HD-TV PRINTING TEST IMAGES AND PRINT QUALITY COMPARATIVE TEST RESULTS

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Abstract: Hardware system and software system of HD-TV(High Definition TV, called Hivision in Japan) become gradually wide spread in many industrial application fields like movie, printing, medical use, display in museum etc.(Nakajima 1992). In these fields, printing industry is one of the most promising area because of high image quality of HD-TV. Further, new image input media e.g. photo-print-CD, HD-TV images, still camera images, Computer Graphics images etc. are effectively used gradually instead of usual photographic film and in near future these digital media are mainly used instead of usual photographic film because of convenience and quickness of image input process. This paper shows two kinds of HD-TV test images and the image quality evaluation test results using these test images.

Introduction

HD-TV is regarded as an effective input system in newspaper industry because it has high quality and possibility of holding the great amount of image information in an event and/or an affair which should be written on a newspaper. So, the Hivision Graph Committee(chairman :Masayuki Nakajima,TIT) was established in Hivision Promotion Center in Japan to discuss how to use HD-TV image as a picture on a newspaper and improve image quality of HD-TV moving picture especially in sports program. This committee has already applied HD-TV images to newspaper pictures in many

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kinds of sport events, e.g. Barcelona Olympic games, baseball, SUMOU wrestling etc.. Fig.1 is the examples of the pictures used on Japanese major newspaper during Barcelona Olympic game. These pictures were received at Toppan printing company in Tokyo through HD-TV Olympic program broadcasting in Japan. In this article, I will show HD-TV printing test images for evalu ation of image quality and the image quality evaluation test results using these images.

The Characteristics of HD-TV for Printing Area

The most effective characteristic of HD-TV for printing field is that it is easy to get digital images by means of HD-TV system. Many ordinary printing systems consist of three processes i.e photographing, scanning and digitalization. On the contrary, digital images are taken by digitalized HD-TV directly. The Hivision Graph Committee has been discussing the possibility to use HD-TV for still pictures on newspaper.

The merits of using HD-TV images as newspaper picture are the followings:

(1-a) Time consume

The ability of shortening the total processing time from the happening of events to printing the article is suitable for a newspaper. For example, HD-TV broadcast program is received at newspaper companies and the companies could take the pitters of the game immediately from HD-TV, so saving of the total printing process time is available.

(1-b) Selection of best scene is available

Selection of the best shutter release time of photographic still-camera is very difficult for photographer. HD-TV is continually capturing the event as moving picture, so it is very easy to select best scene from the VCR of HD-TV.

(1-c) Consuming film resources

For example, we can say that several hundreds of frame of 35mm film are used for one pro-baseball game in each Japanese sport newspaper company,

Figure 1. Examples of HD-TV images used on major Japanese newspaper during Barcelona Olympic Games

especially for the game of Tokyo Giants. However, only one or two still pictures are used on the newspaper. Using HD-TV, silver film resources are consumed.

However, until now, HD-TV has had the following problems as an input system to be used for a newspaper.

(2-a) Low resolution of HD-TV

According to our practical uses of HD-TV images for newspaper like Fig.1, the resolution of HD-TV (1125 lines) must be low to use for printing field. The resolution of 4,000 line is hopefully needed, which is the image quality of photographic film level.

(2-b) Motion blur

At the scene of the rapid moving object, the motion blur appears and it makes image quality worse.

(2-c) Color matching problem

Color matching is the serious problem. Namely, the keeping of color match between color of the image on HD-TV monitor and color of the same image on newspaper is very difficult.

For dealing with these problem, digital image processing technology and consideration of adequate hardware system are needed. The Hivision Graph Committee was discussing how to determine the best system, then the Committee had concluded that HD-TV test image sets were needed to evaluate software and hardware system.

The Hivision Graph Committee has made mainly two kinds of test image sets which were still scene picture to evaluate resolution and moving scene pictures to evaluate motion blur compensation using digital image technology. In this paper, I will show these test images and image quality evaluation results.

At first, I will show the characteristics of the still test image set established in the committee.

[The Designing of HD-TV Test Images]

The Committee has discussed designing the digital test images to evaluate the quality of HD-TV still images. The followings are main objects of the still test image.

