



XILINX ZYNQ ALL PROGRAMMABLE SOC: THE SMARTEST CHOICE FOR SMARTER VISION

If you have seen a demonstration of Audi's Automated Parking technology in which the car autonomously finds a parking spot and parks itself without a driver—or if you have played an Xbox 360 game with its Kinect controller or even just bitten into a flawless piece of fruit you purchased from your local grocery store—then you can count yourself as an eyewitness to the dawning of the era of smarter vision systems. All manner of products, from the most sophisticated electronic systems down to the humble apple, are affected by smarter vision technologies. And while today's uses of smarter vision are remarkable enough, experts say we haven't seen anything yet. Some predict that in 10 years' time, a vast majority of electronics systems—from automotive to factory automation, medical, as well as surveillance, consumer and aerospace and defense—will include smarter vision technologies with even more remarkable capabilities that will dramatically enrich and even save lives.

Smarter vision systems will soon become ubiquitous, and as they increase in complexity over the coming years, we'll very likely become passengers in autonomous automobiles flowing in networked highways. Medical equipment such as Intuitive Surgical's amazing robotic-assisted surgical system will advance even further and may enable surgeons to perform procedures from remote locations. Television and telepresence will reach new levels of immersion and interactivity, while the content on screens in theaters, homes and stores will cater to each individual consumer's interests, even our moods.

Xilinx® All Programmable solutions for Smarter Vision are at the forefront of this revolution. With the Zynq™-7000 All Programmable SoC—the first device to marry an ARM® dual-core Cortex™-A9 MPCore™, programmable logic and key peripherals on a single device—as the foundation, Xilinx has fielded a supporting infrastructure of tools and SmartCORE IP that will play a pivotal role in enabling the development and faster delivery of these remarkable innovations to the world. The supporting infrastructure includes Vivado™ HLS (high-level synthesis), the new IP Integrator tools, OpenCV (computer vision) libraries, SmartCORE™ IP and specialized development kits.

“Through Xilinx's All Programmable Smarter Vision technologies, we are enabling our customers to pioneer the next generation of smarter vision systems,” said Steve Glaser, senior vice president of corporate strategy and marketing at Xilinx. “Over the last decade, customers have leveraged our FPGAs to speed up functions that wouldn't run fast enough in the processors they were using in their systems. With the Zynq-7000 All Programmable SoC, the processor and FPGA logic are on the same chip, which means developers now have a silicon platform ideally suited for smarter vision applications. We've complemented the Zynq-7000 All Programmable SoC with a robust development environment consisting of Vivado HLS, new IP Integrator tools, OpenCV libraries, SmartCORE IP and development kits. With these Smarter Vision technologies, our customers will get a jump on their next design and be able to achieve new levels of efficiency, lower system power, increase system performance and drastically reduce the bill of materials—enriching and even saving lives while increasing profitability as these innovations roll out at an ever faster pace.”

From Dumb Cameras to Smarter Vision

At the root of Smarter Vision systems is embedded vision. If you are unfamiliar with embedded vision, let's look at what this technology is and how it is evolving.

Embedded vision, as defined by the rapidly growing industry group the Embedded Vision Alliance (www.embedded-vision.com/), is the merging of two technologies: embedded systems (any electronic system other than a computer that uses a processor) and computer vision (also sometimes referred to as machine vision).

Jeff Bier, founder of the Embedded Vision Alliance and CEO of consulting firm BDTI, said embedded vision technology has had a tremendous impact on several industries as the discipline has evolved far beyond the days of motorized pan-tilt-zoom analog camera-based systems. "We have all been living in the digital age for some time now, and we have seen embedded vision rapidly evolve from early digital systems that excelled in compressing, storing or enhancing the appearance of what cameras are looking at into today's smarter embedded vision systems that are now able to know what they are looking at," said Bier. What's more, cutting-edge embedded vision systems, or smarter vision systems, not only enhance and analyze images, but also trigger actions based on those analyses. As such, the amount of processing and compute power, and the sophistication of algorithms, have spiked dramatically. A case in point in this remarkable evolution is the rapidly advancing market of surveillance.

Twenty years ago, surveillance systems vendors were in a race to provide the best lenses enhanced by mechanical systems that performed autofocus and tilting for a clearer and wider field of view. These systems were essentially analog video cameras connected via coaxial cables to analog monitors, coupled with video recording devices monitored by security guards. The clarity, reliability and thus effectiveness of these systems were only as good as the quality of the optics and lenses, and the diligence of the security guards in monitoring what the cameras displayed.

