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Industrial vision systems have been available to manufacturing companies for decades. But transformative technologies such as edge computing, cloud, and advanced analytics are changing vision systems into video analytics systems.

Foundation for Quality Assurance: Video at the Edge

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AT A GLANCE

KEY TAKEAWAY

Over the past five years, the Internet of Things (IoT) and edge computing have lowered the costs of applying vision to production processes and improved the speed, data accessibility, and information processing of industrial vision systems. Almost one-third of manufacturing companies plan to invest in video at the edge over the next 12 months.

Introduction: Industrial Vision and Video Analytics

Historically, image analysis has been done with industrial vision systems. These systems have typically had several shortcomings that have kept them from more widespread use:

- Highly complex to configure and install
- Often built from proprietary hardware and software
- Require highly skilled and expensive support staff with specialized skills
- Limited data connectivity and data/image sharing

However, when used, industrial vision systems have proven invaluable in improving quality, increasing safety, and reducing costs. The most common use cases for industrial vision systems that have justified the costs are:

- Counting, notably in pharmaceutical production but also in electronics
- Label validation, especially in food and beverage and life sciences
- Product quality, such as part position, color, and package filling
- Location of inventory, staff, and finished goods, particularly in high-tech assembly

Vision system usage has not always been limited to these use cases, but the previously mentioned applications play such a vital role in product inspection, quality, and compliance that the expense of older vision systems was justified.

One of the biggest shortcomings of traditional industrial vision systems is that the data tends to be isolated from other industrial data sets, including ERP and MES. Vision systems were built to perform a single function and report focused results, which ranged from triggering a visual queue for an operator to automatically diverting bad product to a rework bin. The images were rarely analyzed to determine statistical insight on defects or process drift. Additional image analysis was hampered by issues with bandwidth and storage, both of which were costly and difficult to expand quickly just a few years ago.

Video Analytics as the Transformative Vision System

Over the past five years, the Internet of Things (IoT) and edge computing have lowered the costs of applying vision to production processes and also improved the speed, data accessibility, and information processing of industrial vision systems. The transformation of industrial vision systems into video analytics systems is the result of not only camera cost and resolution but also connectivity, ease of use, cost of data storage, and available processing power.

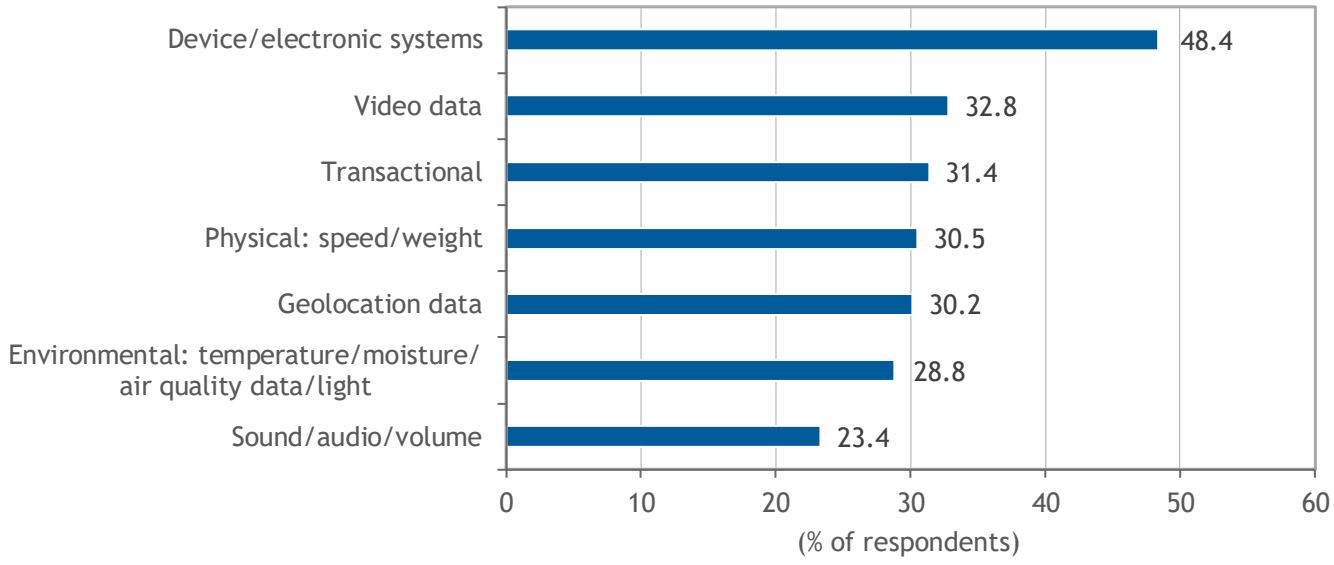
The change centers around edge computing capabilities, with cloud acting as the glue that holds data management and collection together. Edge computing has changed everything to provide access, analytics, and storage to allow vision systems to move from local task-oriented tools to video analytics systems that merge video data with other process data (see Figure 1). While the cloud is opening up connectivity and storage capacities that often held back industrial vision, video analytics is truly enabled by the ability of edge computing to provide near-real-time video analytics. Edge provides the following for video analytics:

