, it becomes a solid reference board for customer design. We also offer a complete software development package to customers.

Fig1. MINI 2440 development board

The board supports Linux 2.6.28, Android2.1 and Windows CE 6.0 operating system and is provided with complete basic drivers which enable a quick channel to evaluate the Samsung S3C2440 processor and customize application software. It would be an ideal development platform for multimedia and communication applications.

In proposed system, Embedded Linux operating system is used. It is necessary to transplant this os in chip s3c2440.

### *a. Transplantation of Linux Operating System:*

The transplant of Linux operating system is related with the hardware. It is necessary to modify the Linux operating system according to the concrete hardware platform to make it running on this hardware platform very well. The Linux operating system's transplant needs to complete three works: boot loader transplant, Linux kernel transplant and file system transplant.

**Installation of USB Driver:** DNW USB driver should install when board connected to PC first time. When we Open DNW, “usb:ok” will indicated on DNW title bar if USB connection successfully.

**Boot loader transplant:**Boot loader is running before the operating system kernel, the mainly role is initializing hardware equipment(including I/O, the special function register), establishing

the memory space map and bringing the environment of the system's hardware and software to an appropriate state.

**Boot Mode:** Boot mode can be selected by switch S2:S2 connect to Nor Flash side, system will boot from Nor Flash ; S2 connect to Nand Flash side, system will boot from Nand Flash。

Switch S2 is set to Nor Flash to enter in BIOS main menu after power on:

Supervivi is a boot loader based on Samsung open source vivi. It can be used as a tool to download and burn OS image to the flash on board. It can also be used to for parameters configuration. Supervivi download OS image file from PC by USB port.

**Linux kernel transplant:** The Linux operating system's kernel can provide good support to the ARM processor and manage most of components which connect to the periphery of the processor.

The transplanted Linux kernel only needs to provide support to the hardware which will be used, therefore we may cut the kernel according to the practical application.

Click DNW USB Port->Transmit to select zimage_w35 kernel image file. Linux kernel image will be updated to Nand Flash after successfully downloading.

**File system transplant:** Click DNW USB Port->Transmit to select rootfs_qtopia_qt4 yaffs file system image file to download. Linux file system image will be updated to Nand Flash after successfully downloading.

**b. *Program design of image acquisition[3]***

a) Open the video equipment: Video equipment is used as device file in the Linux. The device name of USB camera in Linux is /dev/vidooO. The main program code is as follows: if { (vd->fd=open( dev,O RDWR» <O) { perror(''v41_ open:'');

return -1; } *vd is a structure pointer of the defined struct _ v41_ struct. Through the open function to read the device file, it returns device descriptor when read successfully, else returns -1.

b) Read the video information: Reading video information is mainly to read the basic information and images property of equipment, which could be performed through the ioctlO function's control commands.

part of the program codes:

if (ioctl(vd->fd, VIDIOCGPICT, &(vd->picture» < 0) {perror("v41et ""picture:"); return -1; }Of course, in user space program the informations could be changed according to the actual needs. The method is to assign a value to a parameter , then call the control command VIDIOCSPICT.

***c. Video Capture:***

We can Video through mmapO function. In order to get the information of mapped buffer, video_mbuf must be initialized firstly. After got the map memory size, calling mmapO function, then the vd.map pointer points to the

memory space that shall be collected image data.

vd->map = mmap(O, vd->mbuf.size,

PROT READIPROT WRITE,MAP _SHARED,vd->fd,O)

In this way the real program code to obtain the image is as follows:if (ioct1(vd->fd, VIDIOCMCAPTURE, &(vd->mmap» < O)

{ perror("v41et capability: "); return -1; }

Control command VIDIOCSYNC was used to determine whether the interception of the frame completed. The image data could be saved as a file after the image acquisition finished. In order to improve image acquisition speed, it used double buffering, that is, a frame was dealing with collection the other. vd->frame_using[frame] = TRUE; vd->frame _current = frame;

***d. Close device:***

The video equipment must be closed after Video Capture.Close( vd->fd);

## III. IMPLEMENTATION OF IMAGE DECODING[1] [2]

In area of image processing there are many modern ways of compression techniques by using JPEG using computer system. Now we require new approach by using embedded system for image compression which provide high performance along with cost reduction.

This an embedded approaches for the compression which can be useful and suitable for the application like digital camera. Now a day's Digital camera has become fastest and best means

in the world of photography, and so as the images created by it. Fig 2 shows generalized block diagram of ARM based JPEG encoder. As any Images file created by digital is to be compressed by using JPEG standard and then further this file will be processed through serial communication by using ARM processor.

