Application of Electronic Image Processing

-Color Tone Correction-

簡易画像処理装置の色調補正への応用

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Abstruct:

We have developed an image processor prototype, KI-100, dedicated to still video image processings and annouced it at PHOTOKINA '90. The processor has a simplified hardware and complete software controled operations, and can be operated handily by use of ICON graphics to make the choice of menu easy.

This paper will introduce one of applications of it to color tone correction. In order to adjust the color balance of images during the correction, we used a scheme that we transform a desinated color to the target color of interest. And besides, in selecting a target color, the HLS color model was chosen instead of the RGB color model because the HLS model is said to be more suited for human perception.

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1 Introduction

Since digital technology has been introduced into a video signal with a digital video effecter and similar equipment, it has been involved in subjects of research and development of its industrial applications, and even small sized color image processors have been announced along with advance of semiconductor technology over the past few years.

On the other hand, an electronic still video camera as a new application of video equipment[1] has been put on the market, which can record still pictures on a video floppy disk and play back it on a television monitor. It has been demanded to have a still video image processor developed for the system variety. In such a situation, we have been developing a simplified video image processor as one component of still video systems, and announced a prototype model, KI-100, at PHOTOKINA '90.

This paper describes the outline of it at first, and then introduces one application to color tone correction.

2 Development concepts

We also have been developing still video cameras, and paid much attention to its photographylike features. So, we decided to apply them to image processing. Image processing itself is not new technology, and actually many products have been already put on the market. However, most of the conventional video image processors up to date have been focused mainly on real-time operation for moving video to adapt to broadcasting use and professional operations. They therefore tend to bring about a lot of troubles about the operation because it's too complicated to understand plenty of operation switches on the enclosure face. Besides, the prices are still expensive for home appliances because of the fast devices which allow real-time processing. For such reasons, they are not always suitable for processing still images on a video floppy. The followings are the basic concepts for developing our video image processor which is supposed to be used for still video systems with easy and simplified operations at home.

(1) The processor shall provide photographylike editing such as trimming and composition of images.
(2) The processor can provide easy selection methods from each processing menu as looking at a display.
(3) The software image processing shall be adopted to study what processings are exactly needed for still video images.
(4) The processor shall be given little importance of real-time operation.
(5) The processor shall be available at low cost as a consumer appliance.

3 Hardware description

Fig.1 shows a block diagram of our prototype. It has a frame memory block which has two memory banks and each of them consists of three memory areas for each primaries. This structure of memory block was designed for the sake of software productivity. The CPU is used for controlling all of the functions including image processings. The key pad which is connected to the CPU bus by an I/O gate is used for choosing a graphic ICON on a displaying monitor. An image signal coming from either the input terminal or the image memory block is composed with the ICON graphic data at the image data multiplexer, and directly goes out to the D/A converter.

In order to reduce the body size, we developed three gate arrays, i.e. an RGB multiplexer, a Video RAM access scheduler, and a Video RAM access controller.

4 Human interface

(1) ICON and key pad:

Selection of a command for processing can be achieved in the method that the desired graphic ICON which represents each command of processing shall be

Table 1 Major specifications

1	Video input	NTSC
2	Video output	NTSC, Analog RGB
3	Video gradation	256 gray scale levels
4	Video memory	12, 288 kbits
5	Recording	Frame recording
6	ICON gradation	2 gray scale level
7	Dimensions	108mm(W)×170mm(H)×278mm(D)
8	Processings	Multi-image, Text overlay Negative image, Solarization Color histogram modification Color paint & correction Trimming, Zooming Chroma-key composition, Others

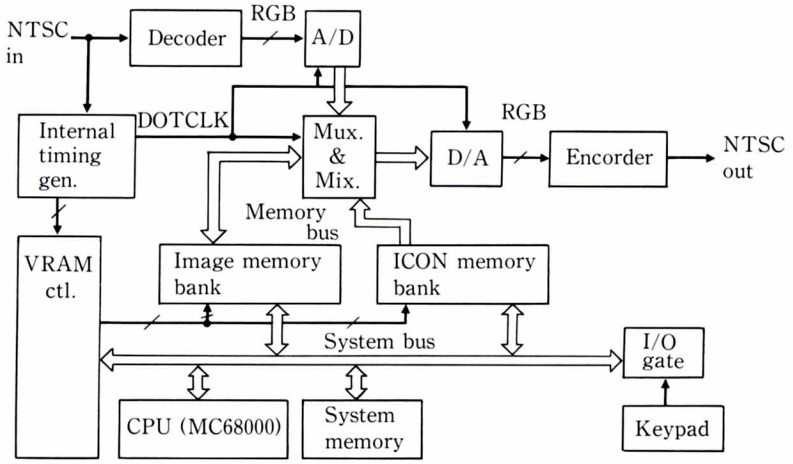

Fig.1 Hardware diagram

indicated by using an arrow pointer on a displaying monitor. If you want to choose one kind of operation in the ICON menu, you have only to move the pointer to the desired ICON and click the key pad button, and then you are to get into the target operation or a related sub-ICON menu.

