The Newly Developed Extra High Quality Imaging System can Display Both Merits of Printing and Electric Imaging: Very Dark Expression Space

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Abstract

Printing can display very high quality image at the low level gradient compared with the electric imaging systems, which can display the higher level of gradient more than $0.5\,cd/m^2$ up to $100\,cd/m^2$. The newly developed Extra High Quality Imaging System can display from 0.005 cd/m^2 to 80 cd/m^2, and the gradient is faithfully compensated by a look up table of 4096 signal level in very dark ambience. The new system used in very dark space can convey the sensation of strikingness, elegance, refinement, dignity, and profundity of impression if an input image source has such information. This is a foundation of very high quality V-R Expression of Images.

The success depends on the new inductive method of development in which we could find six unknown parameters for the reproduction of the higher order sensation. The inductive method means that we have found unknown factors starting from the deep observation of overall image quality displayed with the help of key assessment words: sense of depth, fresh and vivid, and sense related with the black reproduction. The six discovered factors are, gradient of 4096, black level reproduction of lower than $0.5\,cd/m^2$, common mode noise, step response, halation, and cross modulation among R, G and B. We are finding another parameters and developing better displays including LCD and PDP.

Introduction

Printing can display very high quality image at the low level gradient compared with electric imaging systems, which can display the higher level of gradient more than 0.5 cd/m^2 up to $100\,cd/m^2$. We want to make a new very high quality image expression space which has both the merits of printing and the electric imaging considering the profound esoteric spiritual sensation of human brought in very dark ambience. The newly developed Extra High Quality Imaging System can display from 0.005 cd/m^2 to 80 cd/m^2, and the gradient is faithfully compensated by a look up table of 4096 signal level in dark ambience. It can provoke the sense of strikingness, elegance, refinement, dignity, and profundity of impression if an input image source has such information. This is a foundation of a field of very high quality V-R Expression of Images.

The Profound Esoteric Spiritual Sensation Brought By Very Dark Ambience

The very dark ambience brings us the profound esoteric spiritual sensation apart from actual living items. Such examples, we can experience many events at traditional temples and Shinto Shrines in Japan. Considerations are as follows;

1. Observers are free from the constraint that they are looking at images in the plastic frame of CRT display because any actual existing is not observed in dark ambience without the image displayed, and they are in a really, esoteric Virtual Reality space.
2. Also, observers are free from the material of glass of CRT, and then, for instance, contra dictionary sense such as a soft silk cloth is displayed on a grass surface do not occur.

The Defect of Printing; The Illumination is Indispensable

In the cases of electric printing and photograph, the lowest signal level of black is no less than 1.0 cd/m^2 where the highest white is 90 cd/m^2. The reason why the low black is not expressed in the case of printing is that the true black on printing is masked by a scatter light by an illumination, which is indispensable to observe any printing. In the case of printed photographs, the defect is the same and indispensable without a case of rear projection of a transparency film. Then, we will develop a self-emission type display such as CRT in the dark ambience, utilizing the high level technology in printing.

How to Discover Unknown Factors or Characteristics for the New Esoteric Spiritual V.R.

Since, we now have many kinds of displays in various situations, we will be able to discover unknown important physical factors and characteristics by careful observations. Then we have adopted a new inductive method of research.

*** Strategy**

Our strategy to discover important physical factors is as follows; we will assume that the overall quality can be expressed by assessment words, such as those typically used by expert observers. At first, we will collect all of the assessment words relevant to the evaluation of the picture quality and classify them into groups. Each group is then labeled by a representative assessment word.

Secondly, for a set of test images, we must determine the relationship between the overall quality evaluation and all representative assessment words. It was very laborious.

Thirdly, we will find the key assessment words which are correlated with all representative assessment words and which can be evaluated quantitatively.

*** Key Assessment Words**

After much consideration, we have found key assessment words which are appropriate for the evaluation of the extra high quality display. They are sense of depth, fresh and vivid, and sense related with the black reproduction. By "image depth" we mean the fidelity in conveying the sensation of the relative depth of objects in electronic images.

The relative position of objects in a picture is decided principally during the composition of a picture. However, if the reproduced color and the electronic signals forming the objects are much enhanced, the impression of depth of position given by electronic color reproduction will be different from the position which is intended by the composition of a picture. The errors described above cause the deterioration of the sensation of "image depth".

By “fresh and vivid” we mean literally “clear” or the image quality concerned with the fidelity of signal such as color distortion and error of signal waveform. The “fresh and vivid” avoids the contour oversuppression which is apt to be led in representing "image depth".

“Sense related with the black reproduction” is related to the esoteric representation in dark ambience. The representation of “dignity” or “grace” is supreme in dark ambience. A concrete example is that wet surface reproduction with gluster. Therefore, faithful subtle black reproduction and gradient on a display are important.

*** Test Images**

We have tested many kinds of images as candidates; images of glass and metals objects with a deep gloss, or of a woman with an enchanting look in her eyes, or of a garment with a high quality velvet luster and famous paintings.