The advent of embedded vision technology allowed surveillance equipment companies to use lower-cost cameras based on digital technology. This digital processing gave their systems extraordinary features that outclassed and underpriced analog and lens-based security systems.

Fisheye lenses and embedded processing systems with various vision-centric algorithms dramatically enhanced the image the camera was producing. These techniques, which correct for lighting conditions, improve focus, enhance color and digitally zoom in on areas of interest, also eliminated the need for mechanical motor control to perform pan, tilt and zoom, improving system reliability. Digital signal processing has allowed companies to offer surveillance systems at video resolution of 1080p and higher. Indeed, in the case of unmanned aerial vehicles (UAVs) and defense satellites, embedded vision has enabled far higher resolution than historically available. Simply capturing images at this resolution requires a tremendous amount of pixel processing. Enhancing and manipulating these images requires even more processing horsepower.

But a clearer image that can be manipulated through digital signal processing was just the beginning. With considerably more advanced pixel processing, surveillance system manufacturers began to create more sophisticated embedded vision systems that performed analytics in real time on the high-quality images their digital systems were capturing. Every year, vision systems designers field a more impressive array of sophisticated algorithms to create increasingly dynamic analytic features. The earliest of these embedded vision systems had the capacity to detect particular colors, shapes and movement. This capability rapidly advanced to algorithms that detect whether something has crossed a virtual fence in a camera's field of view; determine if the object in the image is in fact a human; and, through links to databases, even identify individuals.

The most advanced surveillance systems include analytics that track individuals of interest as they move through the field of view of the security network, even as they leave the field of view of one camera, move into a blind spot and then enter into the field of view of another camera in the surveillance network. Vision designers have programmed some of these systems to even detect unusual or suspicious movements. "Analytics is the biggest trend in the surveillance market today," said Mark Timmons, system architect in Xilinx's Industrial, Scientific and Medical (ISM) group. "It can account for human error and even take away the need for diligent human viewing and decision making. As you can imagine, surveillance in crowded environments such as train stations and sporting events can become extremely difficult, so having analytics that can spot dangerous overcrowding conditions or track individuals displaying suspicious behavior, perhaps radical movements, is very advantageous."

To further enhance this analysis and increase the effectiveness of these systems, surveillance and many other markets leveraging smarter vision are increasingly using "fusion" architectures that combine cameras with other sensing technologies such as thermal vision, radar, sonar and LIDAR (Light/Laser Detection and Ranging). In this way, smarter vision designers can further enhance the resulting image to enable night vision; detect thermal/heat signatures; or pick up objects not captured or not visible by the camera

alone. This capability drastically reduces false detections and in turn allows for much more precise analytics. Needless to say, the added complexity of fusing the technologies and then analyzing that data requires ever more analytic-processing horsepower.

Timmons said that another megatrend in this market is systems that perform all these forms of complex analysis “at the edge” of a surveillance system network—that is, within each camera—rather than having each camera transmit its data to a central mainframe system, which then performs a more refined analysis from these multiple feeds. Localized analytics adds resilience to the overall security system, makes each point in the system much faster and more accurate in detection, and thus can warn security operators sooner if indeed a camera spots a valid threat.

Localized analytics means that each unit not only requires greater processing horsepower to enhance and analyze what it is seeing, but must also be compact and yet incorporate highly integrated electronics. And because each unit must be able to communicate reliably with the rest of the network, it must also integrate electronic communication capabilities, adding further compute complexity. Increasingly, these surveillance units are connected via a wireless network as part of a larger surveillance system. And increasingly, these surveillance systems are becoming part of larger enterprise networks or even larger, global networks, like the U.S. military’s Global Information Grid (see cover story, Xcell Journal issue 69, www.xilinx.com/publications/archives/xcell/Xcell69.pdf).

This high degree of sophistication can be expected in areas such as surveillance and is being employed in the military-and-defense market in everything from foot soldier helmets to defense satellites networked to central command centers. What’s perhaps more remarkable is how fast smarter vision technology is moving into other markets to enhance quality of life and safety.

Smarter Vision for the Perfect Apple

Take, for example, an apple. Ever wonder how an apple makes it to your grocery store in such good condition? Giulio Corradi, an architect in Xilinx’s Industrial Scientific and Medical group, said that today food companies are using ever smarter vision systems in food inspection lines to, for example, sort the bad apples from the good ones. Corradi said first-generation embedded vision systems deployed on high-speed food inspection lines typically employed a camera or perhaps several cameras to spot surface defects in apples or other produce. If the embedded vision system spotted an unusual color, the apple would be marked/sorted for further inspection or thrown away.