(1). The comparing several HD-TV camera quality.
(2). The comparing of HD-TV image quality under several kinds of lighting conditions.
(3). The comparing image quality between ordinary photograph and HD-TV.
(4). The color characteristics of HD-TV printing image.
(5). The printing quality of HD-TV image.

Fig.2 is the flowchart of the test process. The scenes are taken by HD-TV camera and still camera at the same time. HD-TV signal is digitized and color translation from RGB signal to YMCK signal is applied. Still camera images are scanned, digitalized and printed using usual printing system.

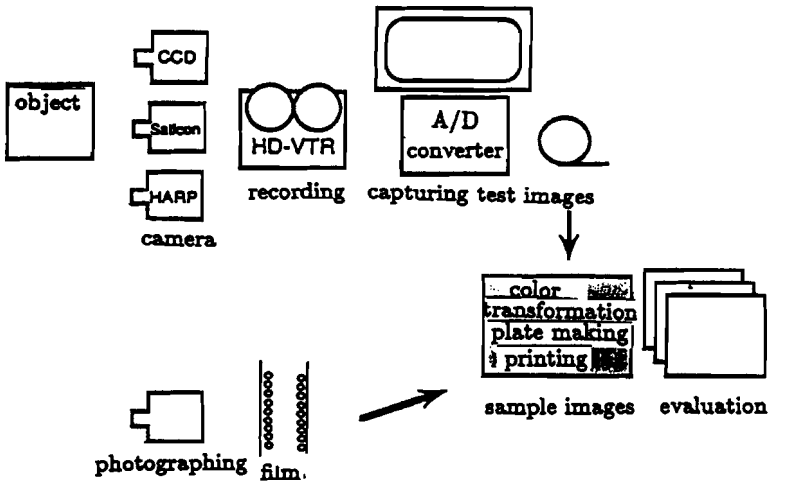

Figure 2. The process for making test images

[The Contents of Test Images]

We took two kinds of pictures as shown in Fig.3(a) and (b). Fig.3(a) consists of many kinds of objects like fruits, flowers, trees, cloths etc. and is for subjective test. Fig.3(b) having color and resolution chart is for objective test. The followings are the recording conditions of HD-TV image.

(1) The type of HD-TV camera

To compare the image quality among used cameras, we used three kinds of HD-TV camera which were CCD, HARP and SATICON. The characteristics of these camera are shown in Table 1.

	Type	Maker	Lens
CCD	HSC-100	TOSHIBA	FUJINON f=60 12×15m/m
SATICON	HDC-300	SONY	FUJINON f=60 12×15m/m
HARP TUBE	HL-1125	IKEGAMI	FUJINON f=48 14×8m/m

Table 1. Hivision cameras used for taking test images

(2) The condition of lighting

In a night game of baseball, unsatisfactory lighting is happened frequently. So we take HD-TV images under three kinds of lighting conditions which are adequate lighting, almost half darkness lighting and extreme darkness lighting. Table 2(a) shows the adequate lighting condition and Table 2(b) shows the HD-TV camera conditions.

(3) Still camera images

We took the pictures of the scenes at the same time using still camera. They were 35mm negative film, 35mm positive film and 4×5 inches positive film.

[Printing Process of HD-TV Test Images]

After recording HD-TV on 1 inch VCR, we decided the adequate still images from the HD-TV while monitoring the scene replayed and these im-

