

White Paper

A Novel 12-bit Grayscale Topology IEI Revolutionary GrayBoost® Technology

Author: Kenny Jan

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1. Introduction

With Picture Archiving and Communication System (PACS) introduced in early 1990's, the LCD monitor-based imaging has grown dramatically to create a film-less diagnostic environment. To be perfectly used for diagnostic applications, a medical monitor must have the ability to display more than 10-bit grayscale images accurately without any image data loss. There is growing number of images which are more than 10-bit generated by image modalities including X-Ray, CR (Computed Radiography) and MR (Magnetic Resonance) modalities. In figure 1, 12-bit grayscale image for mammography is required to display on a LCD monitor for radiologists to view and to diagnose. In order to keep the precision of acquired radiographic images, the optimal medical image system should retain the 12-bit data flow during the process from image acquired, application software applied, graphic controller processed to monitor displayed. This white paper introduces a novel 12-bit grayscale topology, the GrayBoost® topology developed by IEI.

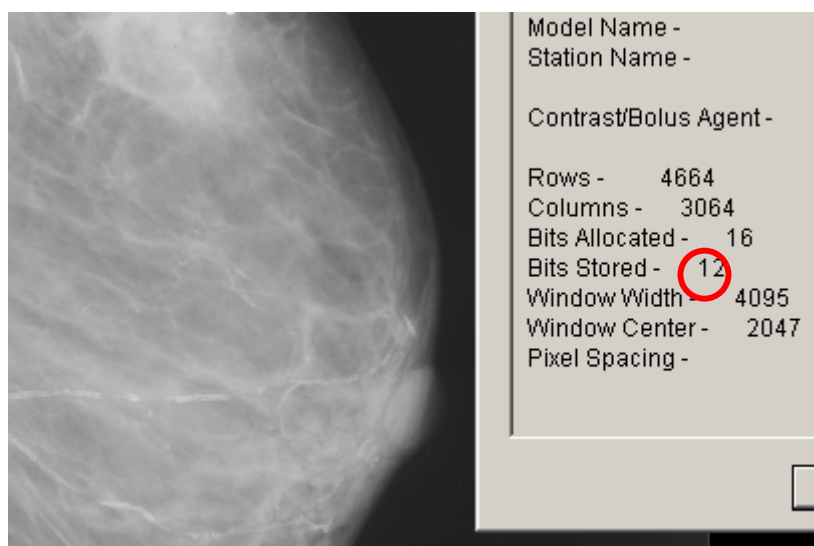


Figure 1 12-bit mammography image

2. IEI GrayBoost® Simultaneous Grayscale Topology

What is the traditional grayscale topology? Figure 2 illustrates the traditional topology of a display system which is commonly used for displaying more than 8-bit grayscale images. In conventional grayscale topology, it needs a specified medical graphic card and a graphic card dedicated image viewer to display a grayscale image which is more than 8 bits. While being processed by an image viewer, the raw image is converted into a 10-bit or 12-bit packed format specified by a medical graphic controller in a medical graphic card. In addition, the display unit needs to be able to process the specific packed format of grayscale data with a corresponding look-up-table (LUT). In the conventional grayscale topology, DICOM calibration is performed through either the LUT in a medical graphic card or the one in a display unit.

