ELECTRONIC ARCHITECTURE OF LCOS MICRODISPLAYS FOR PERSONAL VIDEO-PROJECTION SYSTEMS

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Edited version 1st October 2014

Developed electronic architecture of LCOS microdisplay SVGA format for personal video-projection system are described. Special emphasis was devoted to the selection of the most effective method of independently addressing each pixel, realization of gray scales and also the formation of fully coloured image with required resolution.

Keywords: Microdisplay, electronic architecture, personal video-projection system.

Introduction

Microdisplay – this is a miniaturised combination of electro-optical device capable of reflecting text, graphic or video information. In the present time much interest had been devoted to microdisplay technology which started towards the end of the year 2013. This was when big corporations such as Google, Microsoft, Samsung commenced industrial production of a variety of <smart eye glasses> and mobile telecommunication systems based them. Notwithstanding the fact that the distance in such video-projection systems are only 1-2 cm image reproduction of the sight of human beings as <virtual images> corresponds to a full frame images of bigger television of 40 inches at an observation distance of few meters. Undoubtedly, small eye glasses functionality are defined by the software programme used, their required properties depend primarily on the parameters and characteristics applied in their microdisplay. In this paper, detailed answers to question pertaining to selecting the optimal electronic architecture of current microdisplays based on LCOS technology SVGA (800x600pixels) format were discussed.

Individual pixel addressing

Generally, individual pixel addressing selection for microdisplay is dependent on the number of electrical connections, necessary for efficient independent pixel addressing [1].Presently three methods of addressing can be used:-

Direct addressing- this implies each individual controlled electrical connections to and driver circuit for each display substrate electrode and is suitable for application to displays with low pixels. For instance, seven segment display or low information format matrix microdisplays. For displays that requires counter electrode (LCD or OLED), they have an advantage with direct addressing in which the counter electrode is a continuous and does not need to be patterned at their pixel levels. Displays made up of $M \times N$ pixels controlled using direct addressing requires [(MxN)+1] one for each pixel and counter electrode respectively. This implied that for our case, SVGA format of image size where $M=800$, $N=600$, for example

15x10mm steps of external outputs consists of less than 2μm which is practically unrealizable.

Passive matrix addressing:- employed for microdisplay with pixel matrix characterized with regular repetitive pattern which demands patterning of both upper and lower substrate electrodes. The row and column pixels are then joined with a conducting path formed on two levels as shown in figure 1.

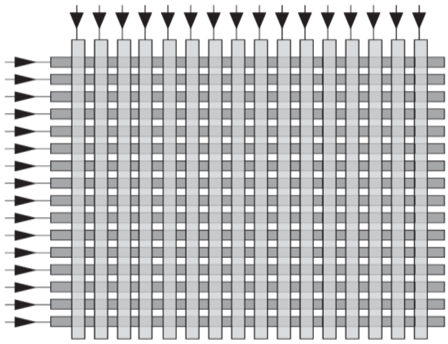

Figure 1. Schematic image of passive matrix microdisplay.

The display is composed of M columns and N rows. i.e. MxN pixels which requires only M+N outputs, M of which are located on one substrate and N on the another. Passive matrix addressing limitation is that the rows can not be addressed for more a duty cycle of 1/M. This can be increased to 2/M using dual scanning in which the top half of the display is driven from above and bottom half from below. The other limitation is that of capacitive cross talk between bus conductor and pixel rows are difficult to control.

Active matrix addressing:- the authors selected addressing method for LCOS microdisplay with higher resolution because average pixels have simple rectangular regularly repeated pattern. This requires patterning only one substrate electrode level over one duty cycle and stored in ROM made up of MOS-transistors formed on silicon chip figure 2 [3]

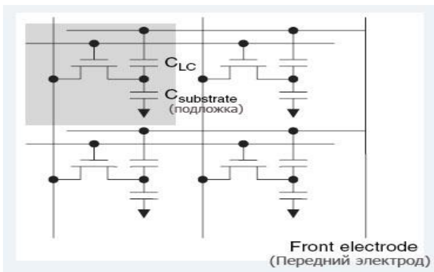

Figure 2 schematic image of active matrix microdisplay

Gray scale formation

The author's selected method for realization of gray scales greatly determines the electrical architecture and drive circuit of LCOS microdisplay . Formation of gray scale or luminance level of a microdisplay can be accomplished using one or a combination of different methods. A liquid crystal characterised by an analog electro-optical response can form a continuous range of gray scale or a set of stepped number of gray scale depending on the precision of control of the amplitude of the applied electronic drive signal (analog or digital). Gray levels can be perceived in a digital system by the spatial segmentation of the pixel area into subpixels of equal size or subpixels whose relative size are binary weighted. In the case of the former 2^n of equal subpixels give rise to 2^n gray scale levels or n-bit gray scale. While in the later case n binary weighted subpixel is enough for obtaining 2^n gray scale or n-bit gray scales. The time domain can also be used to control the gray level using duty cycle i.e. ratio of on time to the frame time. Binary mode or bistable devices are capable of achieving continuous or stepped gray scale by controlling:-

a) The width a single pulse of light of fixed amplitude from each pixel over one time period (single pulse width modulation (PWM))
b) Pulse count modulation (PCM) or count based pulse width modulation (C-PWM)
c) Binary-weighted pulse coded modulation (B-WPCM) or binary coded pulse width modulation.

