The advent of increasingly data-intensive applications such as media processing and mobile video has created the need for processors with higher computational performance but lower cost and power consumption. In response, multi-core Digital Signal Processors (DSPs) have adapted to meet these needs and have subsequently gained a broader market acceptance, opening the doors to designers and manufacturers like Advantech to produce smaller boards with simplified board layout, lower power consumption and decreased cost, while at the same time preserving programmability.

Moreover, with the recent developments in System-on-Chip integration of ARM and DSP cores, the latest boards and systems can now address a broader range of embedded application areas. This move to on-chip heterogeneous processing has accelerated the development of very high performance systems while at the same time facilitating the integration of components that significantly reduce both cost and power. Furthermore, the integration of ARM® Cortex™-A15 processors in TI’s latest Keystone™ II SoCs, greatly reduces system design complexity by removing the need for an additional high-end general-purpose processor.

This article provides an overview of existing multi-core DSP architectures based on exciting new ARM® and DSP technology developments, covering three applications areas and their associated dynamics.

Broadcasting

The disruptive change in the media industry, from linear TV consumption to an enriched on-demand multi-screen video experience, has led to a fundamental revolution in video infrastructure. This revolution is driven by the increasing efficiency, complexity and number of codecs, the explosion of high resolution video traffic, the evolution to all IP-based workflows and the high cost of constrained bandwidth. To benefit from the growing demand of a customized video experience, broadcasters and service providers will have to consider not only video processing power when building their encoding, transcoding and distribution infrastructure but also scalability, flexibility, versatility and upgradability.
High-end vision systems have demonstrated how to provide huge cost-savings in industrial automation, improving manufacturing processes, quality control and minimizing costly errors. However, machine vision covers a much wider field, from which robotics, automotive, avionics, security and scientific applications also benefit.

With image quality being the key aspect to all vision applications, technology is driven by ever-increasing resolution, speed and growing field of vision. The complexity of image and vision processing algorithms has increased geometrically to achieve unprecedented accuracy. Advanced acquisition techniques include multi-camera systems, depth cameras, stereoscopic cameras and multi-spectrum cameras to create 3D volume images, generate depth and surface profiles and go beyond the visible range.

Multicore DSPs are specifically designed to meet the demanding real-time requirements of video processing algorithms at the lowest-possible power budget. With new SoC architectures, video infrastructure manufacturers can offer now a broad range of solutions in a single product line; from embedded acquisition systems in the field to large-scale deployments delivering highest channel density with greenest power usage.

By adopting the KeyStone™ II architecture from TI, versatile media processing cards, like the Advantech DSP-8683 and DSP-8684 PCIe cards, enable highly cost effective solutions that can operate in standalone mode, removing the need for an external host processor. The inclusion of video interfaces, such as SDI-3G input & output and HDMI input, provide direct support for video acquisition and the support of Gigabit Ethernet and USB3 ports also extends the connectivity options for video streaming. Hybrid designs, including a reprogrammable FPGA device, add extra flexibility by allowing the inclusion of customized hardware functions.

At the other end, highly-dense multicore DSPs cards, like Advantech’s DSP-8681 and DSP-8682, are ideal for power efficient solutions based on commercial and industrial servers needing the highest performing video processing technology on fast-to-deploy PCIe add-in cards. With high-speed inter-DSP communications and high-bandwidth interconnection to the host, one single DSP-8682 card supports 240 channels in an H.264 mobile video application (CIF, 30fps) and 120 channels in a content delivery network using H.264 (SD, 30fps). For HD Broadcast applications, it is capable of supporting 5 channels of AVCIntra-100, 10-bit, 4:2:2 at 60fps.. Advantech’s scalable software framework supports the distribution of video processing tasks across multiple video cards enabling scalable implementations from HD to UHD video resolutions.

DSP based solutions also allow developers to get to market quickly on a fully programmable and flexible system. For the media industry, TI provides a Multicore Video Software Development Kit (MCSDK-Video) to get developers going quickly with optimized coding implementations, including HEVC. With upcoming enhancements already announced within the second version of the HEVC standard, to be published in late 2014, considering TI and Advantech’s commitment to latest standards support is a win-win approach when choosing a platform.

**Machine Vision**

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The hardware implementation to accelerate machine vision systems is becoming critical as bandwidth and computational demands rise, especially since most of the applications operate in real-time. But performance is not the only consideration; energy efficiency is a major concern when building not only embedded systems but also modern facilities.