Figure 3 (a). Test image for subjective test

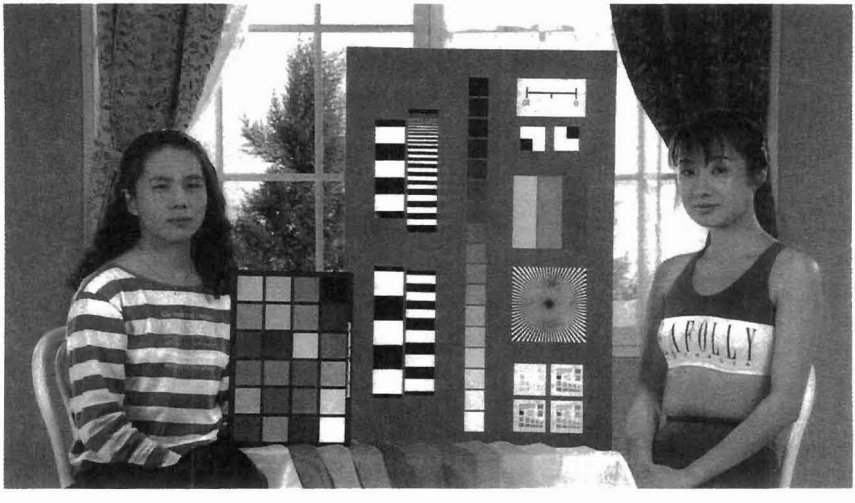

Figure 3 (b). Test image for objective test

Figure 3 Examples of HD-TV still test images

Measuring Point	Intensity (Lux)	Color Temperature ($K°$)
horizont	2850	3620
outside tree	3350	3100
window	1320	2900
flower	2600	2890
upper wall	1170	2940
lower wall	1110	2950
curtain	1170	2940
face of model	2600	2900
grey chart	2600	2920

Table 2 (a). lighting conditions

CAM	HDC-300			HSC 100	HL 1125
γ correction	Hight γ	Standard γ	Low γ	Standard γ	Standard γ
lens variety	12×15m/m Fujinon	12×15m/m Fujinon	12×15m/m Fujinon	12×15m/m Fujinon	14×8m/m Fujinon
lens length	50 m/m	50 m/m	50 m/m	50 m/m	35 m/m
focus	6.5m	6.5m	6.5m	6.5m	6.5m
iris (f)	5.6 1/2	5.6 1/2	5.6 1/2	5.6 1/2	5.6 1/2

Table 2 (b). Camera varieties and capturing conditions

Table 2. Capturing conditions (appropriate)

images were digitized to get 1820×1024 digital images with RGB total 24bits, 5.7GB memory capacity. These digital images were distributed to the companies of the Committee. Each company made printing images using individual HD-TV printing system according to the following same conditions. Image size: 14 dots/mm, almost 130mm× 73mm Paper: 110 Kg. OK coat paper made by Ouji Seishi Company.

[The Configuration of HD-TV Printing System]

These test images were printed using HD-TV printing system by The

Committee members. There are different transformation algorithms from RGB to YMCK, however, almost all of the system are the same configuration. So, we show the HD-TV printing system in TOPPAN Printing Company as example.

(TOPPAN Printing System for HD-TV)

After A/D conversion, digital image pre-processing of noise elimination and sharpness are passed. Next GAMMA compensation to linearize the brightness between HD-TV display and image data to get real printing image is passed and density gamut compensation, namely density compression of low density area and high density area are done. Further, YMCK data are converted form RGB data using table and another color conversion to compensate the color production error to be due by ink irregular absorption on paper. Last, simple color compensation to escape the difference of printing papers is added. After pass these process, we can get the adequate YMCK image data of HD-TV.

[Printing Test Results]

The committee members tried printing out of these test images using individual printing process and color reproduced values of the print tested images were measured. The followings are the results of measuring and comparison results of these images.

(Color Measuring)

We measured the color value of 8 colors (white, yellow, light skin, green, cyan, magenta, red, black) out of 24 colors of color chart on objective test images Fig.2(a) using Multi calorimeter MCPD-100 made by OOTSUKA-DENSHI Corp. and we calculate L*a*b* (CIELAB) values using transformation program from measured color values.

(Color Measuring Results)

Fig.4 shows the CIEL*a*b* measuring result to compare the color gamut of photographic film (Fig.4(a)) and HD-TV images printed using three systems having in each company (Fig.4(b)). We conclude the followings from Fig.4.

