Large LED Display Design using ARM9

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| Abstract -- LED displays are widely employed for advertisements, sports, transportation, Stock markets, traffic signs in public transportation systems, shopping malls, schools, railways etc., The conventional LED display system uses traditional microcontrollers so that many problems such as poor reliability, flickering and more hardware requirement can be seen in display system. This article presents an efficient architecture for controlling LED displays which has the ability to expose monochrome movies and animations. Implementing the LED display screen using 32-bit ARM9 (S3C2440) processor reduces the hardware requirement and also provide the speed of refreshing the screen will be high so that we can avoid the flickering in the display. In this article, a new way is implemented to increase the speed of the monochrome display is by scanning 8 rows at a time(row byte scanning) rather than single row(pixel by pixel). Therefore, the speed of refreshing of LED display will be increased. By allowing constant current through the LEDs in the display will increase the reliability of the display. The 8 GPIO lines of ARM processor are connected to the 8 rows of the LED display via 8 bit latches connected to implement row-byte scanning. Unlike in traditional LED display, rather than many microcontrollers a single ARM processor is enough to refresh the screen. A software tool using Java is present in PC to draw animations and send it to the LED display.

Keywords - 32-bit ARM microprocessor; LED large screen display;

I. INTRODUCTION

LED large screen is widely used in sports, advertising, finance, exhibitions, transportation and other areas for its outstanding advantages such as low cost, low power consumption, high brightness, durability and easiness to be spliced. With continuous development of large screen display technology, the display system needs to process increasingly larger volume of data at higher system frequency and faster data transfer speed. The involved circuit structure becomes much more complex and calls for a more powerful display control system. Most existing LED large screen display control systems as deployed in China are single chip based with partial interface circuit. Simple display mode and display data can be generated by and stored in the client computer while complicated display mode and display data need to first generated by the host computer and downloaded onto the client computer. The control function provided by this kind of display control system is limited in both hardware and software.

The single chip based control system and embedded software handle mainly with generation and storage of display data, arrangement of timing and ordering of control signal as well as communication with the host computer. In order to provide sufficient display control, the hardware has to be enhanced and expanded due to the limited interfaces and weak driver capacity of the single chip based control system.

Described in this paper is an ARM9-based embedded control system design for large LED screen display. ARM microprocessor presents a huge advantage in processing speed, system architecture, address range, peripheral interface resource. This ARM9-based control system can deliver a good visual effect when large number of pixels is to be dynamically displayed at high frame rate. The communication between this control system and the host computer is via Zigbee. The LED Display control is directly driven by GPIO lines of ARM9 processor via 8 bit latches. This control system has simple hardware design and offers speedy LED display refreshing, reliable system operation, convenient system maintenance, powerful function and reasonable cost.

II. PRINCIPALS OF THE SYSTEM

Embedded LED large screen display control system is displayed in asynchronous mode, with asynchronous mode the LED screen has the ability of storage and automatic playback, meaning that both edited text and grayscale images in PC can be imported to LED display system via serial ports or other network interfaces and automatically displayed on the LED screen offline. The system uses Samsung’s High-Performance 32-bit S3C2440 ARM microprocessor as the control core to control the LED display screen refreshing and dynamic displaying. S3C2440 is built completely around ARM920T ARM Thumb processor. It includes a SRAM working space in high speed chip and low waiting time external bus interface (EBI).

It also has a dedicated circuit to simplify its connection with SmartMedia, CompactFlash and
NAND Flash. Advanced Interrupt Controller (AIC) through multi-vector, priority interrupt source, interrupt handling division and transmission time reduction improves the ARM920T processor’s interrupt handling performance.

Peripheral Data Controller (PDC) provides data to all of the serial peripheral DMA channels, so that data transfer between serial peripheral and the on-chip or off-chip memory does not go through the processor, which reduces the processor workload for transmission of continuous data stream. S3C2440 integrates a number of standard interfaces, including USB 2.0 full-speed host and device ports and 10/100Base-T Ethernet media access controller (MAC) which is widely used in most of the peripherals and the network. In addition, this microprocessor offers a range of industry standard peripherals which can be used in audio, telecommunications, Flash cards and smart cards. Communication between the system and the host computer can be realized by S3C2440 chip’s USART, USB, Ethernet interfaces. After booting, S3C2440 initializes, reads boot code, maps the program code stored in Flash memory and the data to be displayed to the SDRAM. Access to the system data access is all realized in high-speed SDRAM. After PC receives the data, S3C2440 adds the corresponding dynamic display control program to the to be displayed data, converts them into the corresponding LED screen display drive signals, transmits through the GPIO interfaces directly to the big screen via 8 bit latches. If needed, data or image data sent by the host computer can also be stored in Flash memory. The screen scan mode is 1 / 16 Dynamic successive row byte scanning (8 rows are scanned at a time) mode. The duty cycle of LED can be set by software to increase the lifespan of the LED. Another technique to increase the lifespan of the LED is by allowing constant current through LEDs. The System can provide system power circuitry required for the regulated 3.3V and 1.8V DC power supply. Three power supplies are required by the system: +5V, +3.3V, +1.8V. System external input voltage is +5V and it is converted into 3.3V and 1.8V using LM1117-3.3 and LM1117-1.8 chips.

