A Software Program for Testing a User's Acceptability of Display Set up Using a Test Image.

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Introduction

With the increasing use of digital images in diagnostic healthcare, images are being viewed on displays throughout the healthcare enterprise - in wards, clinics and surgeries. Whilst in the imaging department the display on a reporting workstation is regularly monitored and calibrated, those outside the radiology reporting domain are not necessarily checked as frequently. A need exists for a simple tool to assess whether the display is suitable for viewing images.

One generally accepted method of display assessment is to view a test image, such as the one produced by the Society of Motion Picture Television Engineers (SMPTE) before looking at a series of images. This is a subjective test to measure the viewer's perception of the quality of the displayed image, rather than an objective test of the actual screen such as would be performed as part of a formal QA programme.

However how does a viewer judge the image to be correct? One common way it to view the test image and if the inner squares on the 0/5% and 95/100% squares on the test image are both just visible the screen is correctly adjusted.

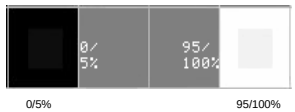
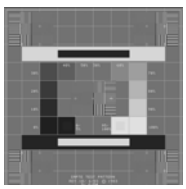
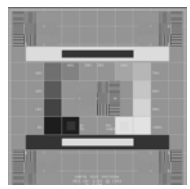
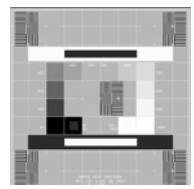


Figure 1. The 0/5% and 95/100% boxes for assessing the contrast and brightness of a display.

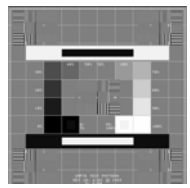
For example, which of the images below is an image of a correctly adjusted display?

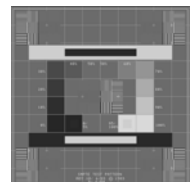

2a


2b


2c


2d


2e


2f

Figures 2a-f. Example images of differing contrast and brightness

Test images can display what may be judged to be a 'correct' image over a range of contrast/brightness values for a display. The aim is to create a tool to test and measure the subjectivity of a viewer in assessing the suitability of a display using a test image and the degree of acceptability in the viewing of such images.

Method

A software application was written using at its heart ezDICOM[1], an open source activeX control for viewing and manipulating DICOM images. Using the control simplified the writing of the application with window width and window level being used as a measure of contrast and brightness. A test image was converted to DICOM and the image displayed with window width and level controlled using the mouse.

The application was written using Borland Delphi™ and the compiled program runs on a PC under the Windows™ operating system. The application comprises two tests. In the first test the test image is displayed as a series of images with differing levels of window width and level applied. The user then has to assess whether the image displayed would be considered acceptable or not by clicking the appropriate button. A pause between each of the images in the series allows the image to fade from memory before viewing the next image. The result of which images are accepted or not are recorded.

Figure 3. Screenshots of the test program

The second test again involves displaying the test image at differing levels of window width and level, but in this case the user can adjust the levels using the mouse until the contrast/brightness is judged to be correct, using the 0/5% and the 95/100% squares for guidance, clicking the 'Accept' button when finished. The results are recorded and a graph showing the results is displayed.

Using the software

The software was tested on a Dell Inspiron 8200 notebook attached to a Dell 17" 1280 x 1024 colour display set for average contrast and brightness. The test programs were run with the subjects viewing the images under normal office lighting conditions.

Users were observed while using the software to see how they manipulated the images. It was noticeable that the users found discriminating between the 95/100% box easier than the 0/5% one. However, the main difficulty users had was in adjusting the levels so that they were both just visible.

The results

The users In the static test at testing whether the single image is acceptable in nearly all cases they were all considered acceptable. Table 1 displays typical results shown for the acceptability test. The example images shown were chosen such that the boxes were visible similar to those shown in figures 2a – f, with Images 3 and 7 being examples of the standard setting.

Image	Width	Centre	User 1	User 2	User 3	User 4
1	95	354	✔	✔	✔	✔
2	150	400	✔	✔	✔	✔
3	127	255	✔	✔	✔	✔
4	48	438	✔	✔	✖	✔
5	120	240	✖	✖	✔	✔
6	100	450	✔	✔	✔	✔
7	127	255	✔	✔	✔	✔
8	230	500	✔	✖	✔	✔

Table 1. The results of the acceptability series.

These results show that the majority of users the images would have been considered acceptable even though there is a large discrepancy in the form the standard settings. This would confirm the suspicion that viewing a single test image may not in itself be sufficient to accurately assess the contrast and brightness settings.

Figure 4 displays the results of adjusting the image to correct the contrast and brightness of the various images. Distinguishing the inner squares on the 0/5% and the 95/100% and finding the point where they are both just visible proved quite challenging. The graph appears to show there is an overall tendency to err towards a lower window centre and higher window width from that of the target image, giving a darker image with lower contrast.

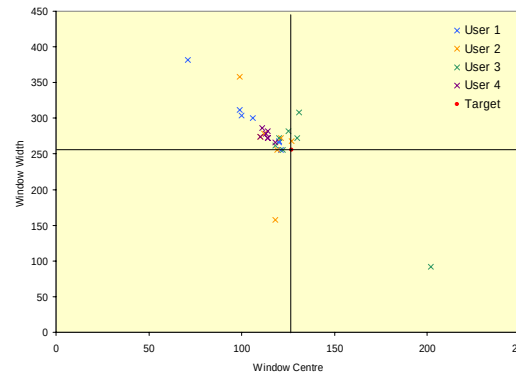


Figure 4. Adjusting the image image results

Discussion

The test image program is simple and easy to use. The use of a DICOM image viewer caused some problems in that artefact could be produced with certain combinations of window centre and width, and this could have been used by the user, although this did not seem to be the case. However, two question arise from the use of this method. Is this a realistic simulation of a display? and does the software measure the ability of the user to discriminate the contrast/brightness levels and not just the ability of the user to use the software?

It is planned to do a further series of studies with a larger group of users. Using different combinations of contrast and brightness setting on the display and then asking the user to repeat the test to find if there is any change in the user's discrimination.

The graph shows that accuracy of the user improves with each turn, so asking a user to repeat the test allowing the user to become more adept at using the software and then compare results.

This program is designed to determine the factors that affect discrimination in subjectively assessing a display screen with the aim of creating a test tool that can assist in assessing and setting up a display.

Acknowledgement

[1] ezDICOM written by Chris Rorden is a version of Wolfgang Krug's DICOM reader. http://www.sph.sc.edu/comd/rorden/ezdicom.html#users

References

AAPM On-Line Report No, 03: Assesment of Display Performance for Medical Imafing Systems, American Association of Physicists in Medicine (AAPM) Task Group 18, April 2005

Video Monitor Test Pattern Tutorials. An introduction on the use of test patterns can be found at http://brighamrad.harvard.edu/research/topics/vispercep/tutorial.html

[Figure 2e is the correctly displayed image]