JPEG acts as a JPEG decoder for the ARM processor. In this paper, we have proposed ARM processor family with JPEG. Here, image file is taken from windows and then converted into grayscale image by using MATLAB then is process through ARM.

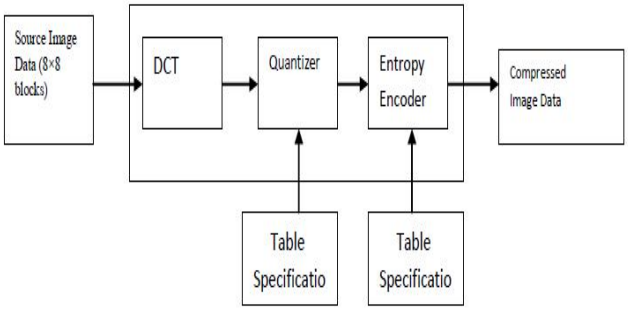



Fig.2 DCT based JPEG encoder

## IV. COMPRESSION METHOD

Joint Photography Expert Groups: JPEG's proposed standard aims to be generic, to support a wide variety of applications for continuous tone images. The DCT is usually applied to reduce spatial redundancy in order to achieve good compression performance. Some of the applications of two-dimensional DCT technique involve image compression and compression of individual video frames. The JPEG process is a widely used form of lossy image compression that centers on the Discrete Cosine Transform. DCT is also useful for transferring multidimensional data from spatial domain to frequency domain to decorrelate pixels, where different operations, like spread spectrum, data compression, data watermarking can be performed in performed manner. The JPEG is used for both color and black and-white images. To meet the differing needs of many applications, the JPEG standard includes two basic compression methods, each with various modes of operation. A DCT based method is specified for "lossy" compression, and a predictive method for "lossless" compression. JPEG features a simple lossy technique known as the Baseline method, a subset of the other DCT based modes of operation. The Baseline method has been by far the most widely implemented JPEG method to date, and is sufficient in its own right for a large number of applications.

***The JPEG compression:*** Joint Photographic Expert Group (JPEG) which is commonly used method of compression for photographic images.

The process may be acquired as such given under:

1. The image first is broken into 8x8 blocks of pixels.

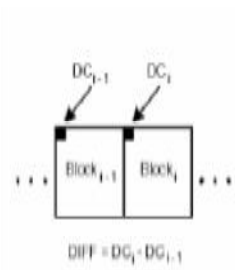
2. The DCT is applied to each block, it is working from left to right, top to bottom.

3. Each block is compressed using quantization table.

4. The array of compressed blocks that comprise the image is stored in a drastically reduced amount of space.

5. When desired, the image is reconstructed through decompression, known as a process that uses the Inverse Discrete Cosine Transform (IDCT).

Fig.1 shows the key processing steps which are the heart of the DCT Based modes of operation . These figures illustrate the special case of Single component (grayscale) image compression. Color image compression can then be approximately regarded as compression of multiple grayscale images, which are either compressed entirely one at a time, or are compressed by alternately interleaving 8x8 sample blocks from each in turn. For DCT sequential mode codec's, which include the Baseline sequential codec, the simplified diagrams indicate how, single component compression works in a fairly complete way. Each 8x8 block is input, makes its way through each processing step, and yields output in compressed form into the data stream. DCT progressive mode codec's, an image buffer exists prior to the entropy coding step, so that an image can be stored and then parceled out in multiple scans with successively improving quality. For the hierarchical mode of operation, the steps shown are used as building blocks within a larger framework. The DCT coefficient values can thus be regarded as the relative amount of the 2D spatial frequencies contained in the 64point input signal. The coefficient with zero frequency in both dimensions is called the "DC coefficient" and the remaining 63 coefficients are called as "AC coefficient". Each of the 64 coefficients is then quantized using one of the 64 corresponding values from a quantization table. After quantization, the DC coefficient and the 63 AC coefficients are prepared for entropy encoding as shown in fig 2.



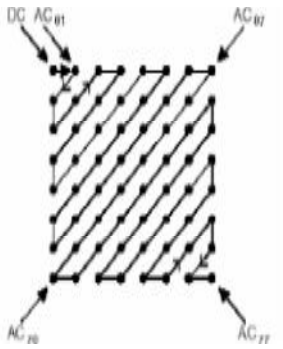



Fig3 differential DC Encoding Fig 4 Zigzag sequence

The previous quantized DC coefficient is used to predict the current quantized DC coefficient, and the difference is encoded. The 63 quantized Ac coefficients undergo no such differential encoding, but are converts into a one-dimensional zig-zag sequence, as shown in fig 4.

