Flat Field Correction for Arrix™ FPOA™

September 2006 **Preliminary Product Brief**

Features

- Calibrates image by computing correction factors for pixel gain and offset
- Applies correction factors to input pixels, achieving uniform response across entire image
- Corrects images at processing rates up to 500 megapixels/sec - 500 frames/sec for 1K x 1K images or 125 frames/sec for 2K x 2K images
- Supports input/output word lengths up to 16 bits
- May be integrated with other cores in MathStar's Machine Vision Library

Applications

- Machine vision
- Professional video
- Military / aerospace
- High-performance digital imaging
- Medical imaging

FPOA Background

The MathStar Field-Programmable Object Array (FPOA) architecture is comprised of an array of silicon objects, each performing a specific function at data rates up to 1-gigahertz. 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 inter-connect structure, which allows for 1-gigahertz connectivity between Nearest Neighbor connections as well as 1-gigahertz 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

Flat field correction is used to adjust image sensor output data to ensure that constant intensity images generate constant pixel values at various levels of image intensity. This correction process addresses three types of pixel-based non-uniformities: gain, dark current offset and defective pixels. The correction process involves calibration and correction while the calibration process determines the correction factors for pixel gain and offset and generates a defective pixel map.

The Flat Field Correction for Arrix FPOA block diagram is shown in Figure 1. Incoming pixels are loaded into the scan line buffer implemented in IRAM banks. The input control and pixel tagging logic uses 2 to 3 ALU objects to identify and tag

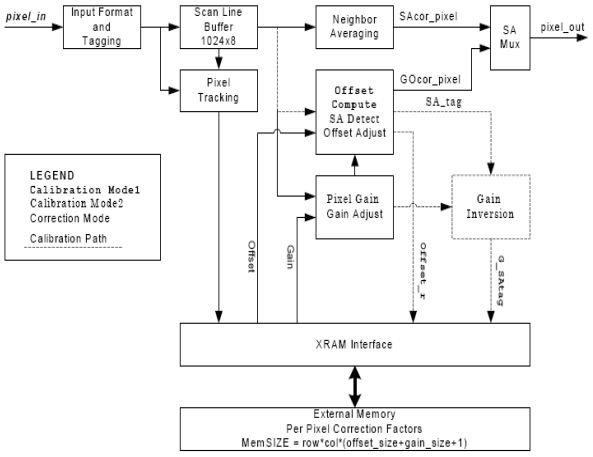

Figure 1 - Block Diagram for Flat Field Correction core

pixels as corner, edge and/or defective so that the correct processing steps may be applied to each pixel. Application of the offset and gain corrections for each pixel requires a single MAC object, supported by the XRAM interface control logic.

The nearest neighbor interpolation process for defective pixel replacement requires 1 to 8 ALU objects, depending on the system throughput and latency requirements. Nearest neighbor averages are swapped into the data stream in place of defective pixels using one of the Party Line muxes, which are available throughout the FPOA interconnect structure. An additional six ALU objects and one RF object are used to support the calibration control logic and inversion of the gain value to calculate the gain correction coefficient.

Combined, these functions typically take only a fraction of the FPOA's resources.

Estimated Performance

The maximum throughput of this architecture is 500 megapixels/sec using a single external memory controller (XRAM), with even higher rates if both XRAM controllers available on the FPOA are utilized. Although the gain and offset correction factors are typically 12 and 6-bits respectively, this architecture uses 16-bit precision for gain correction, offset correction and pixel data to avoid any overhead logic for packing and unpacking the data.

The table below summarizes the estimated performance of the Flat Field Correction core.

Variable/parameter	Value
Input pixel word length	Up to 16 bits
Output pixel word length	Up to 16 bits
Throughput (max)	500 megapixels/sec
Frequency (max)	1000 MHz
Target device	Arrix MOA2400D-10

Image size (grayscale)	Frame rate (max)
1024 x 1024	500 frames/sec
2048 x 2048	125 frames/sec

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

Support

The Flat Field Correction core for Arrix FPOA is warranted against defects for one year from purchase. Twelve months of technical support are included as standard. Licensing terms are available from MathStar.

Deliverables

The Flat Field Correction core for Arrix FPOA includes the following components.

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

Ordering Information

The Flat Field Correction Core for Arrix FPOA is available as part number MIP-FFC02-P12. For further information, contact MathStar, Inc. at info@mathstar.com.