*** How To Discover Unknown Factors**

Through the use and study of such images and the relevant key assessment words, we expect to discover unknown physical factors that are important to the electronic display of images at the high end of the quality range (Fig. 1).

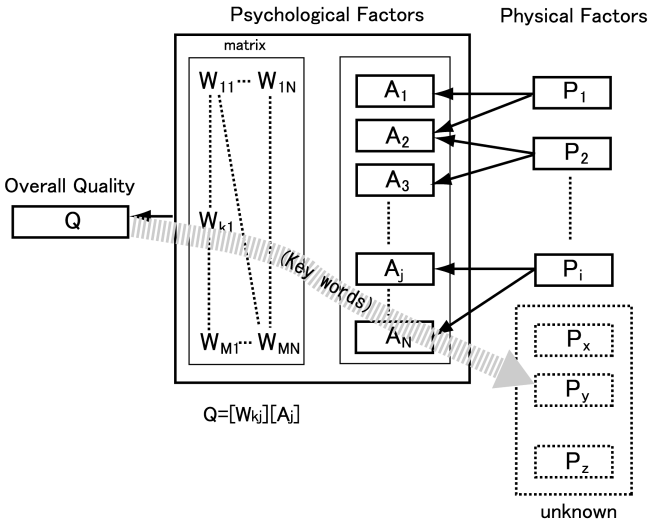

Figure 1. Discovery of Unknown Physical factors

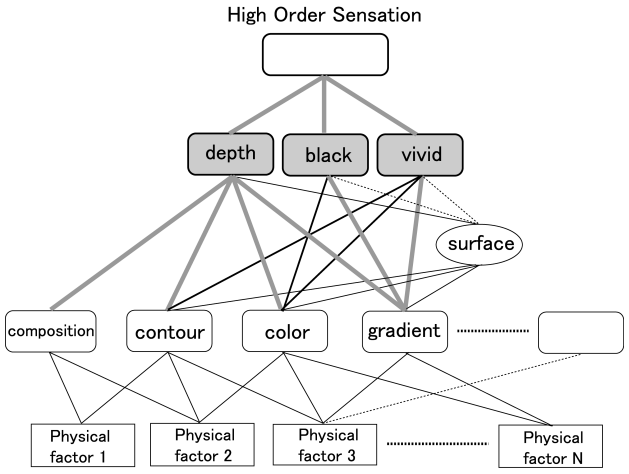

Figure 2. Key assessment words and physical factors

We could find six unknown parameters for the reproduction of the higher order sensation. The inductive method means that we have found unknown factors starting from the deep observation of displayed overall image quality with the help of key assessment words: sense of depth, fresh and vivid, and sense related with the black reproduction (Fig. 2).

Discovered 6 Factors

The six discovered factors are, gradient of 4096 levels, black level reproduction of lower than 0.5cd/m2 down to 0.005 cd/m2, common mode noise, step response, halation, and cross modulation among R, G and B. We are now finding the other parameters and developing better displays including LCD and PDP.

*** How to Realize Black and Faithful Reproduction of Gradient**

We are focusing on the esoteric representation in dark ambience because the representation of "dignity" or "grace" is supreme in dark ambience. A concrete instance is that wet surface reproduction with gluster. In addition to the dark ambience, the faithful representation of black and gradient on a display are important. High order sensations of image will be destroyed if the gamma is not held constant for the whole range of brightness. We have determined that 12bit quantization of each of the R, G and B signals is necessary and that precise compensation of a nonlinear gamma is indispensable to maintain "the color difference is smaller than 1."3

And we have recently found that very faithful reproduction of gamma curve is also very important not only the quantization level of image signal.3 We have made many case studies that the distortion of the gamma value and gamma curve causes a big error of color reproduction. The faithful gamma curve lower than the corresponding brightness of 0.5 cd/m2 is very important, because we must consider the reproduction of images under 0.5 cd/m^2 down to 0.005 cd/m^2, which is not considered up to now. To achieve this requirement, we will compensate a gamma by the use of a look up table.

*** Detailed Consideration to Reproduce Faithful Black of Images**

For the esoteric representation in a dark environment: cut bias of signal When we take picture, we take pictures not the black be sink into the black level, that is, the signal is not suppressed to low limit level. Hence, the taken pictures are apt to be overexposured and image level is biased. Therefore, a special compensation (cut bias) is indispensable to compensate black level signal of images which is taken by a camera. For acrostic presentation of images, careful control of black level is important, and we claim an engineer to have the acrostic sense. Another realization how to realize the 6 factors are described in [1][2]. Brief explanations are;

*** Cross Modulation Among R, G and B**

With the cross modulation present, a dynamic color reproduction is not faithful. The law of additive mixture of colors, which is required for the faithful reproduction of color, is scarcely maintained in all the CRT displays tested. When we consider a strict color reproduction, the requirement, such as the "color difference $\Delta E \leq 1$ in CIE unit"is necessary.