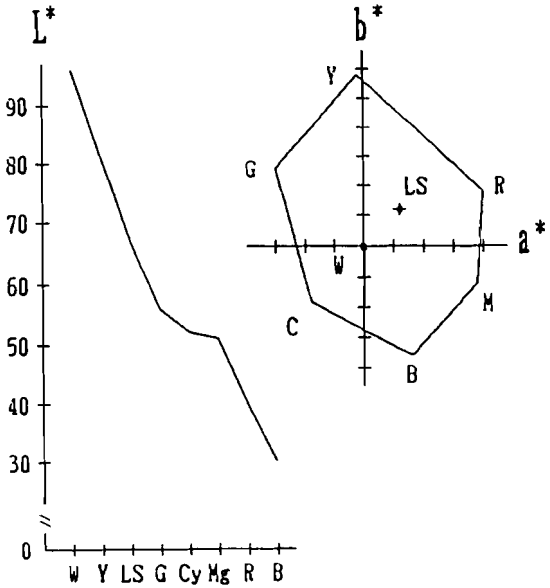

Figure 4 (a). photographic image

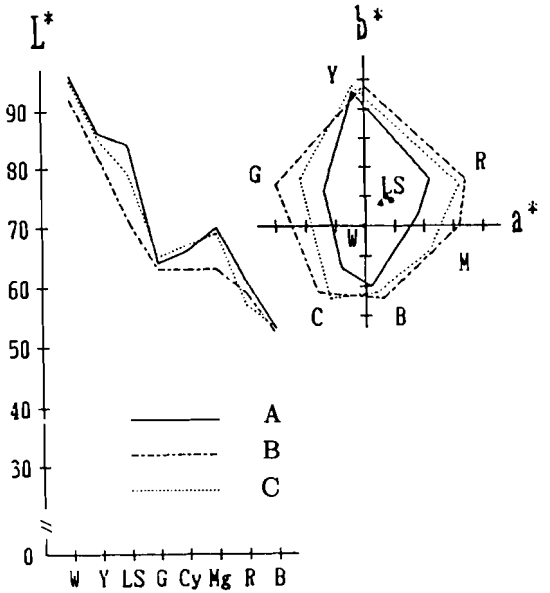

Figure 4 (b). printing SATICON image on high quality paper

Figure 4. Comparison of the values L*a*b* between photographic image and SATICON image

(1). The color gamut of HD-TV is very small compared with that of silver film as shown in Fig.3 (a) and (b).
(2). The color reproduction areas are very different depending on used HD-TV printing system .

(HD-TV Camera Comparing Result)

Fig.5(a) shows the comparing result of CIE L*a*b* values of the test image printed on high-quality paper taken by three kinds of cameras(CCD, HARP and SATICON). From this figure, we can conclud as followings. Fig.5(a) shows that SATICON camera gives the best color reproduction characteristics, but the saturation has low L* value in all of the color. Comparing Fig.5(a) and Fig.4(a), SATICON also shows extreme narrow color gamut. It reduces from 25% to 60% of photographic camera shown in Fig.4(a), however, the luminosity values of M, R, B are extreme high. On the other hand, Fig.5(b) shows CIE L*a*b* of the picture taken by PICTOGRAPH. From this result we cannot find the differences among HD-TV camera system. I guess it depends on color image processing algorithm installed in PICTOGRAPH.

(Color Gamut Differences Between Papers)

Fig.6 shows the CIELAB of images printed on high quality paper, paper for newspaper. And the smallest gamut is the newspaper images passed negative film transmission system.

In this report, I considered the color reproduction characteristics using CIELAB on test image No.1 only. So, I intend to report the other results, for example, the differnces of lighting condition, the color gamut algorithm of each company etc. in near future.

[Test Image Having Moving Objects]

The most difficult problem using only 1 frame of HD-TV is moving blur due to objects moving, especially in sports program. One of the solutions for this motion blur is using high speed camera which has 1/180 sec., minimum 1/2000 sec. using electric shutter. However, it is so expensive a system that almost all the HD-TV programmes have not employed the high speed HD-TV camera yet.

