C O N T E N T S

4

KIR SYSTEM

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4.1. Kyocera Image Refinement (KIR) System

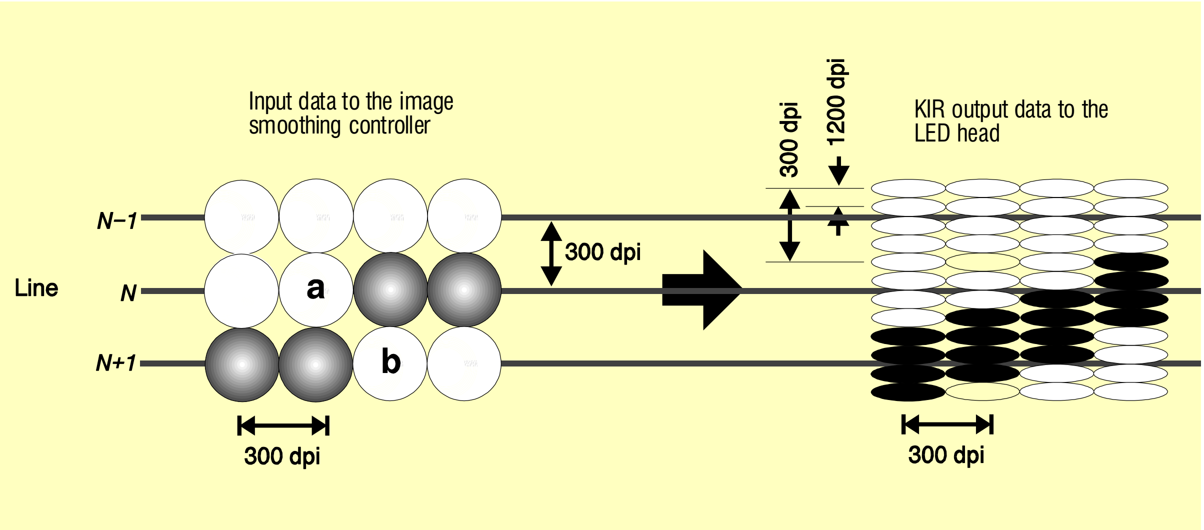
The printer employs the KIR technology which provides refinement of 300-dpi printing images by smoothing stairsteps present in the outlines of the image.

This section describes how image refinement is obtained using KIR. The electrical operation of the LED head driver can be found in chapter 2.

4.1.1. Operating Principle of KIR

Figure below shows how the normal 300-dpi pixels are processed with KIR by increasing the speed of a scan line four times the normal scanning speed. This means that the vertical resolution of the printer becomes virtually four times finer, namely 1200 dpi, than when KIR is turned off.

Figure 4.1. Principle of KIR



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Pixels are divided into subpixels by the image smoothing controller shown in Figure 4.2. This circuit consists of a pattern memory, a decoder, and the image smoothing controller. The pattern memory receives in serial manner the incoming video data for a scan line (from the printer's video RAM) and stores the data. The decoder includes a boolean operation unit. The video data and the pattern memory are subjected to a boolean operation upon receiving an SL signal fedback from the image smoothing controller.

A desired smoothing of stairsteps in the image is obtained by adding extra black subpixels, or, in other words, reversing a white pixel to a black pixel, using the proprietary stairstep recognition algorithm to be detailed in the following. Figure 4.3. shows a typical smoothing implemented by adding subpixels.

This algorithm involves generating border data for each pixel of the image, then using the border data to detect the existence and type of stairsteps to be smoothed. The length of the pixels on a given scan line are then counted to obtain an appropriate reversion code, which is used to determine the appropriate subpixel to be added to effectuate the refinement.

To simplify the discussion, the steps for this theory are divided into the following, different paragraphs.