- Real-time decisions using local or cloud storage, depending on local network conditions
- Image processing and ingestion of video and other data to offload cloud and network
- Local analysis for speed and network optimization
- Local logic processing-based analytics outcomes to provide speed and network optimization

These new capabilities at the edge provide agility in where and how data is processed, analyzed, and stored.

FIGURE 1: ***Video at the Edge for Manufacturing Companies***

Q What type of data are companies investing in for data collection at the edge?



n = 2,668

Source: IDC's Vertical Survey, 2019

Video systems generate immense amounts of data, both image based and process based. Moving all image and analytics data to a cloud system in near real time can be hampered by bandwidth and latency issues caused by rich/high-resolution images and the frequency of image creation (i.e., high-load situations). This is where intelligent edge computing becomes the catalyst for spreading video-based quality systems to more use cases and applications.

Intelligent edge devices provide the compute power and connectivity to ingest and analyze large amounts of data in near real time. The immediate results can be sent to the cloud or back to the production process, while the raw data can be sent to the cloud as bandwidth and processing power allow. This is all potentially controlled by an edge architecture that is optimizing computing power, network performance, and local logic needs in real time.

Quality Assurance as the Ultimate Video at the Edge Use Case

One of the areas most impacted by the increasing usability of vision applications is quality assurance. In a typical discrete manufacturing operation, IDC has found that 3–5% of operators are dedicated to inspection in some form. Whether label inspection, product part fit, color, linear measure, or product configuration, the majority of inspection functions are visually based and manual. An inspector is usually there to validate visually what a machine or another operator has done. As products themselves become smarter and more connected, configurations become more complex, making it harder for the human eye to spot defects. Every plant manager has, at one time or another, dreamt of eliminating the cost and time needed for human inspection.

This will only get worse as shrinking lot and batch sizes are driven by mass customization in a market-driven operation. As lot sizes shrink, the cost of changing work orders/documentation and manually inspecting every lot or batch becomes unaffordable. Video analytics on the edge can match work orders to inspection instructions and automate the process.

As mentioned previously, vision systems have been justified where the inspection of a product or a process was not possible due to cost or physical constraints. But as more powerful and less expensive video analytics systems proliferate, video analytics is becoming the preferred technology for quality assurance.

The ability to completely automate the quality assurance function is incredibly attractive. Edge-based video analytics becomes a cost-effective and maintainable part of the journey to automate quality assurance and inspection.

Video at the Edge Isn't Just About Seeing

While inspection automation is a worthy and productive goal, having an edge device sitting at the local production station provides benefits beyond just enabling a new vision system. It can also provide the following:

- **A distributed, yet independent and intelligent node in a large automation strategy.** This flexible node can work with other edge nodes to share computing power and network operation based on other workloads.
- **A point for other local production processes to connect to for data ingestion and logic execution.** The edge device that is supporting video analytics can also be called upon to support the overall edge network workload as needed.
- **Local connectivity for legacy devices to get their data to other operations systems.** The local video analytics edge device can also be a gateway for onboarding legacy digital data currently isolated from the network.

In other words, don't look at the edge component of the vision system as dedicated to only the vision process. It can do much more. Choose your edge device for its compute power and ability to manage connectivity to other production processes and devices. This is especially true for legacy devices and sensors that need some form of digitization to get their data to the cloud and beyond.

Benefits of Video at the Edge in Quality Assurance

There have always been numerous benefits to using vision for quality functions, as long as the process could bear the cost of implementation and ongoing support. But those systems were isolated and not easy to use to fully automate an inspection process.

The benefits of edge-based video analytics are as follows:

- Expands the use of vision as a quality tool into innumerable other areas of quality assurance
- Provides local logic and data processing power at the edge for data ingestion and process automation
- Delivers flexibility from distributed computing capabilities of edge computing, allowing much broader applications of process automation through vision and imaging systems

The ability to analyze and react to imaging data in near real time opens up a large number of use cases that bring distributed computing and robotic process automation into the picture.