(2) Color adjustment:

The RGB color model is often adopted in this kind of image processor, because it's easy to develop both software and hardware. However, there occur a lot of troubles in setting a color to what you desire. In that case, you have to mix each color component to make a single color, though a result of additive combinations of RGB primaries is difficult to estimate because the result is different from a human perception. Therefore, in color selection, the RGB color model should be transformed to the HLS color model which has three color attributes, that is to say, hue, luminance and saturation. The HLS model is said to be suited for human perception[2].

5 One application to color tone correction

The following describes one application in which our prototype is used for color tone correction. We believe that there are two kinds of approaches to adjust the color balance of an image; one is to try to make the distribution of each color component intensity similar to one another, where the average or center level is usually used. It is often applied to white balance correction of video cameras. The other is to try to transform the designated color to the target color of interest. The latter is the method used in conventional photography, or manual printing. This application

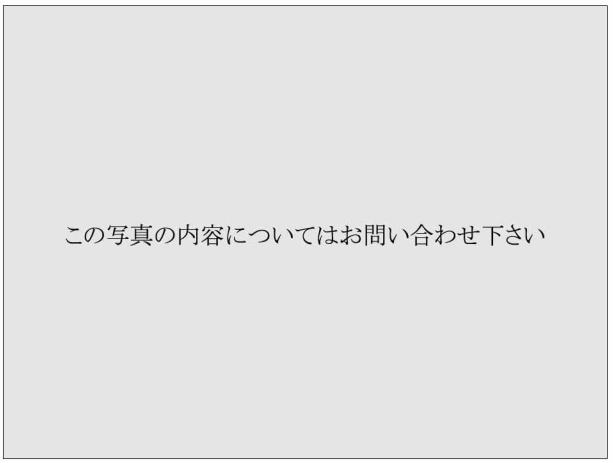

Fig.2 Color setup menu

replaces the latter for conventional silver halide photography by electronic image processing. If a subject is, for example, photographed under fluore scent lights, the video image is often made yellowish. In that event, the original red subject turns orange. The orange can be brought back to original red by applying a correction coefficient. Therefore, all the image data can be corrected by using this correction coefficient.

To set a target color, the HLS color model mentioned above is used. It can be accomplished easily even for a delicate color such as flesh tone (**Fig.2**). Let the color component values of the target color be r0, g0 and b0 and the median color components at the designated pixel and its vicinities be r, g and b. The correction values can be given as r0/r, g0/g and b0/b. The correction values can be used to correct the each color component data of the all pixels read out from the video memory bank.

The median value operation at the designated pixel and its vicinities are to absorb possible variability

among these pixel data due to noise[3].

The operation at the designated pixel is performed with the other four peripheral pixels (**Fig.3**).

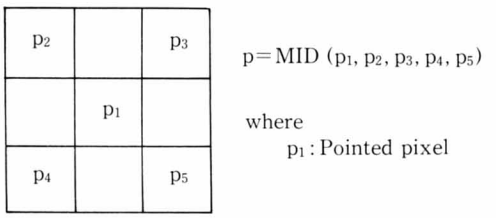

Fig.3 Define pixel color

Let the color components before correction at the points read out from the memory bank be R, G and B, the color components Ro, Go and Bo after correction are obtained by following equations:

$$Ro = R \times r0/r$$
$$Go = G \times g0/g$$
$$Bo = B \times b0/b$$

The algorithm described above is shown by the flow chart in **Fig.4**.

6 Confirmation with real picture

In order to evaluate validity of the present process described so far, the process was performed with use of an actual video image. **Fig.5** shows the distribution of the spectrum at the center of the face before processing. **Fig.6**, on the other hand, shows the one after processed. Designation of the target color was made at a portion in the right hand. From the flesh face color at the portion was extracted yellowish components to correct the color at all of the region (within the white frame in **Fig.2**).

As a result, as shown in **Fig.6**, the distribution of the spectrum can be seen to have been moved to the pinkish region, or to natural flesh color.

