4 Digital Video Signal According to ITU-BT.R.601 (CCIR 601)

Uncompressed digital video signals have been used for some time in television studios. Based on the original CCIR Standard CCIR 601, designated as IBU-BT.R601 today, this data signal is obtained as follows:

To start with, the video camera supplies the analog Red, Green and Blue (R, G, B) signals. These signals are matrixed in the camera to form luminance (Y) and chrominance (color difference C_B and C_R) signals.

These signals are produced by simple addition or subtraction of $R = \text{Red}$, $G = \text{Green}$, $B = \text{Blue}$:

$$Y = (0.30 \cdot R) + (0.59 \cdot G) + (0.11 \cdot B);$$

**Fig. 4.1.** Digitization of luminance and chrominance

\[ C_B = 0.56 \cdot (B-Y); \]

\[ C_R = 0.71 \cdot (R-Y); \]

The luminance bandwidth is then limited to 5.75 MHz using a low-pass filter. The two color difference signals are limited to 2.75 MHz, i.e. the color resolution is clearly reduced compared with the brightness resolution. This principle is familiar from children’s books where the impression of sharpness is simply conveyed by printed black lines. In analog television (NTSC, PAL, SECAM), too, the color resolution is reduced to about 1.3 MHz. The low-pass filtered \( Y \), \( C_B \) and \( C_R \) signals are then sampled and digitized by means of analog/digital converters. The A/D converter in the luminance branch operates at a sampling frequency of 13.5 MHz and the two \( C_B \) and \( C_R \) color difference signals are sampled at 6.75 MHz each.

This meets the requirements of the sampling theorem: There are no more signal components above half the sampling frequency. The three A/D converters can all have a resolution of 8 or 10 bits. With a resolution of 10 bits, this will result in a gross data rate of 270 Mbit/s which is suitable for distribution in the studio but much too high for TV transmission via existing channels (terrestrial, satellite or cable). The samples of all three A/D converters are multiplexed in the following order: \( C_B \) Y \( C_R \) Y \( C_B \) Y ... In this digital video signal (Fig. 4.1.), the luminance value thus alternates

**Fig. 4.2.** Sampling of the components in accordance with ITU-BT.R601