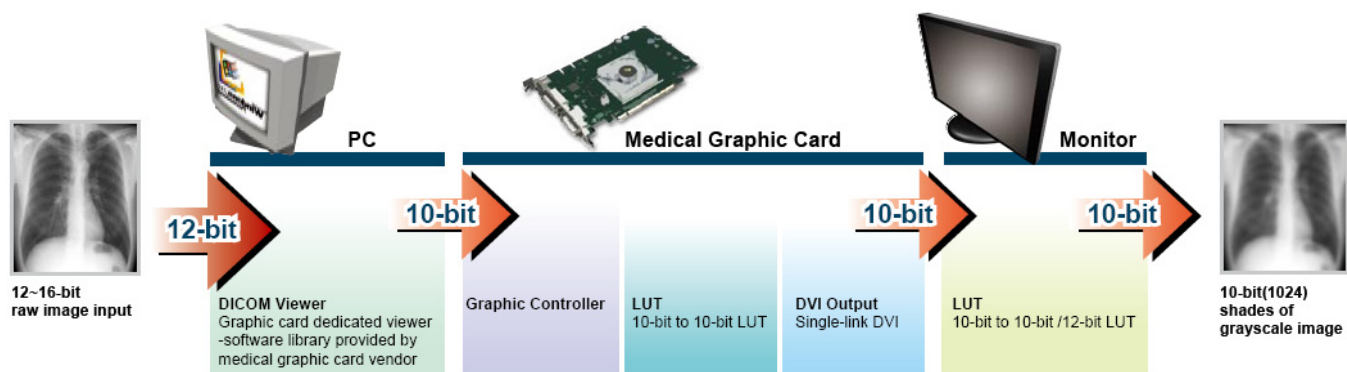


Figure 2 Conventional grayscale topology of a display system

In comparison, the IEI GrayBoost® topology maintains a 12-bit input to 12-bit output grayscale data flow with a standard 24-bit RGB graphic controller. Figure 3 shows the process of the novel GrayBoost® grayscale topology. While the image is transferred from a computer to a monitor, the GrayBoost® dedicated image viewer firstly packs the 12-bit grayscale image to a standard 24-bit RGB format which could be processed by a commercial 24-bit RGB dual-link DVI graphic board. Secondly, the image is unpacked by the IEI display unit to the original 12-bit grayscale data and displayed through the embedded 12-bit to 12-bit LUT. During the process, the input image data is retained in 12-bit grayscale without any image degradation when displayed on a monitor.

Theoretically the GrayBoost® topology is able to process as high as 24-bit and practically 16-bit grayscale when a commercial grade 24-bit RGB graphic controller is applied. Since there is usually no LUT in a commercial grade graphic card, the DICOM calibration is always performed through the LUT built in the display unit.

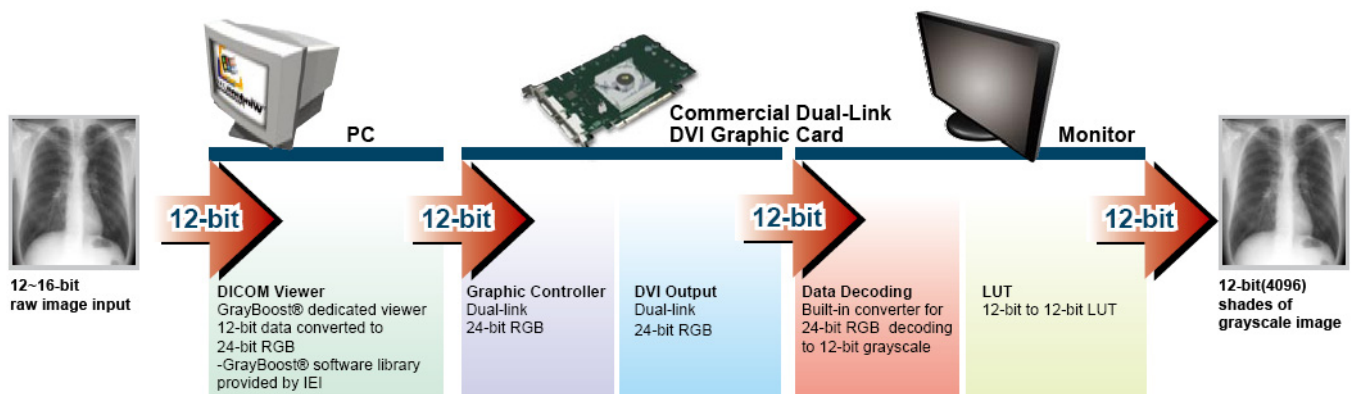


Figure 3 Novel GrayBoost® grayscale topology of a display system

3. Elimination of the posterization in a 12-bit grayscale image

When displaying a 12-bit grayscale image in an 8-bit display system, the four least significant bits (LSB) of the 12-bit grayscale levels will be rounded into the same gray level which creates the posterization effect on the 12-bit grayscale image. Figure 7 shows the posterization effect of a 8-bit monitor displaying a 12-bit gradient image.