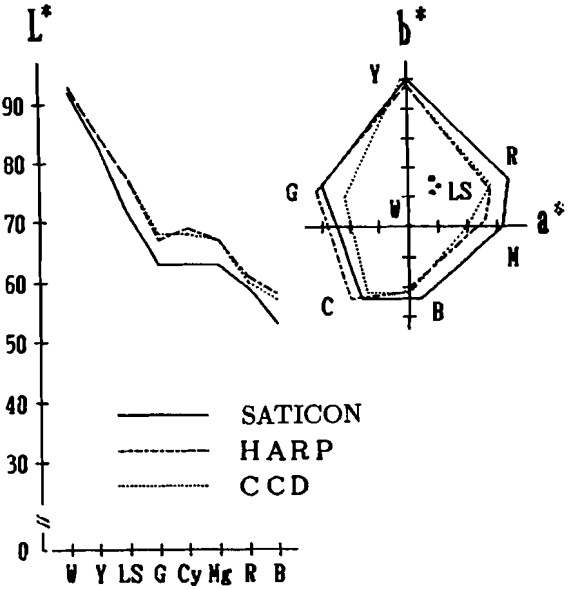

Figure 5 (a) printed on high quality paper

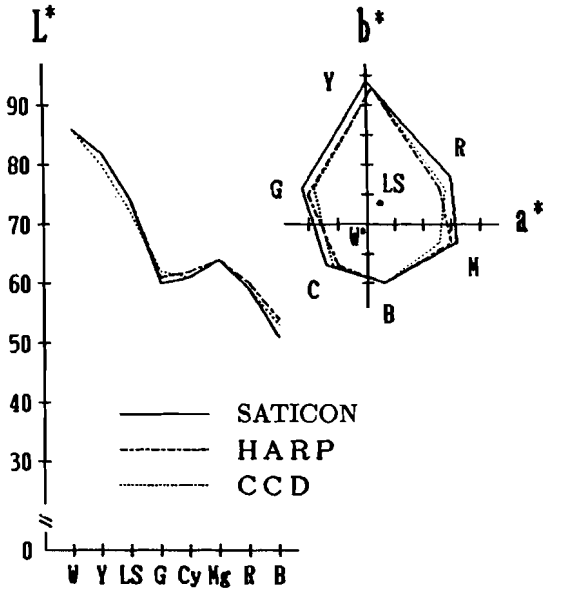

Figure 5 (b) printed on pictography

Figure 5. Comparison of represent colors taken by different camera tubes

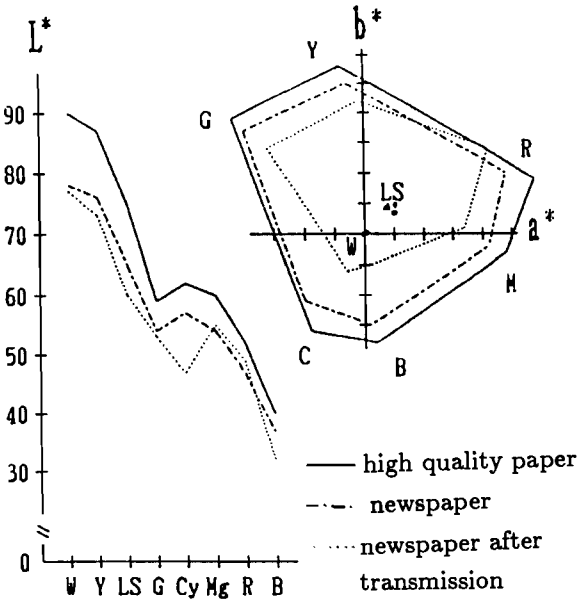

Figure 6. Comparison of the values L*a*b* presented on high quality paper, newspaper and newspaper after transmission

(The Example of Test Image)

We took many kinds of test images having moving objects and still objects in panning camera. They are the test images to eliminate or lighten motion blur using digital image processing technology. They are the images taken indoor and outdoor. Fig.7 is one of the test images of pitching taken outdoor on a baseball ground. The other pictures are bating, sliding and running scenes.

[Motion Blur Reduction Result]

There are many kinds of image restoration algorithms for motion blur. We try to restore using two steps of algorithm for moving objects. First step is segmenting moving object area only and second step is restoring using one dimensional filtering to escape time consuming as comparing with two dimensional filtering. Fig.8 is one of the examples of restored results applied our algorithm, namely Fig.8(a) is the original moving object and Fig.8(b) is the restored image. This filter is calculated according to the LSP(Line Spread Function) having following equation.