Again, the edge computing part of a modern vision system can't be overemphasized. The ability to analyze and react to imaging data in near real time opens up a large number of use cases that bring distributed computing and robotic process automation into the picture.

Key Trends Impacting Vision in Quality Assurance

The following key trends are coming together to make video analytics a cost-effective and transformative technology for quality assurance:

- The cost of imaging devices has dropped while resolution capabilities have increased.
- Connectivity in critical areas of plants has become ubiquitous.
- Edge computing capabilities are used to ingest image and process data as well as provide a local cognitive footprint for process automation.
- Cloud deployments are opening up storage, compute, and connectivity.
- Newer staff talent is being recruited with the skills needed to support edge-based vision systems.
- Recent improvements in accuracy and efficiency as well as a smaller artificial intelligence (AI) model coupled with edge computing capabilities are enabling new use cases to emerge at a rapid pace.

Of all these trends, edge computing and video analytics are the critical technologies that transform a simple vision inspection system into a fully automated quality assurance process automation system.

Considering HPE

With a broad range of core computing solutions, HPE is well positioned to deliver edge-to-core video analytics systems for a wide variety of industrial quality assurance workload and operating conditions. HPE Ergoline Converged Edge Systems, featuring Intel second-generation Xeon Scalable Processors, are built for rugged environments and designed for power-efficient operations. HPE's tested technology ensures security, remote access, and high-availability performance management tools and platforms. HPE's scalable building blocks integrate multiple hardware and software features depending on the compute power needed for industrial inspection. Together they make up comprehensive solutions for video management, AI, and hardware-accelerated video analytics. HPE's video surveillance and analytics solutions also store high volumes of IP video surveillance data efficiently, ensuring the overall performance and reliability of the surveillance solution. HPE Edgeline systems can be tailored for the precise number and quality of video feeds and intensity of processing and analytics needed — including chassis type, number of servers, number of CPU cores, memory, and storage hardware.

The use case, number of cameras, amount of data generated, and data retention period all inform the choice of storage attached to a video analytics solution. Direct-attach storage is appropriate for smaller configurations, while SAN-based storage and Ethernet/iSCSI-based storage work best with larger configurations. Other large configuration options include multitier storage (flash disks for live databases, spinning disks for archive database) as well as predictive flash technology (HPE Nimble Storage), flash-optimized systems offering rapid and automated provisioning (HPE 3PAR), and hybrid cloud file storage (Qumulo, Scality).

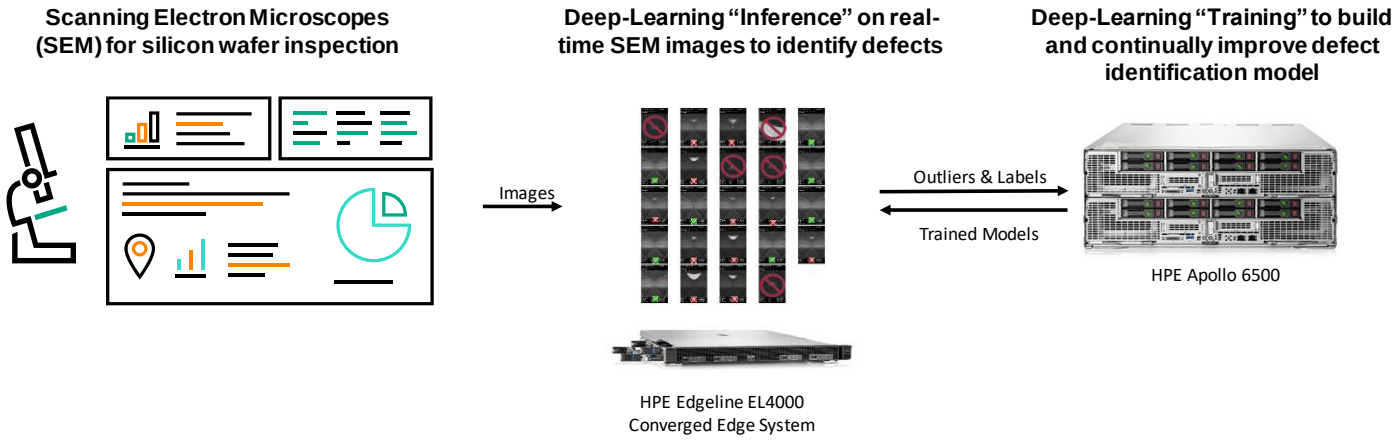
HPE edge-to-core offerings include HPE Edgeline Converged Edge Systems, HPE ProLiant Servers, and HPE Apollo Servers — providing high-performance CPU and accelerator options across a wide range of price points and form factors. A broad range of configurations and partner solutions enables video surveillance and analytics capabilities. HPE's storage portfolio comprises scalable storage options that can handle images from specific processes, plants, or across the enterprise. HPE's Pointnext Services, together with industry-specific systems integrators, can integrate and scale video analytics solutions to create "outcomes as a service" globally.

