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IMPLEMENTATION OF JPEG PROCESSORS

13.1 INTRODUCTION

Among the image compression standards, the baseline JPEG is the easiest to implement in hardware. The first single-chip JPEG processor was introduced by C-Cube Microsystems in 1990. JPEG processors can be found now in a variety of image and video processing systems, such as video editing equipment and digital cameras.

Figure 13.1 shows the block diagram of a typical JPEG implementation. The core of the design implements the baseline JPEG using a DCT unit, the quantizer, and the entropy coder. Up to four DCT quantization tables and four Huffman tables can be stored in local memory. In addition to the core processor, a JPEG IC includes memory and host interface units and local buffers for pipelined processing and I/O. Depending on the target applications, a JPEG processor may also include a color converter, a subsampler, and a level shifter. The processor supports a bidirectional data and processing pipeline for both compression and decompression.

The implementation details for DCT processors and entropy coders have already been covered in Chapter 10 and Chapter 12. In the next two sections we will discuss a few of the design issues for data I/O and color conversion. We will conclude this chapter with a short description of the commercially available JPEG processors from C-Cube Microsystems, LSI Logic, and Zoran.
13.2 DATA I/O AND MEMORY INTERFACE

From Figure 13.1, a typical JPEG processor supports at least two data buses, one for the uncompressed data stream and one for the compressed data stream. In many designs, an additional data/control bus may be used for interfacing and control with a local host.

Processing is usually performed on minimum coded units (MCUs). An MCU can be either an $8 \times 8$ block for grayscale images or a set of interleaved $8 \times 8$ blocks for color images. For example, for 4:2:0 YCbCr data, an MCU consists of two blocks of Y, one block of Cb, and one block of Cr. An MCU can contain up to ten $8 \times 8$ blocks made up from up to four components. For compression, the input buffer needs to store at least one MCU. For improved performance, most designs use double (or ping-pong) buffering. This allows one buffer to be loaded with new data while the data in the other buffer is processed by the JPEG unit. Since the output of the Huffman encoder has a variable rate, an output buffer is also needed to smooth the compressed data flow. The size of the output buffer depends on the worst-case compression ratio and the response time of the external memory.