Implementation of True Color Led Display for Video Processing Using Arm Cortex M3 Processor

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ABSTRACT: *This paper introduces the system design and implementation of a true-color light emitting diode (LED) display system. The improvement of LED (Light Emitting Diode) technology, the LED display system for video has attracted public attention. True color is a method of representing and storing graphical image information in an RGB color space such that a very large number of colors, shades, and hues can be displayed in an image, such as in high quality photographic images or complex graphics. We used the STM32F207MicroController for controlling the LED display system as it has advantages of processing fast video frames [2]. The Digital video is extracted and is converted from video signal to the LED display signal by circuit implementation. The driving circuits receives LED display signals after conversion, and assigns them to LED pixel, and drive the LED screen to display in real time.*

Keywords- *LED video display controller, Gamma correction, LED driver*

I. INTRODUCTION

The LED screens represent the most competitive large-scale display technology for today. The LED video screen is based on the raster-scanning principle. The monochrome or multicolor LEDs form the image pixels. In CRT this pixel control is accomplished by electron beam, deflected by scanning system. In LCD intensity is controlled by shading out the unwanted light portion, image forming is not power-consuming and large number of pixels can be controlled sequentially. In LED displays the pixel control is the major problem. The LED display is probably the largest representative of visual human interfaces. Although capable of displaying many colors, the applications of LED displays are intended for large-screen imaging and high ambient lighting conditions. The large-area video display industry has transitioned completely to LED based technology. As the color depth of VGA increases from 8-bit (256-color) to even 24-bit. To realize high quality video images with longer color depth in LED display, we introduce a new grayscale driving called consecutive PWM. This way of grayscale driving is effective accurate, especially for 18-bit and 24-bit images, because Gama correction can be easily implemented. It is also useful in reducing the Heavy-load Effect in LED display. (Heavy load Effect: when many LEDs are lighted at the same time, the power voltage will drop because of large driving current. Therefore, if only one LED is lighted with certain duty ratio, it may be brighter than that .when many LEDs are lighted with larger duty ratio which causes grayscale error). Following block diagram describes full implementation of TRUE color display. Fig 1 shows the block diagram of true color led display.
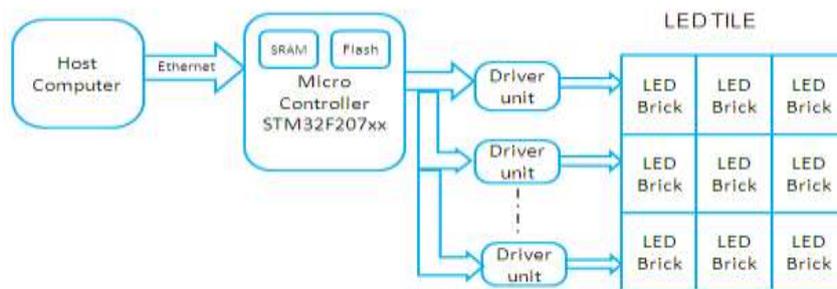
Fig 1 Block diagram of true color LED display

The brief is explained as follows section II is about Conversion of video frames to bitmap frames. Section III describes about Data transfer from host to microcontroller. Section IV describes about Microcontroller (STM32F207). Section V describes about correction of bitmap values by using Gamma correction. Section VI describes about LED brightness control. Section VII is about interfacing LED display panel and microcontroller. Followed by Results and conclusion.

II. CONVERSION OF VIDEO FRAMES TO BITMAP FRAMES

Host or computer is responsible for decoding, configuration and unified format transmission. Display resolution usually differs from conventional video standards. That is why the format converter is needed. Display is typically using the progressive scan. Consider incoming video of resolution 16*48.Image in RAW capture mode should given as input to open source LINUX application called M-player. M-player will convert each frame into bitmap. Linux Command to convert frame to bitmap is,

mplayer –vt scale=48:16 –loop 0 –vo xudp:titlewidth=48:title height=16 videoname.avi

III. DATA TRANSFER FROM HOST TO MICROCONTROLLER

Take bit map data of desired frame. Add Destination & Source address for ethernet. Data length should be between 42bytes & 2.5kb for each packet.

DA	SA	DATA
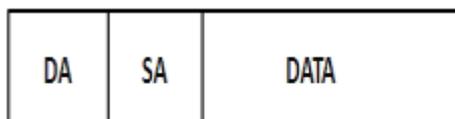
Size of each frame=no of rows*no of columns*3
i.e 16*48*3=2304bytes
Size of each packet should be 1.5kb for bitmap values remaining size is for source and destination address.

IV. LED VIDEO DISPLAY CONTROLLER

The STM32 is based on the cortex_M3 profile, which specifically designed for high system performance combined with low power consumption. It has a low enough cost to challenge traditional 8 and 16-bit microcontrollers. The cortex M3 processor include 32 bit CPU. Performance line which operates up to CPU clock speed of 72MHz.FLASH ROM sizes up to 512K.Fig 2 shows STM32F207 Microcontroller.[2]

