Video Analytics – Choice of Architecture

Which is better?

Last month we explained Video Analytics, its applications, its problems and future trends (Refer pages 64-66, June 2012). This article addresses the choice of architecture.

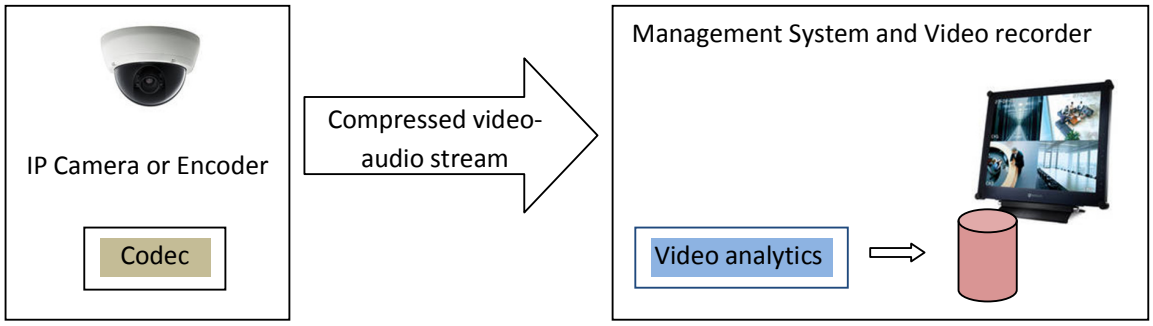
Video Analytical Systems - Architecture

The two predominant video analytic systems architectures in use are:

- **Server based** - IP Cameras or Encoders connected via Ethernet to a Server.
- **Edge based** - Self contained analytics using smart Cameras.

Server Based Implementation

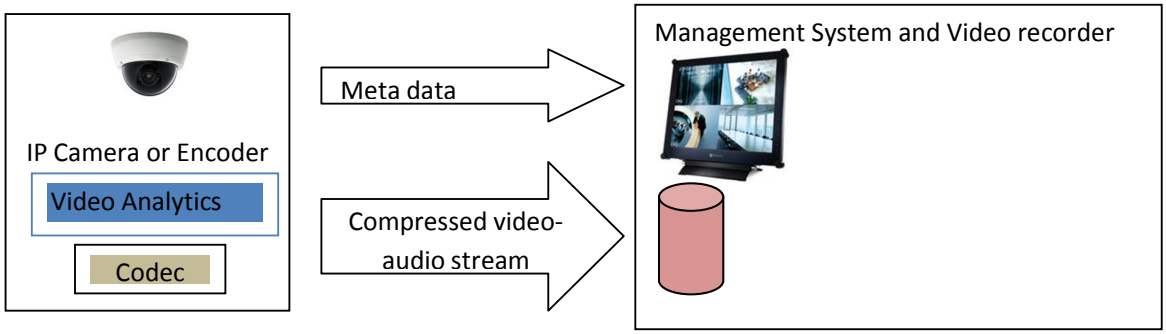
In this approach, the Video Analytics is implemented through a dedicated server that pulls the video, analyzes it, and issues the alerts or analysis results. This approach is independent of the video cameras, and therefore, is applicable to most types of surveillance systems. **The VA intelligence is located in the server.** The sole function of the camera system is to collect and deliver suitable digitized video to the Video Analytics in the server. All decisions are made in the server.



Server based implementation

Edge Based Implementation

In this approach, the Video Analytics is implemented through an IP video camera or video encoder, which must have sufficient processing power to run the Video Analytics functionality. The Edge based system, is a fundamentally different architecture. **The "camera" does both the video collection and the VA processing/event detection.**



Embedded video analytics - implemented "on board" the camera.

The result of video analysis algorithms is the flow of *metadata,* a structured description of what is happening in the surveillance zone. The metadata includes information about moving objects, their trajectory and speed, signs for the automatic classification on the Server, information about the video quality and damage to the camera. Thus, the smart camera simultaneously transmits real-time media data (compressed video and audio) and metadata (the result of video analysis).
This fundamentally different architecture distributes the intelligence to each individual camera with Servers or other network devices optionally serving as a human machine interface or archival devices. All real-time activities are camera based and with all the event detection taking place in the camera, the video sent back over the network is only necessary as it relates to a specific application or installation.

Pros and Cons of Server-based v/s on-camera (edge) analytics?

