AMD

Case Study:

REAL-TIME IMAGE PROCESSING

CUSTOMER:
Company for Advanced Supercomputing Solutions (CASS)

INDUSTRY:
Defense

CHALLENGES:
Real-time image processing with power consumption and size restraint requirements

SOLUTION:
The AMD Embedded G-Series APU combines the parallel processing capabilities of a GPU with the serial processing capabilities of a CPU in a small footprint and low-power solution.

RESULTS:
- Real-time performance
- Processing of 120 frames per second sustained
- HD sensor input resolution of 720p (1280x720)
- 20 to 30 times the performance of a traditional CPU
- Very quick development cycle

"The AMD Embedded G-Series APU delivered very well for the selected application and environment. This solution provides unmatched performance when you take into account the power consumption and size requirements."

Moti Butrashvily, CEO, CASS

Field Video Image Registration Solution with AMD Embedded G-Series APUs

CASS solution offers high-quality, smooth, stable real-time computer vision images for defense and other applications.

When the Company for Advanced Supercomputing Solutions (CASS) was approached by an Israeli defense contractor to create a new field video image registration solution, it was their first venture working with an AMD Embedded Accelerated Processing Unit (APU). It won't be their last.

The defense contractor's executives had come to CASS with a problem: They needed high-quality, smooth, stable real-time computer vision images delivered from ground and aerial systems to backend systems. The defense contractor's digital signal processing (DSP) and field-programmable gate array (FPGA) solutions were incapable of developing the high-speed, higher-resolution images that could more accurately track motion—for example, tracking missiles as they are carried on a moving vehicle or detecting a person climbing into a bunker.

ABOUT IMAGE REGISTRATION

Image registration is the process of transforming a set of sequential images (video stream acquired from a sensor) into a similar coordinate system, creating a smoother visual flow. In real life, physical conditions or normal movement affect the images a sensor gathers and may cause vibrations.

Viewing a continuous frame-set from an image sensor generally looks shaky or unbalanced, as the sensor is often mobile or not stabilized. Image registration fixes this problem by smoothing the output video stream.

Applications for image registration vary from defense to medical imaging and more. Typical registration process stages include identifying movement vectors between two relative images, performing alignment, and applying further correction/enhancement filters to improve image and stream quality.

In defense applications, sensor-based components use registration from ground systems to a variety of aerial systems. Adding to its complexity, defense applications require very high-performance computations (high resolutions and frame rates) and have limited space for hardware, dictating a small system size. This requires a solution with good heat dissipation and the ability to consistently operate at low power.

THE NEED FOR SPEED

CASS was asked to create a compact system that could process a frame-by-frame 720p video input stream at 120 frames per second. While the defense contractor imposed constraints around maximum size and maximum power consumption, CASS was otherwise unlimited in how it could design the solution.

The company got creative by making the right algorithmic adjustments and choosing the appropriate architecture, and the resulting application runs at real-time speeds. The solution built by CASS can serve as a new-generation DSP for sensor and computer-vision platforms, leveraging a combination of parallel and serial processing on a heterogeneous system architecture.

POWER AND SIZE CONSTRAINTS

"Lots of industries use graphics processing units (GPUs) for projects that include video," said Mordechai "Moti" Butrashvily, CASS chief executive officer and chief technology officer. CASS has been building solutions around AMD GPUs for years, and their designers knew that programmable GPUs offer critical performance advantages for applications with a high degree of parallelism – like image processing. "We knew, however, that a stand-alone GPU just couldn't offer a solution that would meet the power consumption and size constraints of our customer."

Butrashvily and his team looked at a variety of possible solutions and realized their options were rather limited. Few manufacturers can offer the performance needed without compromising on size or power consumption. The CASS team found their research kept pointing them to the AMD Embedded G-Series APU, which combines the parallel processing capabilities of a GPU with the serial processing capabilities of a CPU in a small footprint and low-power solution.

"We evaluated several solutions, and nothing else compared to the APU for size, power consumption, and capabilities. No one else provided a similar solution in terms of performance per watt," Butrashvily said. One additional advantage of the AMD G-Series APU is that they are sold as embedded solutions, which is a good fit for defense solutions that require long-term availability and durability in harsh environments.

