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Digital TV standards converter by intraframe line interpolation method

Koji Kinuhata, Hiroshi Sasaki, Hideo Yamamoto, Kitsutaro Amano (KDD R&D Labs.), Koji Kuruma, Goro Demizu (Oki Electric)

1. Introduction

By converting the scanning method of TV signals by digital processing, it is possible to achieve high-precision signal processing that is difficult with analog processing. In conventional format conversion devices, line interpolation, interlace interpolation, and field interpolation within a field cause resolution degradation and line flicker on horizontal edges to degrade the quality of still portions of the converted image. In this paper, an outline of a digital system conversion apparatus that employs a newly developed intra-frame line interpolation method to overcome these drawbacks is reported.

2. In-frame line interpolation

In conventional scanning method conversion, line conversion and field conversion were performed separately (1). By the way, since one frame is composed of two consecutive interlaced fields, this method requires field setting in order to maintain the order of alternate appearance of odd and even fields. In addition, interlaced interpolation is required to correct vertical shifts in the image due to field set. Therefore, one output line is finally synthesized from one to six input lines including field interpolation processing. Therefore, it is difficult to avoid the deterioration of the resolution, and the number of lines to be combined changes depending on the vertical position of the screen and the time. Therefore, line flicker is conspicuous especially in thin lines or edges close to the horizontal.

On the other hand, if line interpolation is performed by combining the weights of two interlaced fields, that is, two adjacent lines in one frame, the above drawback can be eliminated. Compared to the intra-field line interpolation method, the intra-frame line interpolation method halves the distance between two lines to be synthesized, enabling accurate line interpolation, doubling the equivalent bandwidth of line synthesis, and increasing the peak level recovery for a white line with an inclination of 45° as shown in Fig. 1 by approximately 25%(2).

3. Equipment configuration

Fig. 2 shows the block diagram of this device. The luminance signal Y and the color difference signals R-Y and B-Y are separately A-D converted, and after multiplexing, these codes are sequentially written in the field memory in synchronization with the input. Once written, the signal is held until updated by rewriting. Lines corresponding to the same position on the screen are read out from the field memories A, B, and C in synchronism with the synchronizing signal on the output side, and line conversion and field conversion are performed at once. Two lines belonging to the same frame are taken as a set of these three lines, and two line interpolating circuits are used to create two intermediate fields (hereinafter referred to as IFLs) whose odd and even match. Fig. 3 shows two types of line interpolation methods for creating odd or even IFLs in the case of D/C (625/50 → 525/60) mode. LI1 is a method in which the minimum unit of the load value is 1/4, and the two input lines closest to the output line are combined according to their distance. LI2 is a method in which the load ratio is fixed at 1:1. Since the input and output field periods are different, it is not always possible to obtain two IFLs. In the case of this device with three field memories, only one IFL can be obtained for each of 6 to 7 output field intervals in D/C mode and 5 to 6 output field intervals in U/C mode (3). Field synthesis for field interpolation is therefore performed in the interval where two IFLs are obtained. Table 1 shows the main parameters of this device.

4. conversion quality

Fig. 4 shows the converted image obtained by this device. The image converted by LI1 has almost no deterioration for still input images, but jaggedness appears at the edges of fast-moving input images. The effect of line interpolation within a frame is remarkable even for LI2 for still images converted by LI2, and deterioration in normal programs is not detected. In either method, no line flicker occurs and a converted image with high resolution can be obtained.

5. Conclusion

By adopting the line interpolation method within the frame, we were able to obtain a high-resolution converted image, but in order to further improve the image quality, we are investigating a method that adaptively switches the interpolation method between LI1 for still images and LI2 for moving images. In closing, I would like to express my gratitude to Deputy General Manager Kameda of KDD Research Laboratories and General Manager Yoshida of Oki Electric's Imaging Technology Department for their daily guidance.

References

1) For example, Sakata et al. NHK Technical Research 124 Vol 23.
2) Kinuhata et al. IEICE Image Engineering Research Fund IE73-14.
3) Yamamoto et al. CS72-157, CS72-157.

Words in charts

Figure 1 Intra-field line interpolation output

White line with an inclination of 45°

Load ratio 1:1

Target signal

Composite signal

Figure 2 Block diagram

Figure 3 In-frame line interpolation method LI1 and LI2

Figure 4 (a) Static transformed image

Diagonal line by LI1 (top) and LI2 (bottom)

(b) Converted video image

Effect of LI1 movement on edges

Table 1

Conversion mode

Image signal

Sampling frequency

Number of bits

Pixel/line

Memory word

Access mode
Memory capacity
Type of memory
Dynamic MOS-RAM

KDD Institute
2-1-23 Nakameguro, Meguro-ku, Tokyo TEL 713-0111
Oki Electric Industry Imaging Engineering Department
4-10-12 Shibaura, Minato-ku, Tokyo TEL 452-4111