A Verilog Implementation of Hardware Control Unit of LEDTV Display Using Nanotechnology

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Abstract— *Light emitting diodes (LEDs) are used for various applications such as signboards, emotional lighting systems, building lightings, and façades. LEDs are non-toxic, mercury-free, consume low power and provide long lifetime. These advantages make LEDs very attractive lighting devices used for various lighting systems from emotional lighting systems to very large lighting systems used in and on buildings. The LED based display control unit play important role in this using nanotechnology.*

Keywords— Nanotechnology, LED display control unit, LED Display

I. INTRODUCTION

Light emitting diodes (LEDs) are used for various applications such as signboards, emotional lighting systems, building lightings.Various types of LED control systems have proposed. Especially, studies on large screen display systems are being conducted. Large-screen signboard LED controllers can be classified into two types: hard-wired systems that use application-specific integrated circuit and those that use general purpose programmable processors (GPP) such as ATMEL's ARM processor. In generally, a hard-wired system provides superior performance to the GPP-based system. However, hard-wired controllers are typically designed and optimized for a specific application; thus, they lack application flexibility. Compared to this, systems based on the GPP have excellent flexibility. However, if processors with low operation capability are used due to cost constraints, they have a fairly long instruction cycle. So, GPP-based systems operate more slowly than hardwired systems, or they suffer from unnecessarily high cost. As the number of LED applications increase, the necessity for an LED controller with high performance and flexibility is also increasing. It is well known that an application specific instruction-set processor (ASIP) can provide the flexibility of a GPP and the high performance of a hard-wired system. Similarly, using ASIP in the design of the LED controller is expected to provide the advantages of both the GPP and the hard-wired system. For example, because the hard-wired system is usually designed for only one specific application, the system's hardware must be revised when the system is updated for a new application. In this case, adapting the ASIP-based LED controller for use the new application requires software revision only, and minimum hardware revision even if necessary. Thus, the benefits of using ASIP will be low cost and short time-to-market, compared to other two design approaches for LED controllers. In short, the ASIP, as a particular application-specific processor, has various advantages depending on the characteristics and purpose of the application. Full Colour LED display system is a system that able to display multicolour images whether animated or static using arrays of RGB LEDs. LED or Light Emitting Diode are an innovative electronic device that function as it name states to emit light. LEDs are mainly use in display system because it is abundant with advantages. One of it is that LEDs has proven to be an efficient lighting system as it uses less power than any other traditional lighting device. In addition to that, LEDs also has higher luminous intensity (brightness) and longer lifespan than other lighting device making it is more cost efficient than other lighting device. RGB LED is LEDs that has produce three colour, which are Red, Blue, and Green.

The rapid development of LEDs technology has makes it very useful in today display system. There are many types of LED displays but it can be classified into two categories which is indoor LED screens and outdoor LED screens. The different types were use at different place either way the main purpose of it is to display real time information, advertisement and others. In cases for big advertisement board the LEDs panel used can have small pixel density per meter square as it is enough to produce crude image that can be seen as by human eye as perfect images from far away . However for indoor application a small size display the LEDs panel need to be closes to each other to increase the pixel density in order to produce a high definition (HD) image. A light emitting diode is a semiconductor light source that emits light when activated. It is basically a PN-junction diode. LEDs "lights up" when a sufficient voltage is applied, this makes the electrons are able to recombine with holes within the LED, this movement of electrons then produce photon which is the light that can be seen. This is called electroluminescence effect, the colour of the light is determine by the energy of the photon released, to control this energy the band gap of the semiconductor is manipulate. The LEDs are traditionally often used as indicator lamps on electronic devices, then they were packaged to form seven segment displays. Further research nowadays enables LEDs to be used in environmental and task lighting replacing incandescent light sources. LEDs have many advantages over traditional light sources such as longer lifetime, low energy consumption, smaller sizes, faster switching, and better physical robustness . LEDs also has proved to be brighter than other lighting devices and does not produce ultra violet light that attracts insects making it ideal for indoor and outdoor used. The LEDs are more efficient lighting device. using a simplifies logical functions

A. Structure and Principle Technique of the LED Display

It is relatively simple to drive more LED individually. However, as the number of LED increases, the amount of resources needed to operate these LED is growing at an unsustainable level. As such, LEDs are often organized in matrices to make effective use of resources

Structure of display element The largest share of LED display structures are designed to minimize the complexity of printed circuit PCB and save space. The structure proposed in our paper, figure 1 facilitates their implementation and their management. In a matrix, the LEDs are arranged in rows and columns.