But what happens if, at some point before that, the fruit was dropped but the damage wasn’t visible? “In some cases, damage that resulted from a drop may not be easily spotted by a camera, let alone by the human eye,” said Corradi. “The damage may actually be in the flesh of the apple. So some smarter vision systems fuse an infrared sensor with the cameras. In doing so, these more sophisticated smarter vision systems can detect the damage beneath the surface of the apple’s skin and trigger a mechanical sorter to pull the apple off the line before it gets packed for the grocery store.” If the damaged apple had passed by without the smarter fusion vision system, the damage would likely become apparent by the time it was displayed on the grocery store shelves; the fruit would probably have to be thrown away. One rotten apple can, of course, spoil the bunch.

Analytics can also help a food company determine if the bruised apple is in good enough condition to divert to a new line, in which another smarter vision system can tell if it is suitable for some other purpose—to make applesauce, dried fruit or, if it is too far gone, best suited for composting.

Corradi said that smarter vision is also being employed on factory floors to help protect workers. A growing number of factories today are automated and use robotic-assisted technologies or completely automated robotic lines. In the earliest of these automated factories, Corradi said, each robot would perform a small range of tasks on the item being manufactured, and then pass it to the next robot in the line. Because these robots were doing a predictable set of tasks, their range of motion was also predictable. As such, to help protect human workers operating, maintaining or simply working in the vicinity of these robotic lines, many of the facilities built protective cages around the robots themselves.

However, in modern factories, manufacturers are increasingly using more flexible robotic lines to manufacture a wider number of products on an on-demand basis, and might retool the same robotic lines to manufacture future products. To do this, factories have given robots a wider berth, as their range of movement can vary greatly. Safety cages are too restrictive (or too small) to accommodate the range of movement robots require to manufacture changing product lines.

So to protect the safety of workers while not restricting the range of motion of automated factory lines, companies are employing smarter vision to create safety systems. Cameras and lasers erect “virtual fences or barriers” that audibly warn workers (and safety monitor personnel) if someone is getting too close to the factory line given the product being manufactured. Some installations

include a multiphase virtual barrier system that will send an audible warning as someone crosses an outer barrier, and shut down the entire line automatically if the individual crosses a second barrier that is closer to the robot, preventing injury. Bier of the Embedded Vision Alliance notes that this type of virtual barrier technology is being employed in an increasing number of other applications where people work around potentially hazardous equipment and chemicals. “It can have a tremendous impact in reducing the number of accidents in factories, but why not also have virtual barriers in amusement parks, or at our homes around swimming pools or on cars?” said Bier. “I think we’ll see a lot more virtual barrier systems in our daily lives very soon.”

Smarter Vision for Better Driving

Automotive is another market that is fully embracing smarter vision to create a less stressful and safer driving experience. Paul Zoratti, a systems architect within Xilinx Automotive, said that in the automotive market, advanced driver assistance systems (ADAS) is all about using remote sensing technologies, including smarter vision, to assist drivers in the driving process (i.e. to make drivers better drivers) (see cover story on DA in Xcell Journal issue 66, www.xilinx.com/publications/archives/xcell/Xcell66.pdf).

Over the past decade, automakers have begun deploying a range of smarter vision-enabled driver assistance features in many of their high-end luxury vehicles. Each year, they’ve unveiled ever more impressive DA features in their luxury lines, while also making a growing number of driver assistance features available in their sport and standard product lines.

Many of these features—such as blind-spot detection, lane change assist, pedestrian and sign detection—send drivers a warning if they sense a potentially dangerous situation. Most recent offerings from auto manufacturers include even more advanced systems such as automatic emergency braking and lane keeping, which not only monitor the vehicle environment for potential problems but assist the driver in taking corrective actions to avoid accidents or decrease their severity.

Zoratti said that some new-model cars today are outfitted with four cameras—located on the sides, front, and rear of the vehicle—that provide to the driver a continuous 360-degree view of the vehicle’s surroundings. While the first generation surround view systems are using those cameras to provide an image to the driver, future systems will bundle additional DA features. Using the same four cameras and image processing analytics, these next generation systems will simultaneously generate a birds-eye view of the vehicle and also warn of potential danger such as the presence of a pedestrian. Furthermore, while the vehicle is travelling at higher speeds, the automobile will use the cameras on the side and rear of the vehicle for blind-spot detection, lane change assistance and lane departure warning. Adding an additional forward-looking camera located behind the windshield will support traffic sign recognition, and forward-collision warning features. Finally, when the driver reaches his or her destination and activates automated parking, the system will employ those same cameras along with other sensors to help the car semi-autonomously maneuver into a parking spot.