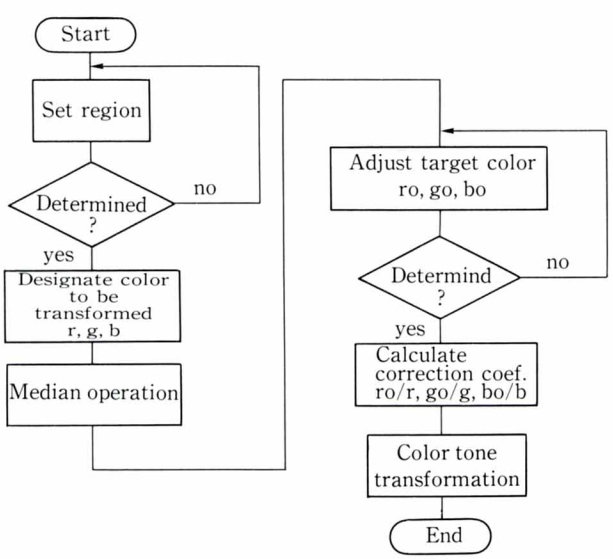

Fig.4 Flow chart of color tone correction

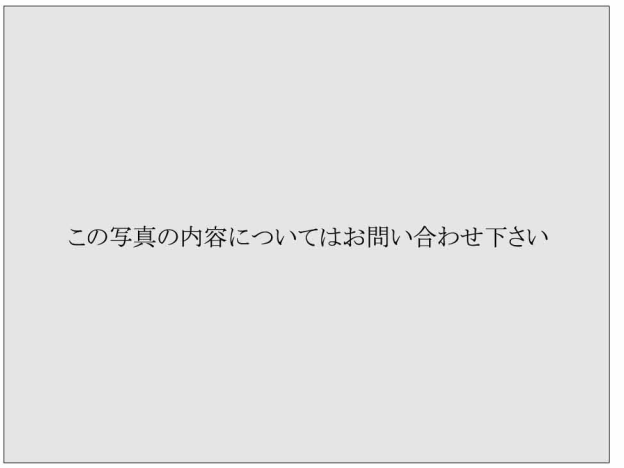

Fig.5 Hue distribution before processing

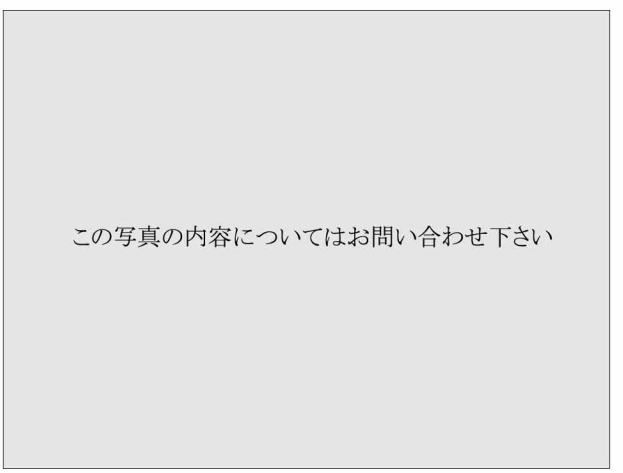

Fig.6 Hue distribution after processed

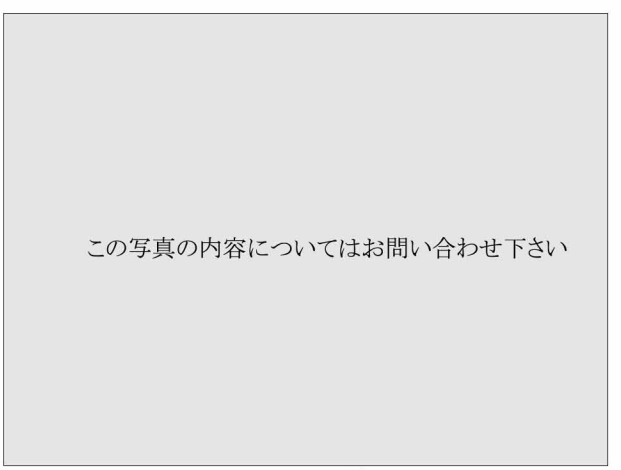

Fig.7 Processed image

7 Summary

This paper has described the outline of our prototype and color tone correction as one application of it.

We developed the dedicated processor-prototype for still video images, which can be operated handily by use of ICON graphics and a key pad to make the choice of menu easy. Besides, the simplified hardware was realized by ignoring real-time operation. The complete software processing method provides the flexibility in developing itself and the possibility of realizing whatever processings we want except real-time operations.

For the application to color tone correction, the approach similar to the manual printing in conventional photography was chosen in this development, because still video image itself has photographylike features. In case of color selection during the actual processing, the RGB color model was transformed to the HLS color model in the color setup menu because it is difficult to obtain a desired color in additive combinations of RGB primary colors. This transformation allowed us the smooth color adjustment.

We believe this processor will be available for a variety of applications of still video system even with further tasks remaining yet. For instance, processing speed is not acceptable enough, though it is only for still images, because even a basic processing such as filtering uses only software this time. In future, we are going to apply the special hardware on such a kind of function, and we are even going to seek automatic processing algorithm for white balance correction, and build up a system able to access other apparatus such as PC, fax and so on.

The author would like to deeply thank the persons concerned for a great deal of cooperation in developing the processor.

References

1) K.Shiozawa: "Compact Still Video Camera using CCD Image Sensor with Electronic Shutter Function," ITEJ Technical Report, **32** (54), (1988)

2) J.D.FOLEY, A.V.DAM: "Fundamentals of Interactive Computer Graphics", Addison-Wesley Publishing Company, (1982)

3) H.Ozaki, K.Taniguchi, H.Ogawa: "Gazo Shori (Image Processing)", Kyoritu Shuppan, (1983)