Evaluation of Monitor Performance for Displaying Medical Images

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Personal Details
I entered the Degree in Applied Sciences in 1999, and in my third year opted for the Physics and Physics Technology option. My academic interests include Medical Imaging Systems, Solid State Physics, Biophysics, Quantum and Nuclear Physics. My hobbies include playing and watching football, socialising with friends and playing the guitar. I also enjoy travelling and working abroad.

Project Summary
The practice of radiology is increasingly changing from being film and light box-based to a computer and CRT monitor-based display medium. Although this transition may seem straightforward and easy to some, it is actually a rather involved and sensitive process. There are many differences between film and monitor displays, not only in terms of how the display looks, but in terms of the amount and type of information that is available to the radiologist for making an interpretation.

Picture archiving and communication systems (PACS) and Teleradiology networks are becoming commonplace, but have aroused concern regarding the consistency of images when viewed on different monitors. With the PACS, medical images are captured, stored, and transmitted in digital form. Teleradiology enables images from remote hospitals to be sent to radiology centres or to far flung experts to provide a secondary consultative reading.

The luminances of four monitors in the Radiology Department in Beaumont hospital were measured, two of which forms part of the Teleradiology section, one is an office Cathode Ray Tube (CRT) display device and the other is a Liquid Crystal Display (LCD). The luminances of these monitors were tracked over the duration of the project and it was concluded that ambient light has a major effect on the image quality produced. Luminance uniformity is also a big problem with digital displays.

Monitors were calibrated using a software package called VeriLUM 4.4. The software addresses three major requirements for video display quality assurance: Acceptance Testing; Calibration to a Luminance Response Model; Verification and tracking. For Acceptance testing the software has two test patterns. The most commonly used test pattern was developed by the Society of Motion Picture and Television Engineers and is known simply as the SMPTE pattern (see figure 1).

The photometric quantity measured in this project was luminance in candela per metre squared (cd/m²). The office monitor which was subject to varying ambient light had an approximate luminance of 120 cd/m². The American College of Radiology recommends that monitors used for primary diagnosis be operated with a maximum luminance of at least 171 cd/m². Secondary class diagnosing displays

Figure 1: The SMPTE pattern.
should be operated with a maximum luminance of at least 100 cd/m². All the monitors examined were secondary class diagnosing displays.

The recommended ratio of maximum to minimum luminance for secondary class devices should be 100, so that all information is retained within the image. The ratios for the monitors slightly exceeded this. Luminance uniformity was a big problem with CRT displays. Luminance values over the monitor surface should agree to within 15%. The right hand side of all the display devices examined operated outside this recommended value.

For monitors that were part of a network the difference in luminance should not be greater than 2%. The centre of the monitors in the Teleradiology section differed by less than .1%. However, because of the non-uniformity of these monitors the difference between the respective corners of the monitors exceeded the 2%.

The LCD display showed continuously varying luminances throughout the project. This device was placed in a diagnosing reporting room and was subject to very little ambient light. The reason for the variation was due to the intensity of the backlight. The longer the back light was on the higher the luminance of the display until it reached its maximum.

The monitors examined in the hospital were all calibrated to have the same maximum and minimum luminance and to have the same ratio in order that an image viewed on one monitor would appear exactly the same when viewed on any of the other monitors. This is a very important aspect for monitor displays. However, due to the non-uniformity of the monitors, it was very difficult to achieve.

The medical image display is typically the last stage of a medical imaging chain. New technologies in image display and acquisition are expanding the ways in which the radiologist view clinical information. As the transition to using new display technologies in the clinical environment is being made, these displays must be carefully evaluated. Monitors used for displaying medical images must be checked regularly.