A. SDRAM circuit design
The System’s SDRAM memory consists of two 16-bit SDRAM memory chips in parallel. HY57V28160ET-H with capacity of 4 Banks × 2M × 16Bit is selected as a program running space and mapped to the S3C2440’s Chip.

B. Flash circuit design
The system design involves both NOR Flash and NAND Flash. These two kinds of storage media have their own advantages and disadvantages.

1) NOR Flash
NOR Flash is characterized by chip implementation (XIP, eXecute In Place) with that applications can run directly within the Flash memory without the need to have the code be read into system’s RAM. The system consists of a 4MB (can be replaced by a 2MB) Flash memory, which stores boot code, Linux kernel and user procedures. Flash memory data width is 16 bits and is mapped to the S3C2440’s Chip Select 0.

2) NAND Flash.
The structure of NAND Flash memory is capable of providing very high storage density and speedy write-and erase operations. The system includes a 64MB (can be replaced by a 32MB) NAND Flash memory as the system’s data storage. NAND Flash memory data width is 16 bits and is mapped to the S3C2440 Chip Select 3.

C. Reset circuit
Reset circuit can be used to complete power-on reset and run time system reset button function. During normal operation, when user presses the system reset button, S3C2440 goes into reset state. When user releases the reset button, S3C2440 goes into normal operation state. LEDs. Full frame refresh time can be less than 8 ms with frame rate faster than 125 Hz, which leads to more than 10 times increase in frame rate when compared to that of the traditional single chip display system and therefore is able to ensure a dynamic display of visual effects. In addition, under the same conditions, it can also produce more actual visible pixels.

III. SYSTEM HARDWARE DESIGN
The ARM9 hardware structure is shown in the Figure1
E. ARM chip circuit design
Data bus is (GPIO-GP17) one of GPIO port in S3C2440. Two lines are used to provide the data and clock to shift registers which are shown in display circuit. Another two lines are used to enable the latches to drive the 8 rows at a time.

F. LED large-screen control interface
Extension interface for achieving large-screen display unit driver control includes 64-bit data bus to achieve and control the interface board. The data bus includes the ARM chip's post driven data bus and related address bus (PA, PB ports) and some additional signals.

G. RS232/debug/Zigbee
The system design includes two RS232 interface. Among them the USART1 port can be used as debug port to provide, through the HyperTerminal, direct cable connection to download and debug application procedures. The USART0 port can be used to receive the data from the remote system via zigbee wireless protocol.

The Entire display hardware structure is shown in the Figure 2.

IV. SYSTEM SOFTWARE DESIGN
The LED Display software is designed in Embedded C to perform wireless data communication, LED screen refreshing, reading the SDRAM, GPIO port access. Display control program uses the timer interrupt method. By setting the appropriate interrupt time constant, refresh frame rate of the LED can be higher than 40 Hz to get steady dynamic visual effects.

Real-time dynamic image processing is realized by various forms of dynamic display coded by subroutines and each display form is an independent subroutine. Specific dynamic display forms are: (the screen) move left, move right, move up, move down, pull down the screen, cover, flash, direct print and other forms.

The Java Software Tool is shown in the Figure 3.
A software tool is designed using java programming language to load bitmap images and also support users to draw their own drawings. A list Graphic APIs in java are used to design the software tool.

V. CONCLUSION

Compared with the traditional general MCU based LED large screen circuit, the system design described in this paper has following advantages:

1) The system hardware uses ARM microprocessor of high-performance 32-bit RISC architecture to overcome the defects of traditional 8 / 16 bit microcontroller in processing power, system architecture, addressing scope and capacity of external interfaces.

2) The system design eliminates the dedicated bus driver and decoder circuit needed by traditional practices in the LED display section. Some other single chip based systems use multi-processor and dual-port RAM to improve the display speed. In addition, the LED screen has to be divided into multi-block schemes. The system described in this paper uses the GPIO interface with S3C2440 direct implemented to realize the logical drive for LED display, which simplifies not only the circuit but also the software-related programming.

3) This system effectively simplified the circuit structure of the display system and improved overall system reliability. The system can be applied in many areas such as monochrome video, animation, textual information LED display, etc.

REFERENCES