Zoratti highlighted that performing all these tasks in a real-time fashion requires a tremendous amount of processing power that is well-suited for parallel hardware computation. That’s why many early generation systems paired standalone microprocessors with FPGAs, with the FPGA handling most of the parallel computations and microprocessors handling the serial decision making.

Unlike other markets, such as surveillance, which make use of multiple camera inputs the cost pressures in automotive are driving the analytics be performed in a central compute hub, rather than at each camera. Doing so allows companies to minimize the cost of each camera sensor and ultimately the cost of the entire system. But this also means that the processing platform in the central unit needs to deliver very high performance and bandwidth to support the simultaneous processing of four, five, or even six real-time video inputs.

A Smarter Vision for Longer Lives

Another area where smarter vision is making a dramatic difference is in the medical electronics industry. Here, smarter vision technology is employed heavily in a wide range of medical imaging technologies, from endoscopes and imaging scanners (CT, MRI, etc.) to robotic-surgical systems such as Intuitive Surgical's Da Vinci, detailed in Xcell Journal issue 77 (see www.xilinx.com/publications/archives/xcell/Xcell77.pdf).

Among Da Vinci's many remarkable embedded systems, perhaps the most sophisticated is its 3D vision system, which allows surgeons to guide robotic surgical instruments with extreme precision, fluidity and tactile sensitivity to perform a number of delicate and intricate surgical procedures. With every generation of system, surgeons are able to perform a greater number and variety of surgeries, helping to ensure better patient outcomes and faster recovery times. The degree of technological sophistication to control and coordinate these procedures is remarkable and is heavily reliant on the combined horsepower of processing and logic. Each generation of newer technology will thus benefit from greater integration between processor and logic.

A Smarter Vision for an Immersive Experience

Smarter vision is also making great strides in keeping us connected. If you work in a modern office building, chances are your company has at least one conference room with an advanced telepresence conferencing system that not only allows you to talk to others around the world, but also lets you see them as though they were there in person. These videoconferencing systems are increasing in sophistication to the point that they can sense who at a table or conference is speaking, and automatically turn and zoom in on that person, displaying him or her in ever-higher-quality immersive video.

Ben Runyan, director of the broadcast and consumer segment marketing at Xilinx, said that companies developing telepresence technologies are seeking ways to create a more immersive experience for users. "The goal is to make users feel like they are in the same room when in fact they could be on the other side of the globe," said Runyan. "To do this requires state-of-the-art cameras and display technologies, which require advanced image processing. As these technologies become more advanced and deliver a more immersive experience, it will make collaboration easier and make companies more productive while cutting down the need, and thus expense, to travel."

A Smarter Network

Most if not all smarter vision systems are part of a local network, and a growing number of these systems are in turn connected to larger external networks. For example, in automotive applications, embedded vision systems communicate via industry-standard protocols such as the CAN bus, LIN and FlexRay. General Motors also offers customers its OnStar wireless navigation, security and vehicle diagnostics service, which allows OnStar operators to tap into a vehicle's system to diagnose problems.

In contrast, it seems that each player in the industrial manufacturing market has developed its own proprietary protocol. However, in a growing number of industries, customers are calling for manufacturers to provide systems that comply with standard Internet Protocol-based/Ethernet networks. Having systems that connect to and communicate via standard networks will allow customers to integrate new systems more easily into their enterprises, while also freeing them to mix and match systems from multiple vendors and thereby gain more pricing leverage. But adding support for network compatibility further complicates embedded vision designs, as vision systems must now incorporate more complex networking technology, high-speed I/O and the ability to update their systems in the event a protocol changes or a new protocol emerges. Often, software-programmable solutions simply can't accommodate the performance requirements of these changes, forcing customers to buy new systems from other vendors. Thus, embedded vision systems must provide the I/O flexibility necessary to grow apace with the rapidly advancing and ever-changing networking technologies.

INTUITIVE DA VINCI SURGICAL SYSTEM



The da Vinci Surgical System puts the surgeon in an electro-mechanical cockpit. From a comfortable, seated position, the doctor has an adjustable-zoom 3D view of the operating field. Controls translate large motions into very tiny, controlled movements of surgical instruments attached to robotic arms. The ability for extreme precision, with minimally invasive tools, speeds many complex procedures and improves patient experiences.