Full coloured image formation

The method selected by the author for the formation of full coloured image substantially defines the electrical architecture of LCOS microdisplay. And the colour can be produced in a number of ways:-

Spatially-segmented RGB colour filter system This requires a colour backplane architecture and a single microdisplay. Then each pixel is separated into individual (R, G & B) subpixels. The standard technique of achieving this in LCDs is by using a white backlight illumination with RGB colour filters covering each of the subpixel..

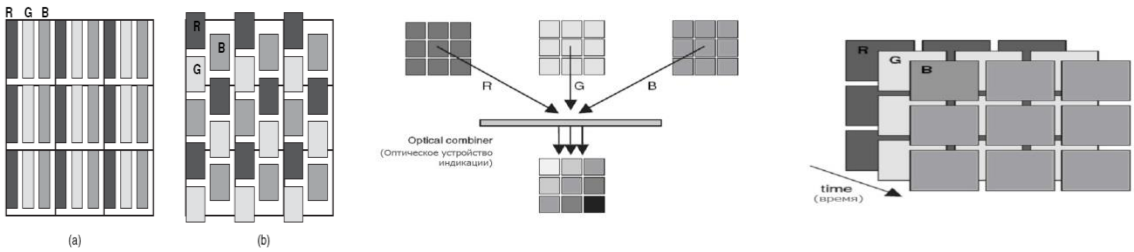

Figure 3. General layout scheme for LCOS microdisplays in one-module and three-module form.

Three panel system This employed 3 identical display in which pixels are not spatially pixelated but each display transmit one primary colour field. The colour image is divided into 3 primary colour fields R, G & B respectively. These are then each sent electronically to one of the display which are then optically overlaid.

Field sequential colour technology This is based on very fast sequence display of three sub pictures or filed that comprises of all the information in red, green and blue (RGB) pixels respectively. Once sequence is fast enough the eye sees a full coloured image and not segmented.

In LCOS microdisplays for the reproduction of detailed technology it is necessary to use an active matrix as a universal device for all types of microdisplays, in which the transmitted colour is stored. When the illuminated properly applied in a synchronized manner such that when a red field is stored in the backplane of the active matrix only red light is displayed by the microdisplay.

Based on comparison conducted, it had been established that the best rational selection is the third variant in which the frame addressing period is reduced three times over.

Electronic architecture SVGA LCOS microdisplay

Developed an electronic architecture for LCOS microdisplay SVGA format as shown in figure 4. It’s special features are:- a silicon chip thatcan use analog video signal with rows that can be controlled at two edges. This is due to the fact that control can be achieved with inverted columns in which both upper and lower video signals falls on even and odd columns respectively. The given data of higher level are processed at the northern part of the matrix and lower data level at the southern part. Sequentially input data must be distributed and stored in cascade 1 of each cell forming columns. Then all data of the columns are then simultaneously transmitted out of cascade 1 into cascade 2. This two-stage approach enables full record into row j and at the same time received data into rows j+1. With the aid of column matrix formation device, theaccepted data is then stored and transmitted as analog or digital or be subjected to data conversion from digital into analog using digital to analog converter (DAC). The critical part of the system is the exact conversion inorder to avoid vertical segmentation of the image.

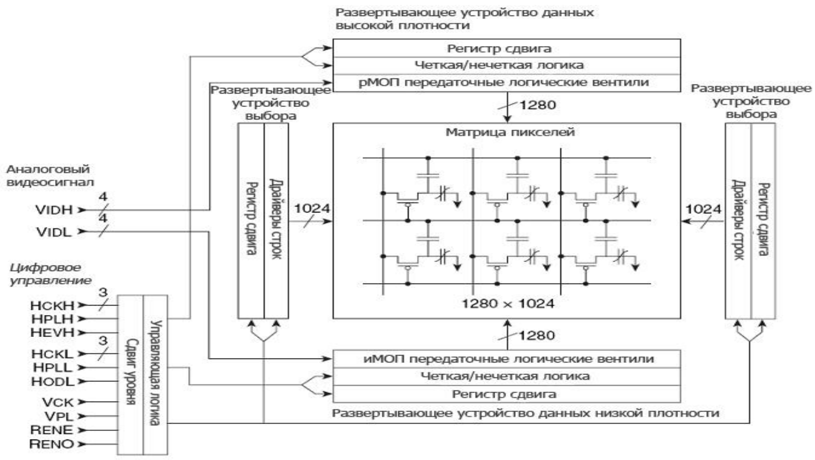

Figure 4. Electronic architecture for LCOS microdisplay with resolution 800x600

The average speed data transmission D, for full coloured microdisplay requires = 3MNF, where F = frame rate frequency, 3MN = number of pixels whereM= column, N = rows & 3 subpixels RGB for coloured pixel. The peak speed of transmitting data can be much higher than the considered format. i.e. data can be transmitted twice to achieve control over constant current in LCOS system or working cycle of transmitting data can be less than 100%. In the last case this can occur in a systems in which for example electronic addressing must be interrupted during the period of stabilizing liquid crystals. Higher speed of data transmission for high definition television requires more simultaneous storage and also interruption in microdisplay, especially for system with sequential transmission of colours.

Conclusion

Carried out a rational selection of LCOS addressing technique for personal video –projection system. Demonstrated that using an active matrix enhances the realization of required quality gray scale without essential combination of electronic parts of the system. Established that field sequential technique is essential for the realization of gray scales and full colour images for LCOS microdisplay which also simplifies the construction and reduced the cost of LCOS microdisplay.

Developed an electronic architecture for LCOS microdisplay SVGA format for personal video-projection system with the possibility of integrating rows and columns drivers on silicon chip.

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