FPD Image Quality Evaluation Based on Visual Ergonomics

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Abstract. Image quality is one of important factor for FPD. In order to evaluate FPD image quality effectively, the evaluation method based on visual ergonomics is proposed. Firstly, the evaluation content is described which includes the background and the definition of the evaluation factors; secondly, the evaluation method is introduced which has four parts. These are equipment, test method, test evaluation and overall uncertainty. Finally, one of evaluation result is provided aiming at FPD image, and the result shows that this method is able to evaluate FPD image quality effective.

Keywords: FPD, image quality, visual ergonomics.

1 Introduction

FPD becomes one of common work tools for users in different types of professions, and image quality is one of important factor for FPD. Good visual ergonomics is a very important aspect of quality that can also have direct effect on the health and comfort of the user [1-4].

In addition to, televisions and multifunction displays are nowadays also common wording tools in many professions, e.g monitoring or to show moving graphic materials on the display. Therefore the picture quality of the moving images has also become an important quality aspect for that type of displays [5-9].

In order to ensure that FPD develops of FPD healthily, the health effects of various parameters have been taken into account since in developing requirements for visual ergonomics, as well as other features that characterizes good quality displays [9].

There are three main ways which are used to determine the suitable level for each labeling program. One is based on acceptable visual levels determined by scientific research. The second is based on statistics from tests carried out in accordance with FPD. The third way is based on manufacturers' knowledge and experience, which is invaluable. Manufacturers, consumer groups and other organizations with interests in the visual ergonomics field have contributed with a great deal of valuable information and ideas through discussions [10-11].

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2 Evaluation Content

Pixel array requirements are the first evaluation content. Image quality is negatively affected by a low fill factor, visible “jaggies”, poor rendering of details, etc. All of these parameters are related to the pixel array of the display. For pixel array characteristics, it is important to take the viewing distance into account.When rendering moving images, the viewing distance is normally further away than for usual computer displays. Therefore the 30 pixels/degree requirement is tested at 4 image heights instead of at 1.5 times the display diagonal.A pixel is defined as being able to the full range of luminance and colors. In normal video definition this is represented by three subpixels consisting of one Red, one Green and one Blue subpixel.The pixel array is the number of pixels in the horizontal direction by the number of pixels in the vertical direction that the display can present..

The second evaluation content is luminance level. It shall be possible to set a sufficiently high luminance level with respect to the ambient lighting in order to present a comfortable viewing situation and to avoid eyestrain. Poor luminance can lead to low contrast and consequently affect legibility and color discrimination and by that cause misinterpretations. It shall possible to set the luminance level according to the lighting conditions of the surroundings.For moving images on displays it is more important to be able to present different levels of both high and lower luminance than for displays for office use. One reason is that the content of moving images varies much more in grayscale, for instance shadow details, than in common office application. These nuances have to be resolved and presented as accurately as possible. It is also important that it is possible to set the luminance to a suitable level in low ambient light and at a level where most video content is produced.

3 Evaluation Process

There are four parts for evaluation method which are equipment, test method, test evaluation and overall uncertainty.Firstly, the luminance of an FPD is angular-dependent i.e. that screen luminance decreases when the FPD is viewed slightly from the side.This can have a negative effect on contrast and can affect the legibility of the screen, especially if two or more users are looking at the screen from different viewing angles or from different heights.

$$\begin{cases} K_{r1} = K_{r\_m_{m1\_n1}\_d_{i1\_j1}} \\ K_{g1} = K_{g\_m_{m1\_n1}\_d_{i1\_j1}} \\ K_{b1} = K_{b\_m_{m1\_n1}\_d_{i1\_j1}} \end{cases} \tag{1}$$

Luminance uniformity is the capacity of the FPD to maintain the same luminance level over the whole active screen area. The luminance uniformity is defined as the ratio of maximum to minimum luminance within the fully active screen area.The angular-dependent luminance uniformity is defined as the ratio of maximum luminance to minimum luminance in the specified measurement areas, as shown in (3).

