Weighing Out Components

Higher resolution strains many parts of a system — bandwidth, storage, visual display and so on — so manufacturers need to strike a balance among resolution, compression and frame rate, in order to satisfy these user needs and deliver quality images.

BY ROSA CHEN

To determine if and which megapixel or HD camera is needed, it is important to survey the location. "You need to find out the number of interest areas, the sizes of these areas, and whether they are located close to each other or spread far apart," said Nafis Jasmani, Sales Manager for ASEAN at Axis Communications.

In determining the right pixel count, users should know ahead of time what detail they want to zoom in on. "If, for example, you are setting up cameras for a teller area, your target pixel count for facial recognition can be 60 pixels from ear to ear to identify a person. The distance from the camera to the bank customer should be measured and the required megapixel count calculated," Jasmani continued.

Online tools provided by manufacturers help determine the right megapixel sensor and lens type, and optimize storage and bandwidth selections. Before choosing a camera and its components, however, integrators and installers must first consider lighting conditions.

LIGHTING

Light levels vary, so cameras must have the tools to handle changing environments, said Michael Hodor, Senior Sales Director for Western North America, Latin America and Asia Pacific, Avigilon. Image sensors (different sizes and types), as well as auto-iris lenses, are tools that can enhance low- or variable-light performance.

To test this, installers should place a camera under good lighting conditions and change the lighting abruptly to see how the camera adjusts, said Paul Bodell, CMO of IQinVision. "This should only take a second or two, but typically low-cost cameras are unable to optimize the image quickly when conditions change. It boils down to the different processing techniques."

The common misperception that megapixel cameras are somewhat limited in terms of low-light performance is actually due to very low-cost image sensors and lens technologies used in low-end commodity network cameras, said James Mihaychuk, Product Manager for Surveillance and IP Cameras, Lumenera.

When such cameras are subjected to variable lighting, video will change and lag, Bodell added.

Looking at components, most are in agreement that CCDs are superior to CMOS sensors. "CCDs combined with day/night IR-cut filters and WDR are suitable for challenging lighting conditions," said Tom Galvin, VP of Product Development at GVI Security.

Sensor size also matters, with larger sensors such as 1/2-inch or 1/3-inch generally outperforming smaller 1/4-inch ones, Hodor said. Exposure settings determine the duration of time a sensor is exposed to light, and if the camera has a good feature set, it will allow for a range of exposure settings to work in tandem with an auto-iris lens.

Tools such as 'visibility enhancers' optimize brightness by remapping pixel by pixel, frame by frame. "Near blacks are expanded and near whites are compressed to provide processing," said Peter Norman, Senior Product Manager,

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Security Solutions Asia Pacific, Sony Electronics.

Oftentimes, a single component is taken as the sole reason for a camera's low-light performance, but this is not the case. "Each component in a camera's setting has an effect on the resulting footage," Hodor said. Users, therefore, should never choose cameras based on a single indicator, such as a low lux level.

▲Low and variable lighting marks the difference in the quality of high-resolution cameras. Low-cost cameras typically are unable to optimize the image quickly when conditions change.

LENS SELECTION

To realize the full benefits of a camera, one also requires a proper lens. "Today, there are more varifocal day/night lenses available for megapixel cameras," Mihaychuk said. "For our higher megapixel cameras, we use 35-millimeter auto-focus lenses used for professional photography."

A typical board lens allows less light to pass through the sensor than a C- or CS-mount lens. Beyond that, single-lens reflex lenses are even more superior, Hodor said.

Compounding the lens with auto-iris capability allows the lens to expand as it gets darker, so that the

image sensor absorbs more light. The size of the iris should be balanced with exposure time to ensure correct exposure. "Overexposure can cause poor-quality images, and too little exposure can create grainy pixels," Hodor continued.

In choosing lens, users can decide on the tradeoff of resolution and area viewed. If users aim to view a wider area at a lower resolution, wide-angle lenses are appropriate. "With this wider view, you dilute the number of pixels available in your area and limit the amount of detail seen after. If, however, you need to identify a person or a license plate, narrow-angle lens will obtain higher detail," Jasmani said.

Low-price lenses often produce megapixel resolution only in the center, which means the image quality and resolution at the periphery would suffer. "Users should ensure that the megapixel resolution power extends across the lens' entire field of view," Mihaychuk said.

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COMPRESSION FORMATS

The adoption of more efficient compression standards is required to exploit the full potential of megapixel and HD camera technology. "When all the tools that H.264 compression supports are implemented, 30- to 50-percent saving in bandwidth and storage can be achieved, compared to MPEG-4, depending on the level of scene activity," said Gary Wong, Market Analyst at IMS Research.

There are, however, many different formats of H.264 that should be considered carefully, and not automatically favored over alternatives such as M-JPEG. Low-quality H.264 like constrained baseline or baseline use too much compression, which can cause pixilated images or visible motion artifacts, producing poor-quality images, Bodell said. "In many cases, H.264 cameras use less storage and bandwidth, but buyers should be aware that there may be a significant impact on image quality."

"M-JPEG compression is usually preferred unless wireless infrastructure is required. In wireless environments, MPEG-4 or H.264 is more suitable to save on bandwidth, but this comes with the necessary compromise of no longer delivering the complete data for each frame captured," Mihaychuk said.

Additionally, the efficiency of H.264 depends on how much demand is placed on a network. The more activity there is in a scene, the more changes and frames are sent, and the more bandwidth is required, Hodor said. This means that compression is not consistent; storage requirements may fluctuate and are difficult to accurately calculate.