Xilinx: All Programmable for a Smarter Vision

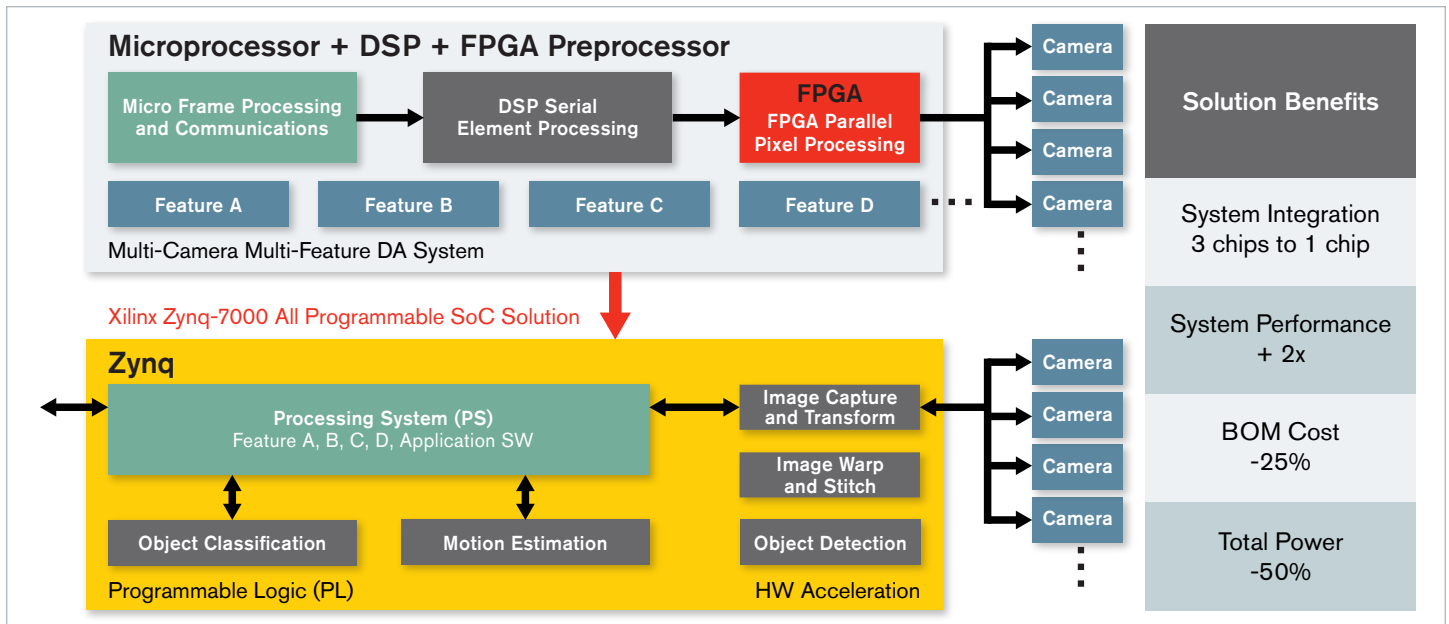
To enable smarter vision to progress on all fronts rapidly and to reach new markets requires an extremely flexible processing platform, a rich set of resources and a viable ecosystem dedicated to smarter vision. Xilinx devices have played a key role in helping companies innovate these vision systems over the last decade. Today, after five years in development, Xilinx is delivering a holistic solution that will help developers of smarter vision applications to quickly deliver the next generation of innovations.

For more than a decade, embedded vision designers have leveraged the programmability, parallel computing and fast I/O capabilities of Xilinx FPGAs in a vast number of embedded vision systems. Traditionally, designers have used FPGAs to speed up functions that were slowing down the main processor in their systems, or were using the FPGA to run parallel computing tasks that processors simply couldn't perform. Now, with the Zynq-7000 All Programmable SoC, embedded vision developers have a fully programmable device that is ideally suited for developing the next generation of smarter vision applications.

“Smarter vision can be implemented in separate processors and FPGAs communicating on the same board, but what the Zynq-7000 All Programmable SoC delivers is a level of integration that the electronics industry didn't have before,” said Jose Alvarez, engineering director of video technology at Xilinx. “Now, instead of interchanging information between the main intelligent processor and FPGA logic at board speeds, we can do it at silicon speeds through 3,000 high-performance connections between the processor and logic on the same chip.”