$$P_{color} = \begin{pmatrix} B_{r\_m_{m\_n}\_d_{i\_j}} & x_{r\_m_{m\_n}} & y_{r\_m_{m\_n}} & Y_{r\_m_{m\_n}} \\ B_{g\_m_{m\_n}\_d_{i\_j}} & x_{g\_m_{m\_n}} & y_{g\_m_{m\_n}} & Y_{g\_m_{m\_n}} \\ B_{b\_m_{m\_n}\_d_{i\_j}} & x_{b\_m_{m\_n}} & y_{b\_m_{m\_n}} & Y_{b\_m_{m\_n}} \end{pmatrix} \tag{2}$$

Luminance uniformity-angular dependence is the capacity of the FPD to maintain luminance level independently of the viewing direction.

$$\begin{cases} C_{r1} = C_{r\_m_{m1\_n1}\_d_{i1\_j1}} \\ C_{g1} = C_{g\_m_{m1\_n1}\_d_{i1\_j1}} \\ C_{b1} = C_{b\_m_{m1\_n1}\_d_{i1\_j1}} \end{cases} \tag{3}$$

Secondly, the degree of contrast is important for legibility and for distinguishing one character from another.Luminance contrast-characters is expressed as the ratio of the Lmax to Lmin difference over the sum of Lmax and Lmin, according to Michanelson's formula. It is measured at two different angles. Luminance contrast-characters is the capacity of the FPD to maintain a high luminance difference between a bright background and dark characters or parts of characters over the whole active area.

$$\begin{cases} x_{r1} = x_{r\_m_{m1\_n1}} \\ y_{r1} = y_{r\_m_{m1\_n1}} \\ x_{g1} = x_{g\_m_{m1\_n1}} \\ y_{g1} = y_{g\_m_{m1\_n1}} \\ x_{b1} = x_{b\_m_{m1\_n1}} \\ y_{b1} = y_{b\_m_{m1\_n1}} \end{cases} \tag{4}$$

Thirdly, for FPDs the luminance and consequently the contrast on the display is angular-dependent. The luminance variations can influence both the bright white and the dark areas of the screen, causing a change in contrast.This has a negative effect on the legibility of the screen, especially when two or more users are looking at the screen from different viewing angles or from different heights.

Finally, luminance contrast-angular dependence is the capability of the FPD to maintain the same contrast regardless of the direction from which the screen is viewed. The luminance at a point on a surface and in a given direction is the quotient of the luminous intensity in the given direction of an infinitesimal element of the surface containing the point under consideration, to the orthogonal projected area of the surface element on a plane perpendicular to the given direction. Luminance

contrast-angular dependence, is expressed as the ration of the Lmax to Lmin difference over the sum of Lmax and Lmin, according to Michaelson's formual.

4 Conclusion

The following figures are the evaluation results of the image quality for Red, Green and Blue subpixels. It can be found from these figures that this method is able to evaluate the image quality effectively.

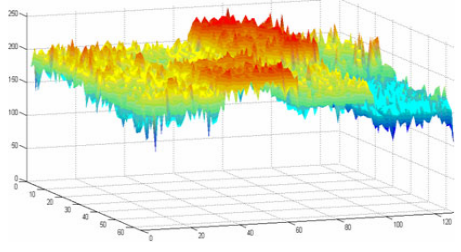

Fig. 1. Evaluation result of Red

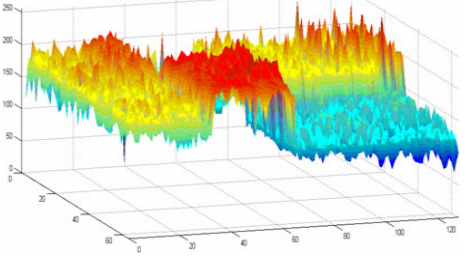

Fig. 2. Evaluation result of Green

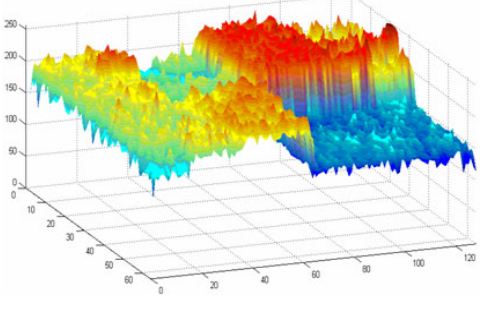

Fig. 3. Evaluation result of Blue

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