Figure-1 Structure and multiplexing of LED Matrix

The principle is that each LED can be turned on by specifying its location in terms of rows (i) and columns (j), Pixel P(i,j) fig.2. The LED on the top left is addressed by P (A, 1), the line i=A and column j=1. This addressing method also indicates the passage of the electric current. The current flow of the A to 1 (forward bias) to turn on the pixel P(A,1), if all switches are closed to each port A to D and 1 to 4, then all LED will be light.

II. PROBLEM IDENTIFICATION

LED Display controller is very important part of the LED TV Display unit. In previous work different control techniques are used to control the LED Display Unit (LDU). It needs to have high efficiency in term of mechanism and exchange of information like images and video between the controller and driver. From research, it has been discovered that previous studies shows that LED display controller hardware unit classified.

III. EXISTING WORK

In previous work it is purposely a good LED display unit controller is needed to ensures that images and videos to be displayed onto the screen. The display controller needs to have high efficiency in term of mechanism and exchange of information like images and video between the controller and driver. From research, it has been discovered that previous studies shows that LED display controller can be classified to hardwire contol unit using Application-Specific Integrated Circuit and general purpose programmable processor using Microcontroller unit(MCU).

IV. LIMITATION OF EXISTING WORK

1) These types of controller can be very complex and expensive depending on the type of hardware control unit and controller system used. Design using hard wired system Application-Specific Integrated Circuit does solve the high efficiency demand. However when designing system using it there many setback that need to be considered.
2) One of them is that hardware control unit usually has a fixed architecture and further improvement of the system are almost impossible as the chip that has been designed can only perform at certain level of performance as specified before manufacture.
3) Application-Specific Integrated Circuit is costly and can produce complexity in term of time synchronization among the chip.
4) If the hardware control unit functioning in cascade mode that required data bandwidth overhead.

V. METHODOLOGY

The main objective is to port the previous work of LED display system on ARM processor and Application-Specific Integrated Circuit to function on Nanotechnology. This is to make the system to become more compact and easy to be moved around. This implementation will also use low power consumption as compared to previous. The current available LED display controller hardware contol unit has many useful characteristic such serial input, this enable the use of less input/output pin of the FPGA. The current system LED display hardware control unit is also able to cascade with each other to obtain higher resolution. The proposed methodology of the project is to improve the design and fix the problem using nanotechnology.

VI. METHODOLOGY FLOWCHART

This project mainly divides to three stages. The first stage is to determine the system architecture and other requirements. The next stage is modular design of the system using top-down design method and then for the last stage the system will be tested and verify using test-bench tools. For further understanding a flowchart of the project will be shown in Figure 4.1.The flowchart explains the overall process of designing in verilog. In previous work ARM processor was used and in this we are im plementing the nanotechnology.

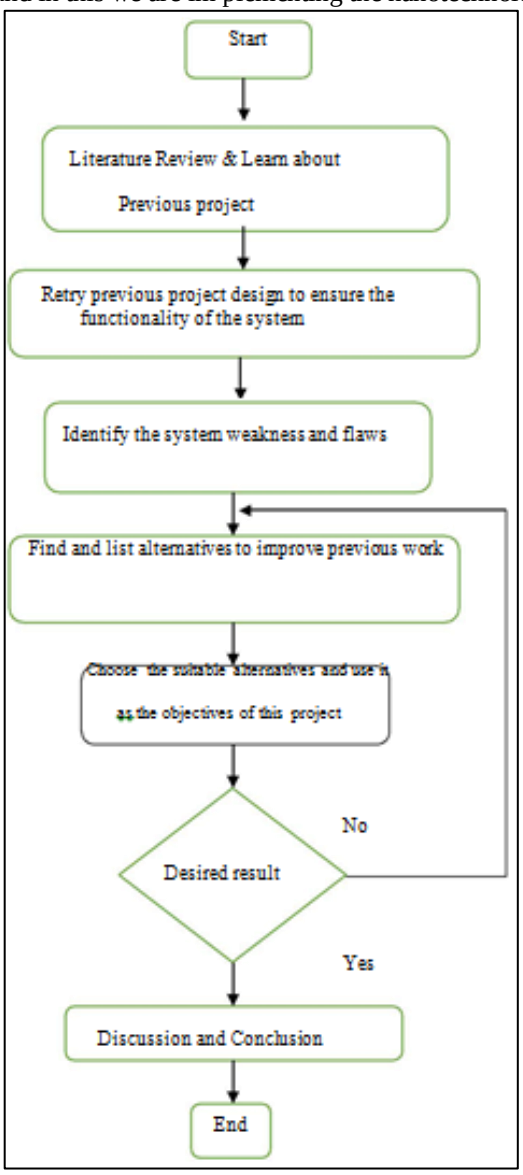

Fig. 4.1:

VII. RESULT AND DISCUSSION

Fig. 5.1: Output for 4 cascaded LED module

Fig. 5.2: shows the faulty output

Figure 5.1 show the actual performance of the LED display system for 4 cascaded LED panel. While Figure 5.2 shows the faulty output after a few second the first image is shown. This is problem arise when the LED driver is directly connected to the FPGA, this is due to the problem in the signal integrity in the design of the driver. By connecting a buffer before connecting to the driver this problem seem to have been solve. However, if the system were to function at higher resolution meaning more module are cascaded together, eventually this problem will arise again

To prevent this problem at higher resolution, the driver design needs to be altered to fix the signal integrity problem. One of the purpose solution is to add buffer into the driver design. The buffer will added to the input, this then will make the driver to have a buffer at the input for each cascaded module and not just a buffer at the first module. Figure 5.3 shows a block diagram of the altered system. However this method were n5t implemented due to time constrain, the objective of improving the LED driver were not met.

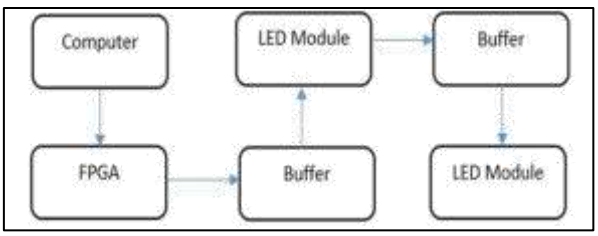

Fig. 1:

Table 5.1 shows the comparison between this project and previous project. The main changes are the boards used at the controller, previous work utilize DE2 FPGA board (Figure 5.6), while, this project make use of DE0 Nano (Figure 5.5). The main reason of choosing DE0 Nano is because of its small size and easy to move around unlike the DE2 board which big, bulky and heavy.

CHARACTERISTIC	DE2	DE0-NANO
BOARD		
SIZE	14cm x 20cm	5cm x 12cm
COST	RM 2206.19	RM 353.60
POWER	More component used	Use less power.
CONSUMPTION	in this design – use more power	
POWER SOURCE	9V adapter	USB port
STORAGE	SD card – up to 2gb	SDRAM - up to 32mb
SDRAM	Available	Use as storage
SRAM	Use as buffer	Unavailable
SD CARD READER	Available	Unavailable

Table 1:

The downside of using DE0 nano is the board does not have SD card reader and SRAM which is the most important component in making a good LED display controller. Previous work makes use of SD card for storage and SRAM for the frame buffer to allow the image to be displayed efficiently. However, since the DE0 nano does not have any of this SDRAM was used instead. SRAM is considerably faster than SDRAM which makes it ideal to be a frame buffer, but the SDRAM is not without advantage. The advantage of using SDRAM is that it has higher storage capacity than SRAM making it useful as a storage device and it also allows access to the data faster than SD card. In term of data transfer this project transfer data faster from storage to the LED driver, however this doesn't make it display image more efficient than previous work because previous design utilize SRAM to compensate for the speed of data transfer.

VIII. CONCLUSION

The result of this project shows that the system is able to display static images and minor animated image. The actual result shows the desired images on the LED display automatically by putting the desired image into the SDRAM. This draws to conclusion that the system able to read data from SDRAM and the display it to the LED panel as it is programmed.

The project also able to display image of 4 cascaded panel as per requirement in the project scope.

IX. FUTURE WORKS

There is many way to improve the system, however due to time constraint, my own knowledge limitation and cost constraint. The system can integrate a mpeg decoder to make it able to display streaming video. The system also can only read image date in SDRAM in format of .RGB, if this is improved and the system can display any format of picture, user can just take the picture what they want to display and just send it to be displayed.

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