Disadvantages of Server based Analytics.
With a **server based architecture** the arriving compressed video is at first uncompressed, thus putting an additional demand on the server. Further, 'losses' in the compression/decompression cycle may hamper the Video Analytics (VA) from functioning or may even cause false alarms.
Since all Video Analytics processing takes place in the server, the processor power of the server and resources are shared. Further, Video Analytics is processor intensive. As more cameras are added or additional or more processor intensive Video Analytics are installed, the server will either have to be upgraded or the system restructured to add additional servers.
Advantages of Server based Analytics.
As the size of the installation grows, the need to perform analytics or correlate metadata on live or stored video from hundreds of cameras requires the greater processing power and central management capabilities of a Server-based solution. Server-based analytics enable more complex analytics and fast searches through archived video. Server solutions are critical for making a variety of video analytics tools available to various departments, from security to HR, operations and marketing, and allowing searches for after-the-fact criteria or analytics (such as facial recognition or object identification) that are beyond the capabilities of 'on-camera' solutions.
Advantages of Edge based Analytics.
Performing video content analytics at the edge helps conserve overall processing capacity since the video analytics is done before the image is compressed. This means that the image will not need to be decompressed again at the Server again for video content analysis. Instead, metadata (data about data) provides the necessary information for easy identification and retrieval.
All real-time activities are camera based and with all the event detection taking place in the camera, the video sent back over the network is only necessary as it relates to a specific application or installation. As an example, if a camera has a motion detection VA installed, the camera could be programmed such that when an event is detected, it also flags the pre and post event video frames located in its video buffer. The result would be an event message sent out over the network with the sequence of images that precede, include, and follow the motion event detected. During normal, non-event conditions, nothing needs to be sent out and therefore no network bandwidth is required. Further, the camera can be programmed to send time stamped compressed video frames to an archiving Server located anywhere on the network. During non-event times, this can be done at low frame rates and then changed to high frame rates during event detection. This not only saves archival storage space, but also network bandwidth.
On-camera analytics aids the adoption of megapixel cameras that provide the detail necessary for many video analytics products to perform complex operations. On-camera video analytics can ensure that only 'video of interest' is disseminated through the network.
The other major advantage of Video Analytics on the edge over Video Analytics done in a Server is that the VA algorithm has full access to high-resolution, high frame rate, raw uncompressed video as input for its algorithms. After the VA has processed the frame, the camera can then optionally

annotate, highlight those areas of interest in each frame, or even reduce the frame size, before compressing the video and sending it out. The camera can be programmed to manage bandwidth and resources based upon the events taking place.
Ease of system expansion is another advantage with Edge based analytics. As the camera is "self-contained", adding another can be as simple as plugging it into the network and configuring it.

Disadvantages of Edge based analytics.
Most edge devices still lack sufficient processing power for high-end Video Analytics requirements, and therefore such implementation compromises on either the range of functions or performance quality of the Video Analytics, or both.
In addition, most surveillance installations include different types of cameras, and not all cameras are suitable for "edge based implementation" nor do all cameras support it to the same quality.
Only very few algorithms can run and will run on the present generation of IP cameras. It is technically possible to increase the processing power of the DSP (digital signal processing) chip and RAM. However the resulting price would make the camera far beyond mass market needs. Such a solution will be far more expensive than a centralized Server based solution.

Summary

In Server-based solutions, the analysis is usually done centrally with the full video stream sent across the network. In embedded solutions, the Video Analytic software is loaded on a digital signal processor (DSP) or embedded processor which is physically installed in the video surveillance device (Camera) at the time of manufacture. In some cases, the software is up-loaded directly into the video surveillance device as a plug-in, whilst the device is in the field. "Analytics at the Edge" also referred to as "Embedded solutions" have the ability to analyze the video before sending it across the network.
Server-based solutions offer more processing power than can be provided at the edge. For this reason, processor intensive applications, like face recognition, are normally Server-based, whilst edge-based solutions are restricted to simpler applications, such as people counting and tripwire.

Conclusion

A truly future-proof solution is one that enables some part of video analytics at both points – Server and edge. This is partly because some types of video content analysis will always require the greater processing power and speed of a central Server and also because we will see more and more edge devices with the capability of performing some video content analysis. Customers may choose between Server and edge analytics according to their needs. They could combine an affordable edge analytics for intrusion detection on the majority of cameras and select enterprise class behaviour recognition on a Server from another vendor.
With the increasing processing power of standard IPcameras more features will be available at the edge. It is also likely that vendors of edge analytics will also provide Server based and library based algorithms.
IMS Research predicts that in the coming years the types of applications that can be performed at the edge on the device's main processor will increase. This will mainly be driven by the availability of more powerful processors and partly by the refinement of VA applications to make them less processor intensive.
As powerful processors at affordable price points become available to video surveillance manufacturers, they will increasingly add VA to their devices. Basic analytics will become standard features and more advanced "paid for" analytics will be performed at the edge. Over time, an increasing variety of analytics will be added as standard features, at no extra cost to the customer. Moreover, more powerful processors will enable multiple VA algorithms to be performed at the same time, for example loitering and object tracking to improve the detection capabilities. Another

possibility is cross camera tracking, where one camera hands-over to another to follow a person as they move through a building.

The power of processors will continue to increase quickly. Moreover, VA is increasingly being used outside of the security industry, such as driver assistance cameras in cars and interactive gaming console peripherals. Some of these new markets for VA offer high volume potential, which is attracting the attention of the chip makers. **It is likely that the higher volumes will drive the introduction of powerful processors that are optimized for VA applications. This will inevitably result in more analytics at the edge.**