REAL-TIME THREAT DETECTION

"The defense contractor needed semiautomatic systems that could help aid pilots in making decisions," explained Butrashvily. "The way to do that is to take images from both aerial and ground systems to stabilize video streams, enabling the detection of immediate threats." This required a system that was compact and low power enough to be used in unmanned aerial and ground vehicle (UAV and UGV) surround-vision systems for continuous monitoring of objects and threats anywhere in the world.

The AMD G-T56N APU met the power requirements of the system and could deliver the high performance necessary to meet the image registration goals. Since the processor had to employ further image filtering to enhance results, CASS needed to ensure there was enough performance overhead to run additional algorithms while maintaining real-time operation. CASS selected OpenCL™, the first open and royalty-free programming standard for general-purpose parallel computations on heterogeneous systems, to implement the accelerated algorithm building blocks.

In the prototype, the APU served as a digital signal and image processor and was connected to a sensor. "We tested the APU to see if we could achieve the real-time performance the sensors require," Butrashvily explained. "There was no option for delays: The signal had to be processed at the time it was being received with minimum latency."

FASTER-THAN-REAL-TIME PROCESSING

The entire algorithm was implemented in OpenCL™, with the APU serving as the host manager/coordinator and frame grabber. With the goal to achieve faster-than-real-time processing, CASS leveraged parallel processing for the intensive dense matrix operations, including GEMM (matrix multiplication), GEMV (matrix-vector multiplication), and GESV (matrix Inverse), achieving up to 130 times the performance of running those basic building blocks with the AMD BLAS (basic linear algebra subprograms) libraries on the processor alone. To verify the numeric stability, which is especially important in long-running, mission-critical operations, the arithmetic results of the APU were compared to the x86 CPU following IEEE 754 standard. CASS found high correspondence and accuracy, assuring that the system achieves great numerical stability.

OPENCL™, OPENGL, AND MULTI PLATFORM SUPPORT

Within two months, CASS completed the prototype development, including software optimization. The solution was developed to support Linux®, Windows®, and their embedded variants. The algorithmic processing engine was also integrated with OpenGL, delivering a live display of the processed results. "The AMD G-T56N APU delivered very well for the selected application and environment," Butrashvily explained. "This solution provides unmatched performance when you take into account the power consumption and size requirements."

The performance achieved was impressive, showing nearly 150 frames per second (FPS) peak at HD resolution of 1280x720 with 16-bits per pixel, measured from input to output of corrected images. With the AMD Embedded G-Series APU, CASS was able to achieve the following:

- Real-time performance
- Processing of 120 frames per second sustained
- HD sensor input resolution of 720p (1280x720)
- 20 to 30 times the performance of performing the entire algorithm on a traditional CPU

The overall algorithm processing flow was complex, incorporating additional filters for image enhancement; therefore, runtime speed-up was summarized by 20 to 30 times.

MATCHING SENSOR DIMENSIONAL CONSTRAINTS

For its next steps, CASS is working on support for hard real-time operating systems, hardware commercialization and board design to match sensor dimensional constraints, and support for next-generation APUs for even higher performance and resolutions.

Moreover, because the job was not proprietary to the defense company, CASS is researching additional applications of its new AMD APU-based image registration technology. Being an important core component in many image-processing systems, registration has relevance for other applications in defense, medical imaging, and machine vision.

ABOUT CASS

The Company for Advanced Supercomputing Solutions Ltd. (CASS) is a privately owned SME/SMB founded in Israel in 2008. CASS provides pioneering, cutting-edge HPC solutions for global markets based on advanced CPU/GPU architectures. For more information, visit **www.cass-hpc.com**.

ABOUT AMD

AMD is a semiconductor design innovator leading the next era of vivid digital experiences with its groundbreaking AMD Accelerated Processing Units (APUs) that power a wide range of computing devices. AMD Embedded Solutions give designers ample flexibility to design scalable, x86- based, low-cost and feature-rich products, and drive energy conservation into their systems without compromising application performance or compatibility, graphics performance, or features. For more information, visit **AMD.com/embedded**.

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