**Preparation of Quantized Coefficients for Entropy encoding** The quantized coefficients are then passed to an entropy encoding procedure that compresses the data further. One of two entropy coding procedures can be used. If Huffman encoding is used, Huffman table specifications must be provided to the encoder. If arithmetic encoding is used, arithmetic coding conditioning table specifications may be provided; otherwise the default conditioning table specifications shall be used. It uses Huffman encoding as mentioned previously .

***Run-Length Encoding (RLE):*** RLE stands for Run Length Encoding. It is a lossless algorithm that only furnishes decent compression ratios in specific types of data. It is form of data compression in which the same data value occurs in many consecutive data elements (known as *Runs)* are stored as a single data value and count. This is most useful on data that contains many such runs: for example, simple graphic images such as icons, line drawings, and animations. It may be increase the file size because, that doesn't have many runs, and is not useful with files.

***Huffman Coding:*** The Huffman compression algorithm is invented by David Huffman, formerly a professor at MIT. Huffman compression is a lossless compression algorithm that is apotheosis for compressing text or program files. This credibly explains why it is used a lot in compression programs like ZIP or ARJ. Huffman encoding can be further optimized in two different ways:

• Adaptive Huffman code dynamically changes the code words concordant to the change of probabilities of the symbols. • Extended Huffman compression can encode groups of symbols rather than single symbols .

## V. PROPOSED METHODOLOGY

***The Discrete Cosine Transform:*** DCT Attempts to decorrelate the image data after decorrelation each transform coefficient can be encoded without dropping off compression efficiency. The DCT and some of its important properties.

***The One-Dimensional DCT:*** The DCT of a list of n real numbers s(x), where x=0, 1, , n-1, is the list of Length n given by:

$$D(i,j)=\frac{1}{\sqrt{2N}}C(i)C(j)\sum_{x=0}^{N-1,N-1}\sum p(x)p(y)\cos\left[\frac{(2x+1)i\pi}{2N}\right]\cos\left[\frac{(2y+10j\pi}{2N}\right] \quad \text{For u=0, 1, 2, N-1}$$

Similarly, the inverse transform is defined as-

$$f(x)=\sum_{x=0}^{N-1}\alpha(u)\,C(u)\cos\left[\frac{\pi(2x+1)u}{2N}\right]$$

Thus, the first transform coefficient is the coefficient is the average value of the sample sequence.

***The Two-Dimensional DCT:*** The Discrete Cosine Transform (DCT) is one of many transforms that takes its input and transforms it into a linear combination of weighted basis functions. These basis functions are commonly the frequency. The 2-Discrete Cosine Transform is just a one dimensional DCT applied twice, once in the x direction, and again in the y direction. One can imagine the computational complexity of doing so for a large image. Thus, many algorithms, such as the Fast Fourier Transform (FFT), have been created to speed the computation. The DCT computes the i, jth entry of the DCT of an image.

$$D(i,j)=\frac{1}{\sqrt{2N}}C(i)C(j)\sum_{x=0}^{N-1,N-1}\sum_{y=0}p(x,y)\cos\left[\frac{(2x+1)i\pi}{2N}\right]\cos\left[\frac{(2y+10j\pi}{2N}\right]$$

$$C(u)=\begin{cases}\frac{1}{\sqrt{2}} & if \quad u=0\\ 1 & if \quad u>0\end{cases}$$

N is the size of the block that the DCT is applied on. The equation calculates one entry (i, j) of the transformed image from the pixel values of the original image matrix. For the standard 8*8 block that JPEG compression uses, N equals * and x and y range from 0 to 7. Therefore D (i , j) would be as in equation:

$$D(i,j)=\frac{1}{4}C(i)C(j)\sum_{x=0}^{7}\sum_{y=0}^{7}p(x,y)\cos\left[\frac{(2x+1)i\pi}{16}\right]\cos\left[\frac{(2y+10j\pi}{16}\right]$$

Because the DCT uses cosine functions, the resulting matrix depends on the horizontal and vertical frequencies. Therefore an image block with a lot of change in has a very random looking resulting matrix of a large value for the first element and zeroes for the other element.

## VI. CONCLUSION:

This article based on ARM9 processor and embedded Linux operating system, realize a USB camera image data acquisition, image decoding and image display. The entire system is simple, small size, low cost. It can be applied to many areas such as video phones, cameras, surveillance systems, etc.

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