The illustration below reveals the benefits of the Zynq-7000 All Programmable SoC over a traditional multi-camera, multichip architecture in the creation of a multi-feature automotive driver assistance system. Using one set of cameras connected to one Zynq-7000 All Programmable SoC, the Xilinx architecture (bottom left in the graphic) can enable feature bundles such as blind-spot detection, 360-degree surround view, lane departure warning and pedestrian detection. In comparison, existing multi-feature DA systems require multiple chips and multiple cameras, which complicates integration, adversely affects performance and system power consumption, and leads to higher BOM costs.

ZYNQ ALL PROGRAMMABLE SOC VS. MULTICHIP, MULTIPLE-CAMERA SYSTEMS IN DRIVER ASSISTANCE APPLICATIONS

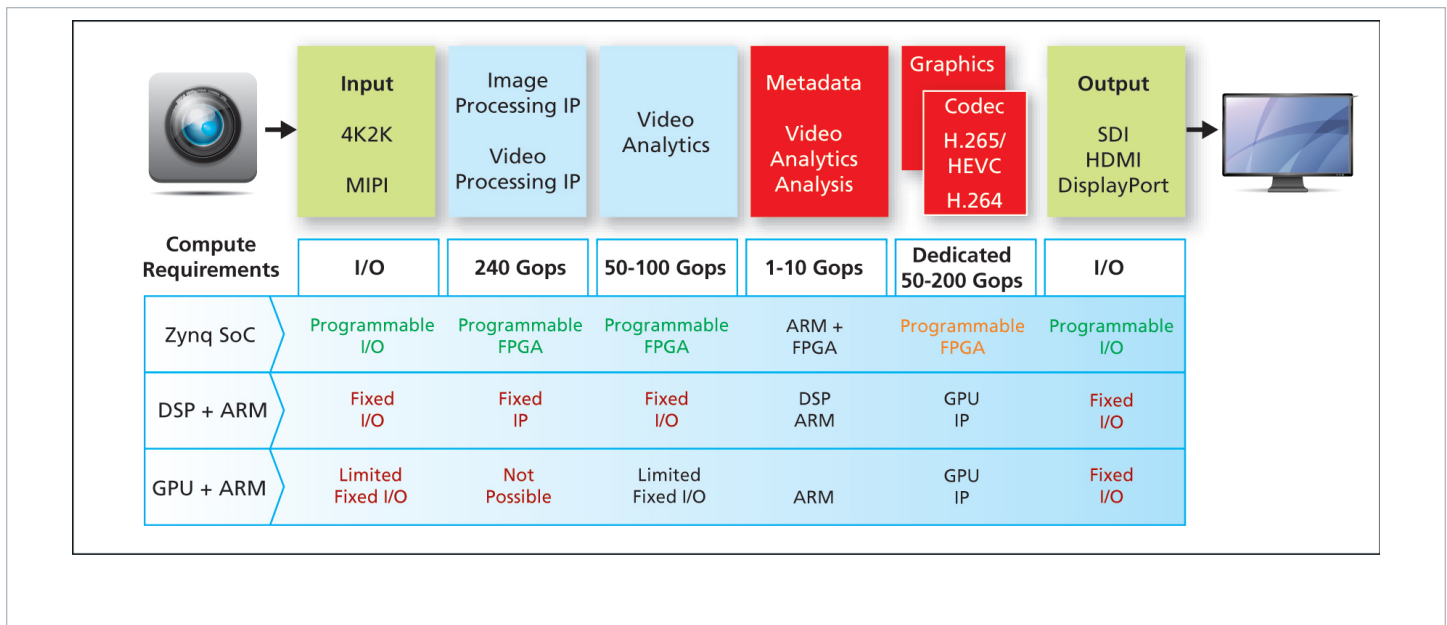


A few silicon vendors offer ASSPs that pair ARM processors with DSPs or with GPUs, but those devices tend to be too rigid or provide insufficient compute performance for many of today's smarter vision applications. Often, solutions based on these devices require the addition of standalone FPGAs to fix these deficiencies.

The Zynq-7000 All Programmable SoC's programmability and performance provide key advantages over GPU- and DSP-centric SoCs. The ARM processing system is software programmable; the FPGA logic is programmable via HDLs or C++; and even the I/O is fully programmable. As a result, customers can create extremely high-performance smarter vision systems suited to their specific applications, and differentiate their systems from those offered by competitors.

The following illustration details a generic signal flow of an smarter vision system and shows how the Zynq All Programmable SoC stacks up against ARM-plus-DSP and ARM-plus-GPU-based ASSPs.

