

# Intelligent systems add brainpower to everyday electronics

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What is an intelligent system? It's any system that can input information, analyze it, and intelligently make decisions or take actions as a result. Intelligent systems have been emerging for decades, but they are on the brink of an intelligence explosion that will revolutionize the way we interact with machines, making our world smarter, safer and more fun.

### Processor requirements

Intelligent systems attempt to automate as much of the decision making process as possible to minimize human involvement. In the past, automation was limited to data conditioning and pre-processing. With today's technology, real-time processors can utilize sophisticated algorithms to enable a system to determine a solution and take the appropriate action, sometimes with little or no human intervention. While intelligent systems are found in a wide variety of industries, there are many processor requirements that these systems share:

- **Programmability:** The variety of intelligent systems in today's world requires a diverse set of sophisticated mathematical, statistical, signal processing algorithms, and the way these algorithms are combined is unique to each application. These algorithms usually need to be slightly adjusted, making programmable processors very important. Programmability also enables on-the-field adaptation by leveraging machine learning and other dynamic algorithms.
- **Real time:** Sophisticated algorithms create a huge computational load that must be processed in real time for the system to make effective decisions. As a result, high performance and predictable latency are necessary processor requirements. Also, time allocated for processing must be bounded and deterministic to ensure that the system responds to external stimuli in an acceptable manner. Advanced architectures with parallelism are important in this regard. Local embedded processing is required even for intelligent systems that can tap into the seemingly unlimited resources of cloud computing. The latency-critical parts of the system are implemented locally in embedded processors to optimize the response time, while cloud computing resources can handle less time-critical parts.
- **Extreme data throughput:** With huge amounts of data brought into the system from sensors, cameras, microphones and other input devices, high data throughput must be maintained so that the data can be processed rapidly. Advanced solutions like hierarchical memory organization, advanced

direct memory access (DMA) controllers and wide memory interfaces are key to enabling extreme data throughput.

Due to their programmability, parallel architecture and real-time signal processing capabilities, digital signal processors (DSPs) provide an ideal option. With DSPs and other real-time processors now available at a range of performance, power and price points, intelligent systems are about to become pervasive in a variety of industries.

### **Intelligence explosion: Where will we see it first?**

While the sky is the limit as far as where intelligent systems can exist, there are three main industries that will first experience a boom in intelligent systems: automotive vision, security and industrial.

#### *Automotive intelligent systems*

Global positioning systems, or GPS, are a type of automotive intelligence already found in a variety of cars or mobile phones. Another type of automotive intelligent systems—advanced driver assistance systems (ADAS) — was introduced in high-end vehicles more than a decade ago and is becoming a “must have” feature in many cars. Based on vision or radar, an ADAS processes the environment around the car to warn drivers when the vehicle begins to move out of its lane; automatically adjusts the level of the car’s headlights when the lights from an approaching vehicle are detected; recognizes traffic signs to ensure the driver doesn’t miss a speed limit change or other important road signs; and automatically take offer night vision functionality and provide adaptive cruise control that adjusts the speed of the car to maintain a pre-determined distance from the car ahead and stop automatically to avoid a collision. As communication between vehicles, road infrastructure and the cloud becomes ubiquitous and complements on-vehicle sensors, the vision of autonomous vehicles becomes more reality than science fiction.