*** Erroneous Display of Contours in Images**

Preliminary observations and measurements have revealed some physical factors related to the ``image depth''. A very faithful reproduction of signal waveforms and of their transformation to emitted light is necessary. In particular, the step response of electronic circuit should be adjusted strictly and a high slew rate is necessary. Overshoot and undershoot should be lower than at most 1/10 of a traditional specification. High slew rate is necessary because low-level contours are emphasized if the slew rate is not sufficiently high. Note that the erroneous contours of image will also be large when the number of quantization levels is small such as in the case of 8 bit/sample of R, G, and B respectively.

*** Aliasing**

Aliasing generated by the optical structure of the display surface also causes distortion in the contour of objects. The same kind of error is observed in various situations, for an instance, zig zag shaped distortions when the number of quantization levels is small. These errors or distortions cause an apparent enhancement of contours and degrade the "image depth".

*** Halation**

Halation, caused by the optical reflection at the surface of a display, causes a serious degradation of the picture quality of fresh and vivid, and the black reproduction. This effect should be as small as possible.

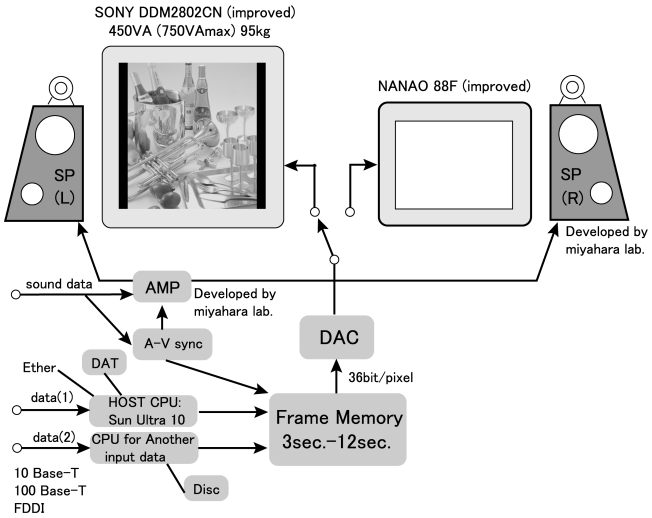

Figure 3. Extra High quality Visual-Audio System

A Developed Pilot System of Extra High Quality Imaging

Figure 3 shows a pilot system of extra high Quality characterized by 12 bits for each R, G and B signal; 36 bits/pixel (4096 quantization signal levels). NANAO 88F is a 21" CRT system, and SONY 2802CU is a 51cm x 51cm

CRT Display. Both of them are specially made or remade considering the new six factors and characteristics described above. The extra high quality sound system is accompanied with.

Difference of Expression Between Printing and the New Profound V.R.

I will compare the expression difference of the expression of images. The superiority of the new profound V.R is mysterious expression because of dark ambience and subtle expression of "black".

Table.1 Printing vs The New Profiund V.R

	Printing	The new profound V.R.
Ambience	500-3000lux	0 lux
Minimum black	$0.5\ cd/m^2$	$0.005\ cd/m^2$ (CRT) $0.05\ cd/m^2$ (PDP)
White	$90\ cd/m^2$	$80\ cd/m^2$ (CRT) $300\ cd/m^2$ (PDP)
Control of gradient (gamma)	Difficult	Easily completed by a LUT
Number of gradient	256	4096 (CRT) 256 (512) (PDP)
Size of frame	120cm x 80cm	51cm x 51cm: CRT 120cm x 70: 52inch PDP

Evaluation of the Expression in the New Profound V.R.

For the test images of high quality described by such assessment words as strikingness, elegance, refinement, dignity, and profundity of impression, the impression displayed by the Extra High Quality pilot system is supreme compared to any kind of traditional image presentation. Representative evaluations are, "Wonderful! It is not mere more beautiful images of traditional TV, CG, Cinema and Slide projection. It is rather a new media. We are really in a 3 dimensional new world apart from actual world." Thus, it will not be fare to compare the displayed images in such a dark ambience to the images in a lighter ambience, if we dare assess, the impression of displayed images is evaluated as more than score +3 in the seven grade scale. We will begin to represent the degree of emotion evoked by a measure of quantity of electroencephalography (EEG).

Conclusion

For the images of high quality described by such assessment words as strikingness, elegance, refinement, dignity, and profundity of impression, the impression displayed by the Extra High Quality pilot system in dark ambience is supreme compared to any kinds of traditional image presentation. The new profound V.R. shall be expected from now on. I expect the persons in printing field and photograph field to develop this extra high imaging system with us because the high sense on images is indispensable to develop this Extra High Quality Imaging.

Acknowledgement

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Reference

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Biography

Professor Miyahara received his Ph.D degrees in electrical engineering from the Tokyo Institute of Technology in 1975. During 1966-78, he was at the Technical Research Laboratories at NHK. He proposed the basic idea of MUSE. He was a professor at Technological University of Nagaoka during 1978-92. During 1983-84, he was a siting professor at UC/Davis. Since 1992 he has been a professor of School of Information Science at JAIST. From 1997, he is the representative of a big project: "the research project on the creation of future audio-visual culture" (JSPS-RFTF97P00601).