Within this scenario, several subsystems in high-end imaging can benefit from the real-time high performance offered by low-power multicore DSPs. By combining multiple DSP cores with CPUs and dedicated hardware accelerators in an integrated design, hybrid boards deliver highest performance, run control code and provide custom high bandwidth interfaces, allowing for the most cost- and power-efficient designs.

Based on TI KeyStone™ II architecture, the Advantech DSP-8102 PCIe card integrates 32 TI C66x DSP cores, 4 ARM Cortex-A15 cores and a Xilinx Artix-7 FPGA to offer unrivalled processing capabilities for data and control plane processing in a full-length PCIe format.

Built-in industrial camera interfaces, including dual Full Camera Link, USB 3.0 and GigE, enable connectivity to line-scan and area-scan cameras which makes it ideal for highly cost-effective high-speed frame grabbers and multi-camera centralized vision systems.

Building a machine vision solution on a flexible TI multicore DSPs platform also minimizes manufacturers’ development efforts. TI now provides the open-source computer vision OpenCV library optimized to run on DSP+ARM™ SoC architectures. With TI DSP/ARM OpenCV library, machine vision solutions developers can easily migrate their OpenCV software to fully-integrated fast-to-deploy cards such as the DSP-8102, taking maximum advantage of the real-time processing performance offered by multicore DSPs to differentiate their products from ARM-only approaches.

Medical Imaging

Another application area where control plane and intensive compute/data plane requirements have traditionally been served by separate processor boards or silicon is in Medical imaging. Manufacturers of MRI equipment are constantly focusing on offering higher levels of performance in terms of improved image quality and consistency, faster imaging and processing, and higher patient throughput. From a patient perspective, speedier scan times and less confinement are critical considerations.

A typical MRI system consists of a scanning element plus a processing and control element. The scanning element includes a main magnet, an RF transmit and receive unit, a number of RF coils, and the gradient coils which are carefully positioned around the person to be scanned. The processing element includes a control unit to control and acquire data from the gradient coils while a scanning processor sends commands to the control unit to activate gradient scanning and receives the measurement results. In addition, it controls and acquires data from the scanner’s RF module in order to process RF data and to build a scanned image. With a capital outlay of at least 1M$ per scanner, hospitals and clinics need to ensure the longevity and long-term support of their investment as well as ensuring that the scanner design features meet the latest needs. Many manufactures design the tracking processor and control unit use readily available commercial hardware. Signals from the sensor are digitized by A/D converter boards and processed in real-time by DSP cards which also provide a communication interface to a host computer.

The latest DSP-8683 from Advantech can now consolidate multiple scanner workloads onto a single board with the ARM processor in the TI 66AK2H12 serving the control
functions and the TMS320C6678 multicore processor providing the compute power needed for real-time image processing. For some manufacturers the Xilinx Kintex-7 FPGA device can add flexibility to the design by enabling accelerated customized hardware functions for specialized algorithms for example. In addition, an onboard gigabit Ethernet interface allows the board to connect to modern IP networks to provide fast upload to the hospital facility’s computer network for multiple processes from immediate analysis by specialists to digital archiving.

Moreover, solutions using a workload consolidated solution open new avenues to significantly lower overall system costs. For manufacturers requiring workload separation at the board level, for example for architectural or legacy reasons, Advantech’s DSP-8681 and DSP-8682 boards based on the TMS320C6678 from TI offer the highest DSP performance available in a PCIe form factor and can be readily integrated into many of the PCIe-based topologies chosen by manufacturers today. Each C6678 DSP core can deliver 40 GMACS/20 GLFOPS of processing performance at 1.2 GHz and includes 512-KB local L2 per core and large shared L2 on-chip cache for image manipulation and processing. With up to 10GHz of total processing power, the eight-core TMS320C6678 DSP is well suited for complex imaging applications. The C6678 DSP has up to 320 GMACS/160 GFLOPS of processing performance at 1.2 GHz and includes 4-MB shared L2 on-chip cache for image manipulation and processing.

Advantech multicore DSP boards equipped with both ARM & DSPs offer a very compelling and cost effective consolidation path for future designs while DSP-only boards ensure a solid upgrade path for current equipment designs.

**Advantech PCIe DSP Boards Selection**