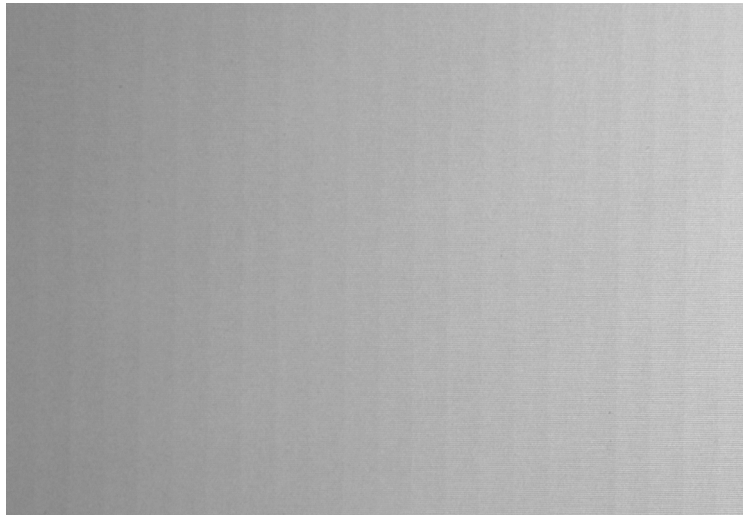


Figure 7 Posterization of a 12-bit image on a 8-bit display system

By applying the novel GrayBoost® 12-bit grayscale topology to a display system, the IEI 12-bit monitor can render the same 12-bit image much smoother than a 8-bit one and eliminate the posterization visible by human eyes. Figure 8 shows the elimination of the posterization effect of the 12-bit image.

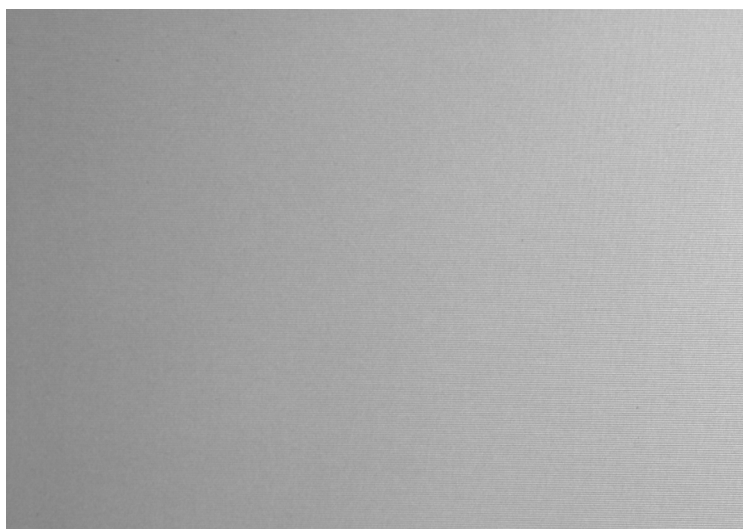


Figure 8 Elimination of the posterization effect of the 12-bit image in the GrayBoost® display system

4. Conclusion

By applying the GrayBoost® topology to the display system, 12-bit grayscale images are successfully and precisely reproduced on the PACSmate™ monitor using a commercial grade 24-bit RGB graphic card instead of a medical graphic card which requires special packed data format. The Grayboost® 12-bit display system eliminates the posterization effects in conventional 8-bit display systems and reaches the optimal conformance to the DICOM Grayscale Standard Display Function (GSDF.)

5. Reference

[1] H.K. Huang, D.Sc. FRCR, "Image Acquisition Gateway," in *PACS and IMAGING INFORMATICS: BASIC PRINCIPLES AND APPLICATIONS*, NY: John Wiley & Sons, 2004, pp. 214-215.

[2] DICOM Supplement 28: Grayscale Standard Display Function.

Available: http://medical.nema.org/dicom/final/sup28_ft.pdf