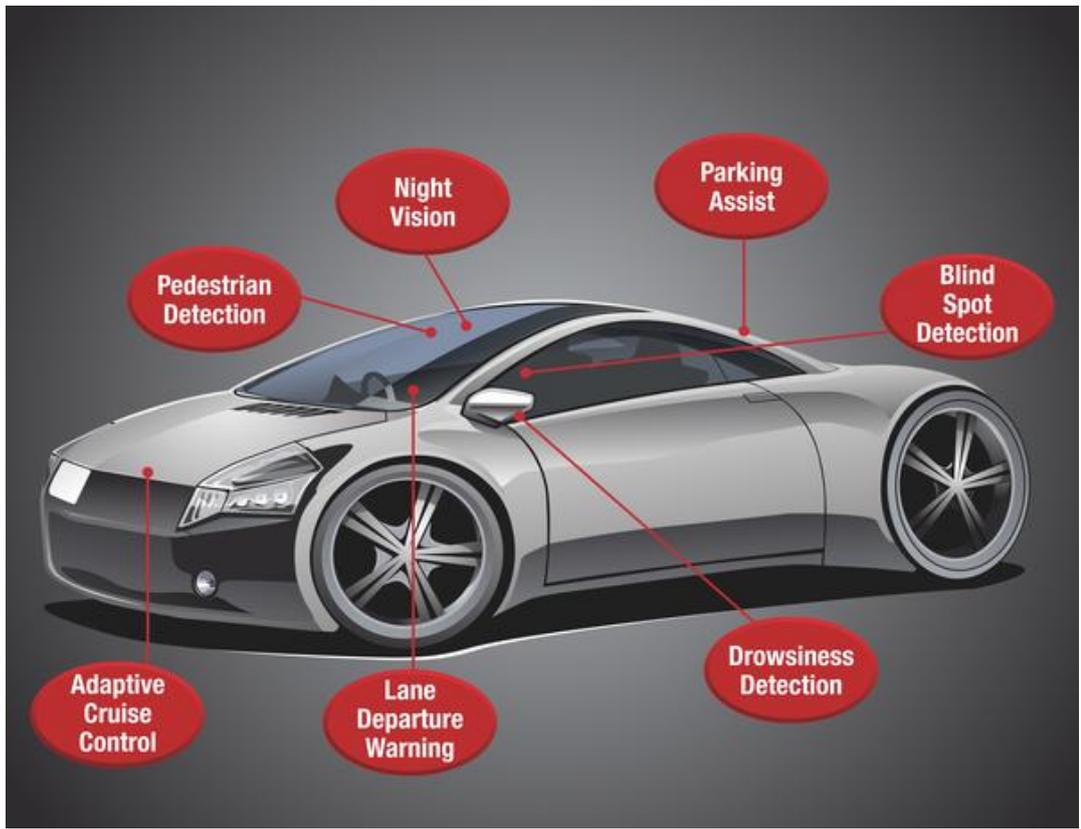


Figure 1. Cars with ADAS keep drivers and others on the road out of harm's way, day or night.

### Security

Surveillance and access control systems have both been around for years, and some have already incorporated analytical algorithms to improve the accuracy and enhance the functionality of these systems. An increasing number of surveillance systems are automatically monitoring property and infrastructure, traffic conditions and more, and sophisticated algorithms enable the cameras to add people counting, trip zone, tamper detection and motion detection functionality to these systems. More sophisticated systems incorporate sound-assisted video analytics (SAVA) to detect glass breaking, gun shots and other sounds and redirect the camera to the region of interest.

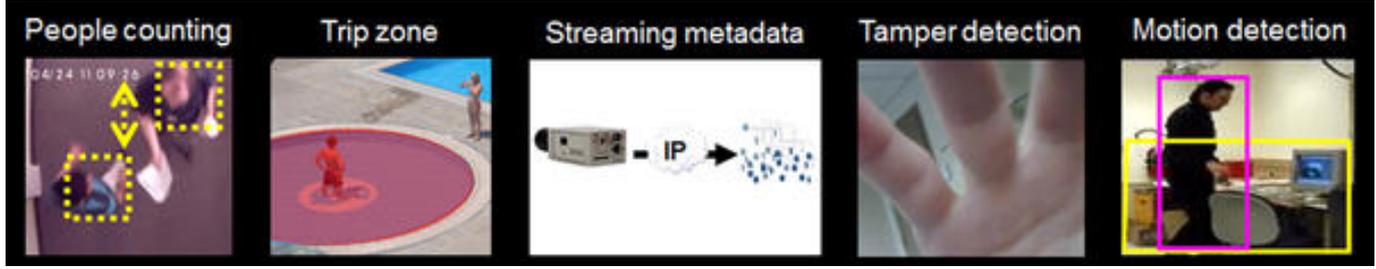


Figure 2. Analytical algorithms enable a range of functionality to make our world safer and smarter.

In addition, biometric-based access control systems are making physical security systems more failsafe. For example, fingerprint and iris scanners are used for identity verification at public safety facilities, on cell phones and laptops, and at

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health care facilities to enable quick and easy access to personal information and secure facilities. Other systems can take advantage of human's unique motion signatures. For example, an intelligent pen with an embedded processor and accelerometer can capture not only someone's handwritten signature, but unique motion parameters that can enhance security.

### *Industrial vision*

Control systems, factory automation, robotics, automated optical inspection, currency inspection and many other types of intelligent industrial systems are consistently growing in performance and intelligence. As a result, cameras on the factory floor and the centralized vision processing systems they are connected to can function as powerful platforms for additional analytics processing. A smart camera, for example, might perform some of the image enhancement and refinement functions locally that had previously been performed in the central vision processing system. Then, the camera can analyze the image and respond to it by zooming in or out, or turning itself for a better angle. Higher performance systems can support more complex analytics like 3D object analysis, surface texture analysis and more.



*Figure 3: Industrial inspection systems are gaining performance and intelligence, enabling increasingly accurate and efficient systems.*

### **What is to come?**

While the first explosion of intelligence will appear in automotive, security and industrial systems, the high availability of real-time processors and sophisticated algorithms will enable intelligence to emerge in a wide variety of applications, including augmented reality, natural user interfaces, medical imaging diagnostics,

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interactive digital signage and beyond. As analytical algorithms become more sophisticated, processor performance increases, and power and cost decrease, many yet-to-be imagined applications will appear. The sky is the limit for the intelligent systems of the future.

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