Figure 4.2. Image Smoothing Controller

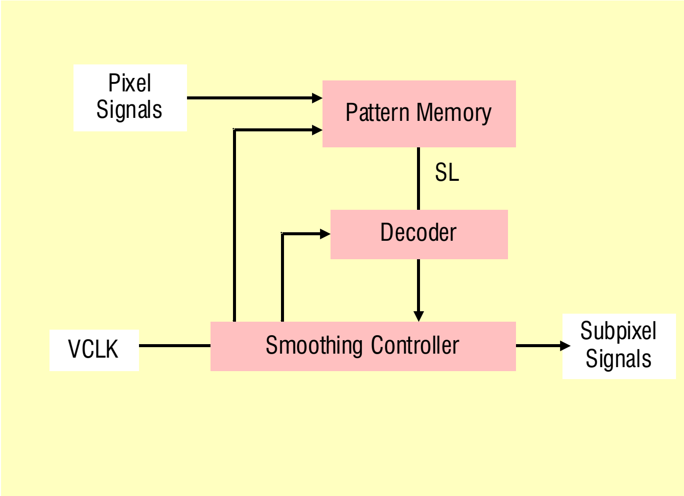
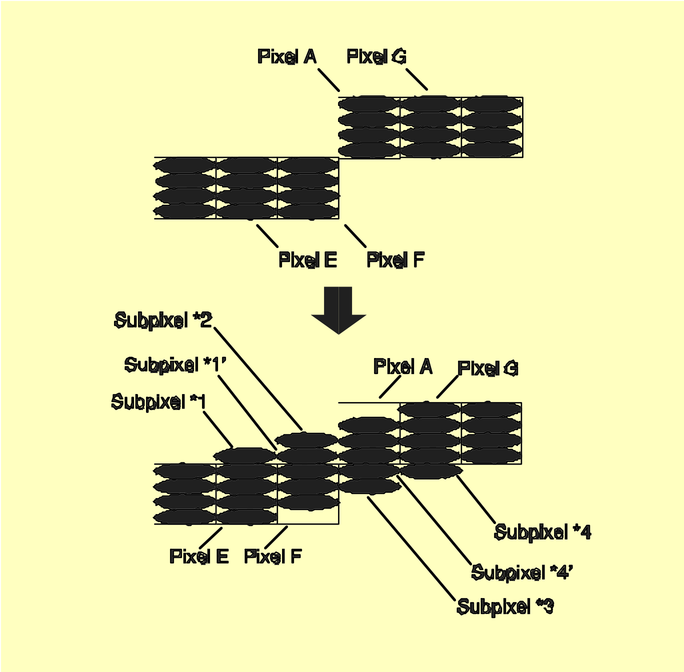


Figure 4.3. Added subpixels



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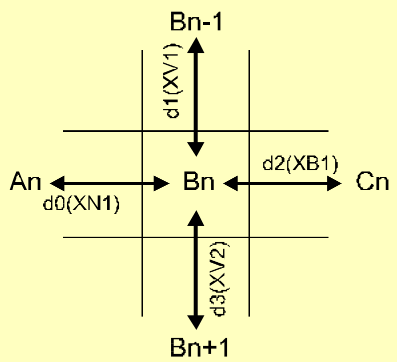
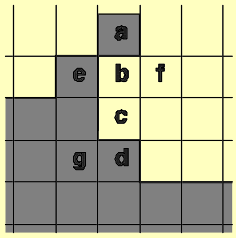
4.1.2. Generation of Border Data

Refer to Figure 4.4. For all pixels, represented by Bn, a four-bit code d0, d1, d2, and d3 is generated. For each di (i=0, 1, 2, or 3), if the adjacent pixel on the corresponding side differs from pixel Bn, di is assigned a value of 1, while if the adjacent pixel on the corresponding side is the same as pixel Bn, di is assigned a value of 0. The reversion code, thus generated, describes the relationships between pixels.





	a	b	c	d	e	f	g
d0	1	1	1	0	1	0	0
d1	1	1	0	1	1	0	0
d2	1	0	0	1	1	0	0
d3	1	0	1	0	0	0	0