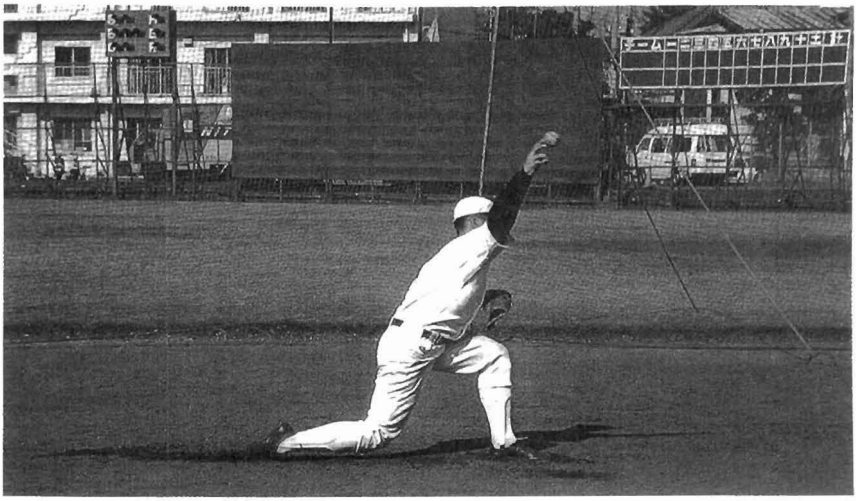

Figure 7. Example of test image of pitching

$$h(x) = \begin{cases} e^{-0.2|x|} & -N \leq x \leq N \\ 0 & otherwise \end{cases} \quad (1)$$

Conclusions

In this paper, we show the still test images and the test image having moving objects. And using these test images, we are now trying to use image processing algorithm to get high quality HD-TV images for newspaper. We intend to show these results in near future.

Literature Cited

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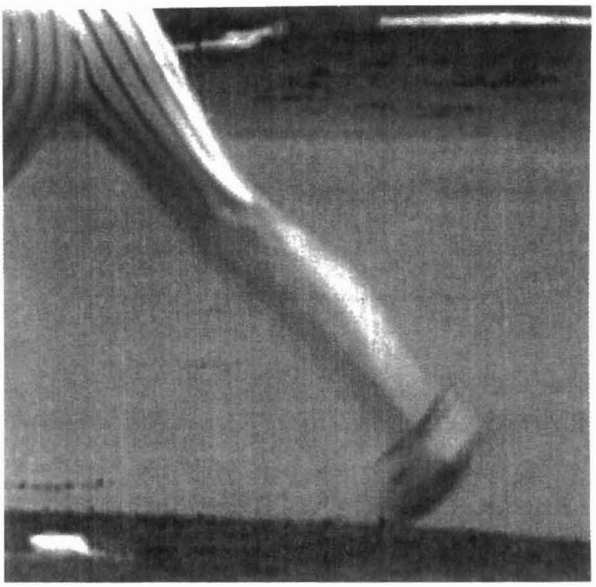

Figure 8 (a) motion blurred original image

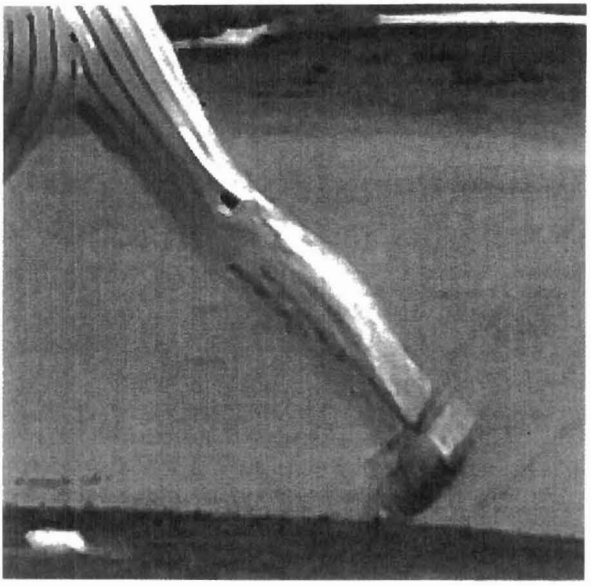

Figure 8 (b) restored image using one dimensional filtering

Figure 8. The example of motion blur reduction