ZYNQ-7000 ALL PROGRAMMABLE SOC VS. DSP- AND GPU-CENTRIC ASSPS



The first signal-processing block in the flow (shown in green) is the input that connects the device to a camera sensor. In the Zynq-7000 All Programmable SoC, developers can accommodate a wide range of I/O signals to conform to whatever camera connectivity their customers require. The next signal-processing block performs pixel-level processing or video processing (depending on whether the application is for image processing or display). The next block performs analytics on the image, a compute-intensive process that often requires parallel computing best implemented in FPGA logic. The subsequent three blocks (in red) are where the processing system derives metadata results from the analytics, creates a graphic representation of the result (shown in the graphics step) and encodes results for transmission. In the Zynq-7000 All Programmable SoC, the processing subsystem and FPGA logic work together. When compression is required, the appropriate codec can be readily implemented in FPGA logic. Then, in the final signal-processing block (labeled "Output"), the Zynq-7000 SoC's programmable I/O allows developers to target a vast number of communication protocols and video transport standards, whether they be proprietary, market specific or industry-standard IP protocols. In comparison, in both DSP- and GPU-centric SoCs, developers run the risk of developing algorithms that require performance not achievable with the DSP or GPU sections of these ASSPs. They will often have to make up for this deficiency by adding a standalone FPGA to their systems.

While the Zynq-7000 All Programmable SoC is clearly the best silicon choice for smarter vision systems, Xilinx realized early in the device's development that programming needed to be streamlined, especially for designers who are more accustomed to C and C++ based development of vision algorithms. To this end, in June 2012 Xilinx delivered to customers a state-of-the-art software environment called the Vivado Design Suite that includes, among other technologies, best-in-class high-level synthesis technology that the company gained in its January 2011 acquisition of AutoESL. Vivado HLS is particularly well-suited to embedded vision applications. If, for example, vision developers using the Zynq-7000 All Programmable SoC have created an algorithm in C or C++ that doesn't run fast enough or is overburdening the processing system, they can send their C algorithms to Vivado HLS and

synthesize the algorithms into Verilog or VHDL to run in the FPGA logic on the device. This frees up the processing subsystem on the Zynq-7000 All Programmable SoC to handle tasks it is better suited to run, and thus speeds up the overall system performance. Xilinx has also rounded out its Smarter Vision technology offering by releasing its OpenCV (computer vision) library.

OpenCV is an industry-standard, open-source library of algorithms from OpenCV.org that embedded vision developers use to quickly create vision systems. Embedded vision developers across the world actively contribute new algorithms to the open-source library, which now contains more than 2,500 algorithms written in C, C++, Java and Python. Algorithms in the library range in complexity from simple functions such as image filters to more advanced functions for analytics such as motion detection. Alvarez, Xilinx's engineering director of video technology, said that these OpenCV algorithms target implementation in processors such as microprocessors and DSPs from vendors like Intel, ARM, Nvidia, MIPS/Imagination Technologies, TI and others. Because the Zynq-7000 All Programmable SoC uses an ARM processing system, users can implement these algorithms, written in C++, in the processor portion of the Zynq-7000 All Programmable SoC.

Thanks to Vivado HLS, said Alvarez, users can also take these algorithms written in C or C++, modify function calls from OpenCV to HLS and then, using Vivado HLS, synthesize or compile the algorithms into RTL code optimized for implementation in the logic portion of the Zynq-7000 All Programmable SoC. Having OpenCV in the Vivado environment allows smarter vision architects to easily compare and contrast whether a given algorithm in their design will run most optimally in the processor or FPGA logic portion of the Zynq-7000 All Programmable SoC. With the release of Xilinx's Open Source library, Xilinx has essentially given customers a head start. Using Vivado HLS, Xilinx has already compiled more than 30 of the most used embedded vision algorithms from the OpenCV library. Customers can quickly make processor vs. logic trade-offs at the systems level and run them immediately in the Zynq-7000 All Programmable SoC to derive the optimal system for their given application.