Fig 2 STM32F207 Microcontroller

V. CORRECTION OF BITMAP VALUE USING GAMMA CORRECTION

Gamma correction matters if you have any interest in displaying an image accurately on a LED screen. Gamma correction controls the overall brightness of an image. Images which are not properly corrected can look either bleached out, or too dark. Trying to reproduce colors accurately also requires some knowledge of gamma. Varying the amount of gamma correction changes not only the brightness, but also the ratios of red to green to blue. Almost every computer monitor, from whatever manufacturer, has one thing in common. They all have a intensity to voltage response curve which is roughly a 2.5 power function. Fig 3 Graph with out Gamma correction. This just means that if you send your computer monitor a message that a certain pixel should have intensity equal to x, it will actually display a pixel which has intensity equal to $x \wedge 2.5$ Because the range of voltages sent to the monitor is between 0 and 1, this means that the intensity value displayed will be less than what you wanted it to be. ($0.5 \wedge 2.5 = 0.177$ for example) Monitors, then, are said to have a gamma of 2.5.Fig 4 shows Gamma Corrected output [4].
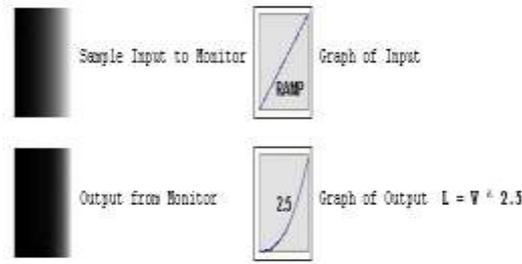
Fig 3 Graph without Gamma correction
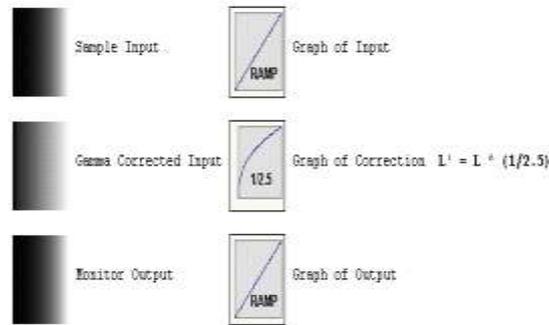
Fig 4   Gamma Corrected output

Gamma correction is used to correct for the nonlinear relationship between luminance and Brightness. When an LED emits light, gamma correction is used to account for the power-law relationship between luminance and brightness. Although often used interchangeably, luminance and brightness are not synonyms. The intensity values have been gamma corrected to approximate a linear change in brightness.

Gamma correction, also known as gamma compression or encoding, is used to encode linear luminance or RGB values to match the non-linear characteristics of display devices. Gamma correction helps to map data into a more perceptually uniform domain, so as to optimize perceptual performance of a limited signal range, such as a limited number of bits in each RGB components. In this paper, we used the following equation.

$$R_{transmit}, G_{transmit}, B_{transmit} = 255 \times \left(\frac{R_{received}, G_{received}, B_{received}}{256} \right)^{0.45} \quad \text{(From [4])}$$

Where the input digital signal is 8 bits wide; that is, the range of the input signal is within range [0,255] and the compensate gamma factor is 0.45.

VI.   LED BRIGHTNESS CONTROL

PWM or Pulse Width Modulation dimming is actually turning on and off the LED current for short periods of time. The on/off frequency has to be faster than what the eye can perceive so as not to cause a flickering effect. PWM dimming can be achieved a number of ways driving V_{adj} (adjust voltage) directly by a PWM signal, via open collector transistor, by a microcontroller as detailed in product datasheets. The average current to the LED is the product of the total nominal current and the duty cycle of the dimming function. A designer must also take into consideration the delays in shutdown and start-up of the converter's output which leads to limitations on the PWM dimming frequency and range of duty cycles.[5]

VII.   INTERFACING LED DISPLAY PANEL AND MICROCONTROLLER

The truecolor LED display is controlled by the LED drivers in the control circuit board. To handle true color LEDs in each LED display bar, the system requires 16-bit constant current LED drivers, Fig. 3 gives a typical schematic diagram of the LED driver. The driver for true color display is MBI5030. The PWM resolution and the desired refresh frequency define the driver requirements. A large development has been done until the LED control had settled to some driving circuitry standard. Because the data shifting process should not be visible on screen, driver usually contains two levels. One is the shift register, responsible for serial data reception. It has a serial data input node (SDI) data output (SDO) for cascading and a clock. The next data path level is a data latch, responsible for holding the previous data. This layer is controlled by separate control line. The output stage is using the latch

layer data for LED control. The output can be turned off by using output enable signal. The output stage structure divides the drivers into three categories: switch output, constant current output and PWM output.
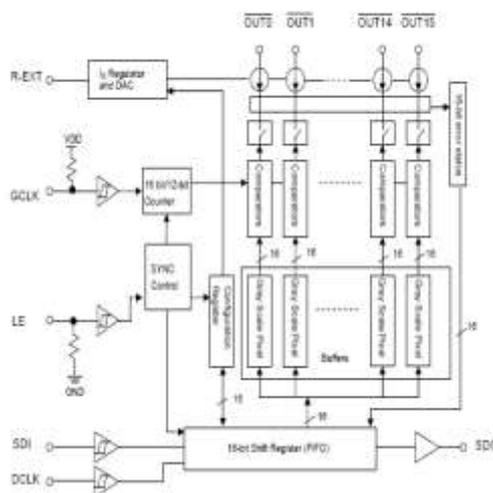
Fig 3 MBI5030 LED Driver Schematic[3]

VIII.   RESULT

Fig 4 True color LED Display output

IX.   CONCLUSION

The LED display system for targeting a high quality video processing was implemented. The proposed architecture has three benefits. Firstly microcontroller which is used is stm32f207 was much effective for processing video display. Second,The suggested LED driver have solved majority of problems associated with LED dimming implementation in video display. It controls the overall brightness of an image. Thirdly, LED display board consist of 16x48 RGB LED.

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