JPEG 2000 Encoder for Arrix™ FPOA™

Features

- Input sampling rate up to 200 megapixels/sec (monochrome) or 100 megapixels/sec (color)

- Supports 4:2:2 subsampling

- Complies with ISO/IEC 15444-1 JPEG 2000 Image Coding System

- Selectable DWT filter type – 5/3 or 9/7 – to support lossless or lossy compression

- Programmable image and tile size

- Selectable Region of Interest (ROI)

- Programmable code-block size

Applications

- Machine vision

- Professional video

- Military / aerospace

- High-performance digital imaging

- Medical imaging

FPOA Background

The MathStar Field-Programmable Object Array™ (FPOA) architecture comprises an array of silicon objects, each performing a specific function at clock rates up to 1-GHz. The architecture supports three kinds of 16-bit core objects: an Arithmetic Logic Unit (ALU), a Multiply-Accumulator (MAC) and a Register File (RF). The objects are interconnected by a two-tier interconnect structure. The interconnect structure allows for 1-GHz connectivity between Nearest Neighbor connections as well as 1-GHz connectivity between non-adjacent objects through patented Party Line interconnects. These objects are coupled with distributed internal RAM (IRAM),

dedicated external memory controllers (XRAM) and a wide range of high-speed and general-purpose I/O to form the complete FPOA architecture. Because of its high performance, an FPOA can run many applications up to four times faster than FPGA architectures.

Functional Overview

The JPEG 2000 Encoder for Arrix FPOA is an implementation of the JPEG 2000 compression algorithm based on the ISO/IEC 15444-1 standard for MathStar's Arrix product family.

The JPEG 2000 Encoder comprises seven modules (see Figure 1) that include a DC level shifter, a Color Conversion module, a Discrete Wavelet Transform (DWT) module, a Quantization module, a Coefficient Bit Modeling module, an MQ-Coder, and an output to a JPEG 2000 file format generator. The JPEG 2000 Encoder can effectively process 200 MSPS. The samples can be monochrome or RGB. The input data sampling and compressed bitstream output are supported via two high-speed GPIO ports.
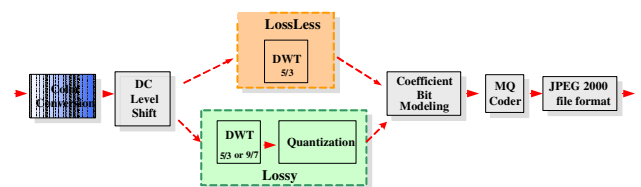

Figure 1 - JPEG 2000 block diagram

DC Level Shifter

The DC level shifter module subtracts half the dynamic range of the pixel data from the incoming stream to center the data about zero.

Color Conversion

The Color Conversion Module converts the RGB input pixels into 4:2:2 YUV format. JPEG 2000 supports two conversion transforms: the Reversible

Color Transform (RCT) and the Irreversible Color Transform (ICT).

Discrete Wavelet Transform (DWT)

Images are wavelet transformed to a programmable depth by the DWT module, resulting in a collection of sub-bands that represent several approximation scales. To obtain a transformation with multiple levels of resolution, the DWT is applied sequentially on the sub-band that contains the lowest horizontal and vertical frequency information.

Quantization

The Quantization module performs scalar quantization of the sub-band coefficients. In practice, the precision of these coefficients is reduced, which in turn reduces the number of symbols needed to represent the data.

Coefficient Bit Modeling (CBM)

The quantized sub-bands are split into code-blocks. Code-blocks are created for a single sub-band and all have equal sizes for a given tile-component. The CBM encodes the bits of all quantized coefficients of a code-block, starting with the most significant bits and progressing to least-significant bits. Except for the first significant bit-plane, each bit-plane of the code-block is encoded in three passes.

MQ-Coder

The bits selected by these coding passes are encoded by a context-driven, binary MQ-coder that produces a code stream.

JPEG 2000 File Formatter

The resulting code stream is ready to be packaged in the JPEG 2000 file format.

Estimated Performance

The table below summarizes the estimated performance of the JPEG 2000 Encoder for Arrix FPOA.

Variable/parameter	Value
Pixel depth	Up to 12 bits
Throughput	200 megasamples/sec (monochrome)
	100 megasamples/sec (color)
Frequency (max)	1 GHz
Target device	Arrix MOA2400D-10
Resource utilization	Approx. 75%

Image size (monochrome))	Frame rate (max)
1024 x 768	250 frames/sec
1280 x 1024	150 frames/sec
2048 x 2048	45 frames/sec

Note: The information provided above is preliminary and should be considered as an estimate.

Support

The JPEG 2000 Encoder for Arrix FPOA is warranted against defects for one year from purchase. Thirty days of technical support are included as standard. Licensing terms are available from MathStar.

Deliverables

The JPEG 2000 Encoder includes the following components.

- Cycle-accurate, bit-true simulation model for Visual Elite™ simulator
- Testbench
- OHDL files
- Mapping files for MathStar's COAST tool
- Design guide

Ordering Information

The JPEG 2000 Encoder for Arrix FPOA will be available from MathStar as part number **MIP-J2E02-P12**. For further information, contact MathStar, Inc. at info@mathstar.com