"During playback, if you're looking for a point in time, H.264 will rebuild the image based on the changes that have occurred. This means there might be variations in the image that just do not make sense, as the image is not a true photo," Hodor continued. JPEG-2000, on the other hand, is capable of visually lossless compression, essentially producing better image quality. It does, however, require more storage, compared to H.264.

"Systems using JPEG 2000 can provide data aging, which discards individual frames over time, in order to optimize storage and bandwidth," Hodor said.

Looking at processing power, H.264 uses a more complex algorithm, requiring more resources to compress and decompress the video signal. This means that they require more power and generate more heat, which, in a harsh environment, could result in reliability issues, said Mark Wilson, VP of Marketing at Infinova. "The advantages offered by H.264 would be offset against increased cost for more processing power and video management."

NETWORKS AND BANDWIDTH

Bandwidth concerns related to megapixel and HD cameras can be lessened by specific per-camera calculations; storage needs can also be calculated prior to installation. The typical bit rate per channel for megapixel cameras is about 10 megabits per second (mbps) for JPEG compression, and 2 mbps using H.264.

Once bandwidth restrictions are set, cameras need to stay within the limits. "If you set a bandwidth limit of 2 mbps, some cameras might deliver 2.1 mbps, which exceeds your storage capacity. Over time, this could increase your storage needs and become a huge liability," said Neeraj Purandare, Product Manager for Physical Security Business Unit at Cisco Systems.

Streaming modes — variable bit rate (VBR) and constant bit rate (CBR) — are also important considerations. "VBR allows the camera to automatically adjust the bandwidth it uses, depending on the scene activity, whereas CBR is fixed," said Steve Collen, Director of Marketing at Cisco Systems. With high scene activity, such as at airports, CBR is preferred, as it flattens out the changes caused by high throughput.

Manufacturers can now offer users a third choice — a mix of VBR and CBR that allows users to cut down on traffic when there is no change in the scene, while setting a bandwidth cap, Collen said.

The worst case scenario has to be taken into consideration as well. With low light and significant movement in the scene, bandwidth requirements can increase dramatically. "It is, therefore, important to set up the network to work under harsh conditions," said Hardy Mehl, Director of IP Business at Basler Vision Technologies. "The real difference of cameras in quality and bandwidth consumption becomes visible under harsh conditions."

While users and integrators are concerned about the performance of video on their networks, video can be safely placed on general-purpose networks as long as the network is properly segmented, Galvin said. "The basic idea is to place the video stream from the camera to the recorder on a separate network

segment, so that it does not interfere with the rest of the network."

Finally, consider two, not one, sets of bandwidths. Most camera manufacturers only address the bandwidth between the camera and the recording device. The other bandwidth, between the recording device and the client, is just as important. "Our HD stream management allows users to stream video at a reduced bit rate, by only sending the front layer of the image, or by streaming only the particular region of interest within the entire image," Hodor said. "You may have a user on the other side of the world using a smart phone to view their surveillance cameras. Additionally, providers need to be able to simultaneously send multiple camera streams to their clients."

STORAGE CALCULATIONS

Increasingly, storage needs — how long the video needs to be kept, what frame rate is used, and camera resolution — are calculated prior to installation. Storage calculators make it easier for users to gain an understanding of exactly how much storage space, in terabytes or even petabytes, they need. "This way, we ensure that our customers have a NVR that can handle their megapixel video requirements," Collen said. "Increasingly, we are being asked to support shared-area networks, for larger clients with dedicated servers at data centers."

▲ High-resolution cameras truly escalate storage requirements. From the onset, more expensive storage equipment and sophisticated VMS must be considered.

On the other hand, concerns for storage have been continuously declining with each passing year. "Storage cost keeps falling, and capacity is growing," Mihaychuk said. Additionally, video management software (VMS) can now enable operators to set different recorded frame rates based on a preset schedule or when activity occurs.

Dual-streaming techniques, which garner the advantages of M-JPEG's high-quality image and live monitoring with the lower storage consumption of H.264, alleviate more storage burdens, Wilson said.

Despite that these tools can accommodate escalating storage needs, megapixel and HD technology has completely changed the landscape of storage requirements, said Patrick Lim, Director of Sales and Marketing at Ademco. From the onset, more expensive storage equipment and sophisticated VMS must be considered.

VISUAL DISPLAYS

Finally, there is little point selecting megapixel or HD cameras if images are to be displayed on a low-quality monitor. The display should be selected to accurately render motion while preventing operator fatigue, meaning that appropriate heights and distances are critical considerations, Mihaychuk said. "Naturally, a high-quality, high-resolution display is best. An LCD is acceptable, provided that it has high resolution, good contrast and refresh rate. Low-end consumer products should be avoided."

"HD video can kill a low-performing PC," Collen said. If users need to view HD video on a laptop, however, techniques such as screen scrapping can be employed. Screen scrapping takes snap shots of video streams, meaning that only particular frames are sent. As a result, users will see jittery images rather than fluid footage, but resolution and image are not compromised.

Interestingly, sophisticated display management systems can be problematic. "The system may not understand the protocol for megapixel and HD cameras, and as a result, resolution might suffer. These display management systems are not built specifically to receive megapixel footage; they integrate data feeds from multiple systems," Lim said. Users should take heed and run multiple tests to ensure smooth integration and full functionalities before purchasing.

STRIKING A BALANCE

Clearly, multiple components need to be considered before deploying megapixel and HD cameras. The ways in which any given camera can vary in these features make it almost impossible for users, with little technical understanding, to specify their requirements properly. It is, therefore, up to manufacturers and channel partners to continue to educate and train integrators, and simultaneously work on finding the perfect component combination for every application. SSI