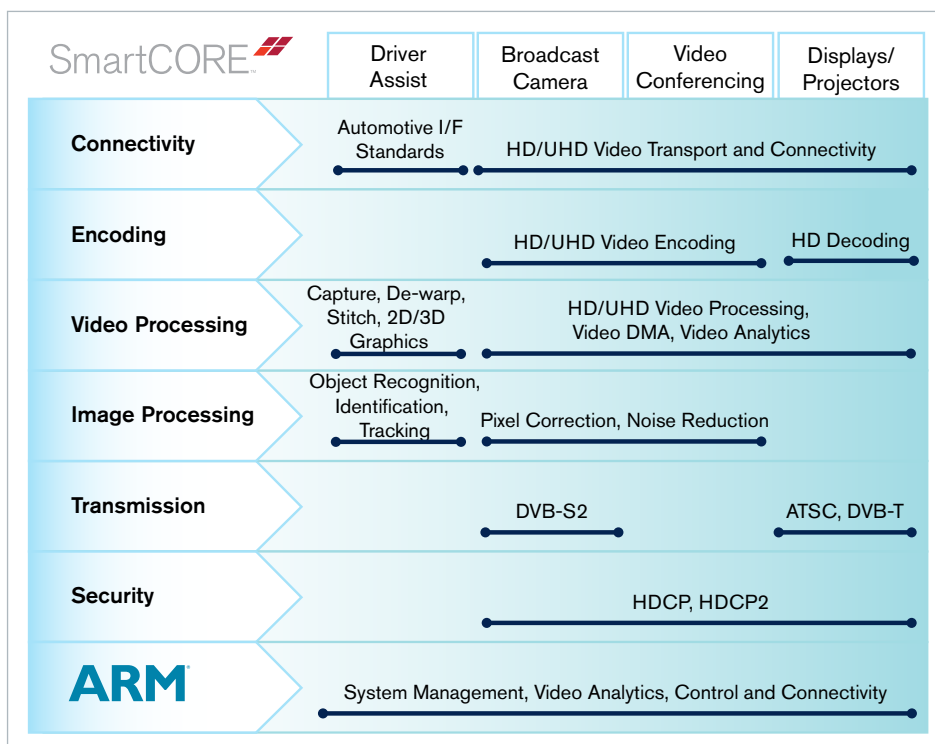
Xilinx and its Alliance members will actively migrate more functions from the OpenCV library on an ongoing basis, making them available to Xilinx's expanding user base quarterly. Because developers can run OpenCV libraries on just about any commercial processor, vision designers will be able to compare and even benchmark the performance of algorithms running on various silicon devices. This is where Xilinx is confident that the advantage of the Zynq All Programmable SoC will become crystal clear. In fact, you can witness the power of Zynq-7000 All Programmable SoCs and Xilinx's Smarter Vision technology in this demo, in which Xilinx distinguished engineer Kees Vissers demonstrates how he was able to take standard OpenCV algorithms and, with Vivado

HLS, quickly implement them in the FPGA logic portion of the Zynq-7000 All Programmable SoC and deliver a 50x to 100x performance improvement over the same function implemented in the ARM A4 processing subsystem.

As part of its Smarter Vision initiative, Xilinx has also created an intellectual property (IP) suite called SmartCORE IP, addressing smarter vision requirements from across the many market segments that will design smarter vision into their next-generation products. Customers can implement cores from the SmartCORE IP suite and algorithms from the OpenCV library into their designs quickly using Xilinx's newly introduced IP Integrator tool. The new tool is a modern plug-and-play IP environment that allows users to work in schematics or, if they prefer, a command-line environment.

Alvarez said that since the Vivado Design Suite's inception, Xilinx architected the suite to be device aware,

PROVEN SMARTCORE IP



Xilinx's SMARTCore IP portfolio addresses the necessary requirements of sophisticated smarter vision systems across different market segments.

so as to take full advantage of each device's capabilities. Alvarez said that thanks to IP Integrator, the Vivado Design suite is not only device aware but now targeted platform aware as well—supporting all Zynq All Programmable SoC and 7 series FPGA boards and kits. Being target platform aware means that the Vivado Design Suite now configures and applies board-specific design rule checks, which ensures rapid bring-up of working systems.

For example, when a designer selects the Xilinx Zynq-7000 SoC Video and Imaging Kit, and instantiates a Zynq-7000 All Programmable SoC processing system within IP Integrator, Vivado Design Suite preconfigures the processing system with the correct peripherals, drivers and memory map to support the board. Embedded design teams can now more rapidly identify, reuse and integrate both software and hardware IP, targeting the dual-core ARM processing system and high-performance FPGA logic.

Users specify the interface between the processing system and their logic with a series of dialog boxes. IP Integrator then automatically generates RTL, and optimizes it for performance or area. Then users can add their own custom logic or use the Vivado IP catalog to complete their designs.

It's remarkable to see what smarter vision systems Xilinx customers have created to date with Xilinx FPGAs. Xilinx is very excited to see what customers will be able to do with the Zynq-7000 All Programmable SoC and the powerful Smarter Vision environment. Given what we've witnessed so far, we're sure it will be amazing.

Take the NEXT STEP

To learn more, please visit: www.xilinx.com/smartervision

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