Figure 4.4. Generation of Reversion Code

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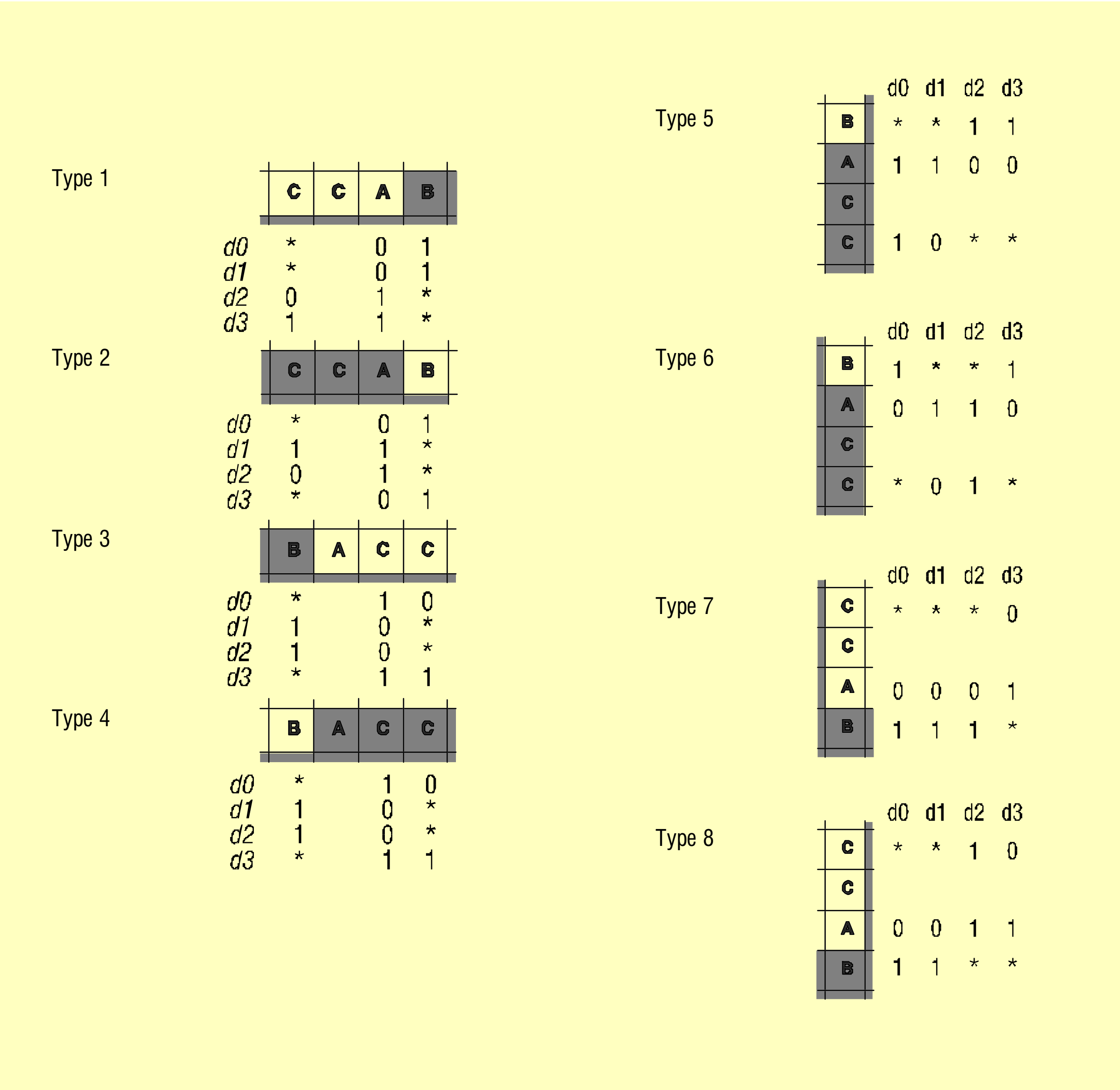
4.1.3. Detection and Style Recognition of Stairsteps

Figure 4.5. shows eight different types of stairsteps 1 through 8 that are used as templates for style recognition of stairsteps. The type of stairsteps is determined according to the four-bit code. For example, in Figure 4.4., if transition pixel A has a 0011 code, and the bits d0 and d1 of pixel B both have a value of 1, and bits d2 and d3 of pixel C have values 0 and 1, respectively, then the stairstep is of type 1. The existence of a stairstep is determined by boolean operation on the pixels C and B adjacent to a specific pixel A (which may be a transition pixel).

Figure 4.5. Smoothing Templates



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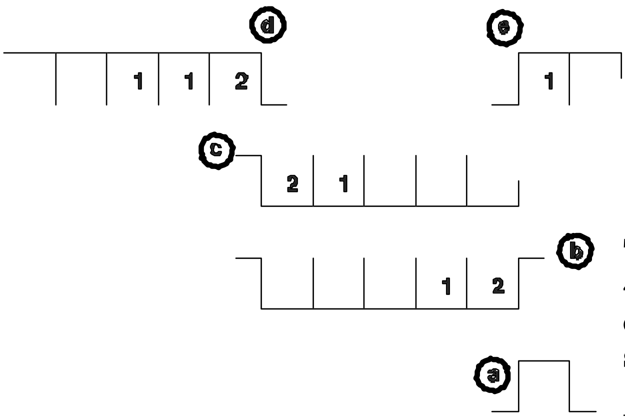
4.1.4. Assignment of Reversion Code

The length of the pixels on a given scan line are counted (i.e. pixels succeeding or preceding the stairstep), and a reversion code of either 1 or 2 is assigned. Figure 4.6. shows an example.

Figure 4.6. Assigning Reversion Code



Number of pixels succeeding or preceding the stairstep	Length of level pixels				
0	1	1	2	2	2
1			1	1	1
2					1

The length for the stairsteps e in Figure 4.6. is 1 (the pixel at the stairstep is not counted) and the pixel adjacent to the stairstep is assigned a reversion code of 1 (See the table above). Likewise, the length for the stairstep d in the figure above is greater than 5 and the pixel adjacent to the stair step is assigned a reversion code of 2 (It has zero distance from the stairstep.), while the pixel which is on pixel from the stairstep is assigned a reversion code of 1, and so on.

Depending on the type of stairsteps 1 through 8 as shown in Figure 4.5. on the previous page and the reversion code assignd as 1 or 2, the corresponding subpixel is selected as shown in Figure 4.7.

Figure 4.7. Reversion Data Table