Two examples highlight the end-to-end and edge-to-core workflow for video-enabled quality assurance for server (deployed at HPE's factory) and disk drive production (manufacture of hard disk drive wafers). The first example involves an edge-to-core architecture. Image inferencing (for pass and fail of a given hardware configuration) is done on an HPE Edgeline EL4000 system, and when a new model is needed, the training is done in the core/datacenter and the trained model is deployed on the edge. The edge also hosts the operator human-machine interface (HMI).

Other consolidation functions reside at the core: consolidation dashboards, correlation with order management, and specific images are stored for post-analysis. Automated server quality audit requires as much as 600Mbps of data to be processed in real time. With the new systems, image processing can be achieved with latencies as low as 1s at the edge compared with a transmission latency of over 21s (mean averaged). In addition to saving time, the HPE factory has been able to reduce the defects on arrival of a given server configuration by as much as 25%.

The second example analyzes silicon wafer quality at a disk drive manufacturer (see Figure 2). In this case, a scanning electron microscope captures images of the drive head. Quality assurance in silicon fabs demands cutting-edge AI and video analytics to reduce errors, recoup investments, and maximize output.

FIGURE 2: ***HPE's AI-Enabled Video Analytics Solution for Silicon Wafer Inspection***



Source: HPE, 2020

HPE Pointnext Services deployed analytics, AI, and data experts to develop an edge-to-core architecture. The system includes an HPE Edgeline EL4000 for real-time inferencing at the edge. In the datacenter, an HPE Apollo 6500 trains its AI/visual analytics models to improve the Edgeline's pass/fail inferencing capability over time. The manufacturer then replicated its quality assurance inference engine across multiple factories in different geographies. All sites adopted the latest updated AI model for detecting pass/fail SEM images (one site learned from the results in another — a closed-loop edge-to-core system). In all deployments, the core HPE Apollo 6500 acts as a centralized resource to train/retrain multiple AI models for this task. This core-to-edge solution has reportedly enabled a 20% reduction in cleanroom investments, a 10% reduction in manufacturing throughput time, and as much as a 300% return on investment.

Challenges

Even with the new capabilities of modern cameras and edge computing, HPE's customers face some challenges in using edge-based video analytics:

- Maintaining and accessing the talent needed to support ongoing changes as production processes change
- Integrating video analytics into other production systems (Although greatly simplified, integration can be a challenge.)
- Developing a unified cloud strategy to simplify distributed edge device orchestration

The overall challenge is still around talent and integration, but modern edge-based vision systems have come a long way in making the previously mentioned challenges surmountable for a much broader range of quality applications.

Conclusion

As edge, cloud, IoT, and analytics become the foundation of a modern production system, quality assurance is a key beneficiary of these transformational technologies. By automating tedious and often error-prone manual processes, video analytics at the edge can perform a vital role in improving process and product quality. As manufacturing companies transform to be more resilient to market forces, they must look at data and the product itself as equally important commodities. That datasphere of production information will be heavily dependent on video at the edge to drive the reliable decision making needed in the transformed operation.

About the Analyst

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Kevin Prouty is Group Vice President for IDC Energy Insights and IDC Manufacturing Insights. He is responsible for managing a group of analysts that provide research-based advisory and consulting services that will enable energy executives in oil and gas and utilities to maximize the business value of their technology investments and minimize technology risk through accurate planning. Kevin's research specialties are Utilities, Manufacturing, Enterprise Applications, and Product Innovation research.

MESSAGE FROM THE SPONSOR

About HPE's Video Solutions

For additional resources on using video analytics in production and quality control:

- Intelligent Factory Video - ***https://www.youtube.com/watch?v=JPGjYzuzsPY***
- Video Analytics White Paper - ***https://www.hpe.com/h20195/v2/Getdocument.aspx?docname=a00091771enw***
- Seagate - ***https://www.youtube.com/watch?v=WW_4z7qB7rs***
- Edgeline Family Guide - ***https://h20195.www2.hpe.com/v2/getdocument.aspx?docname=a00050138enw***

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