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ETHERNET IP CAMERA FOR AIRBORNE APPLICATIONS

Ethernet IP cameras used as flight test instrumentation should be ruggedized and use the latest compression technology and network equipment to provide excellent results

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// BY RUSSELL MOORE

Ethernet-based networks having become the dominant choice for flight test instrumentation (FTI) applications, requirements for integrating Ethernet-based (IP) cameras with FTI data acquisition (DAQ) equipment, network recorders and telemetry devices have increased. As cameras move to HD formats, transmitting raw video adds complexity and limits the number of video frames that can be transmitted and stored. Synchronizing this data with other flight test parameters can also pose a challenge.

Dedicated compression cards can solve some of these issues, but they have negative implications for size, weight and power (SWaP). Ethernet cameras with integrated compression can address these issues, providing multiple output streams to support recorder and telemetry applications. An Ethernet switch can also manage video streams and synchronize FTI and video data.

The extreme environmental conditions typical of FTI applications require highly ruggedized and reliable HD Ethernet cameras. For new flight test applications, video data needs to be coherently synchronized for telemetry and available for storage. Ideally, data in the telemetry stream will be highly compressed to minimize downlink bandwidth. Recorded data, on the other hand, can be lightly compressed to provide maximum quality for post-flight analysis.

Various image-processing functions are essential for delivering the appropriate image quality during test flights. Rolling shutter cameras can be used in airborne cabin and over-the-shoulder cockpit applications. Global shutters use simultaneous acquisition to capture the entire frame in a single instant of time and can be used where the subject is rotating, or moving with high velocity, to eliminate motion-induced distortion.

ENVIRONMENTAL FACTORS

During flight test, the aircraft and its systems must be pushed to their limits to prove the validity of the design assumptions and to record the safe operational limits. FTI cameras must be designed to meet stringent and harsh environmental requirements in order to withstand extreme vibration, shock, humidity and temperature. For example, an FTI camera may need to operate on a runway at 50°C (122°F), and shortly afterward at -30°C (-22°F). Such thermal differences can change electronic component impedances as a result of temperature or moisture condensation.

CAMERAS IN FTI APPLICATIONS

Full HD video at 60fps can take up to 3Gbps of bandwidth per channel. Several HD cameras recording uncompressed video can overload the data acquisition system. Also, transmission bit rates affect video quality. Lowering the bit rate will reduce the video quality unless the frame rate is decreased. To maintain video quality, changing the frame rate has a linear effect on the suggested bit rate. Compressing HD

1 // Curtiss-Wright's HDC-430-1 Full HD GbE streaming IP camera

2 // Video frames contain similarities which codecs exploit to compress data

"HIGHER-QUALITY VIDEO WILL REVEAL DETAIL SD CAMERAS CAN'T PROVIDE"

video with an industry standard algorithm can reduce bandwidth to a more reasonable amount without significantly affecting image quality.

COMPRESSION STANDARDS

Modern video compression algorithms, also known as codecs, exploit the similarities between and within video frames such as in Figure 2. Codecs used for FTI include MPEG2, H.264, JPEG 2000 and H.265 high-efficiency video coding (HEVC) compression. Codecs can compress an HD video stream down to less than 10Mbps, reducing the bandwidth and recording capacity needed without a loss in quality.

A camera that supports onboard compression and Ethernet packet-based transmission can handle multiple compression streams, which can be particularly useful for FTI. For example, two compression rates can be defined for the same video channel over the same Ethernet connection, enabling the user to set one data rate for the recorder and a second data rate for PCM transmission.

AN IP CAMERA ECOSYSTEM

Curtiss-Wright provides FTI system solutions that integrate with data acquisition and recording systems. These rugged HD IP cameras (1080p; 30fps max.) include the rolling-shutter HDC-430-1 and the global-shutter HDC-450-1. They support image/video streams from under 1Mbps to 20Mbps compressed with a next-generation H.265 HEVC codec. They also support NTP time synchronization and time-stamping.

Properly optimized, this approach delivers excellent video quality for telemetry. A second, higher quality video copy, with a bit rate of around 20Mbps, recorded on board the aircraft, will reveal details that traditional SD cameras can't provide. An Ethernet camera that supports onboard compression enables video compression to be removed from the DAQ system, or eliminates a dedicated unit. The camera can be connected via an Ethernet switch directly into the system, like any other DAQ unit. Even better, because there is no need for dedicated hardware compression, SWaP is minimized and installation wiring greatly simplified. \\

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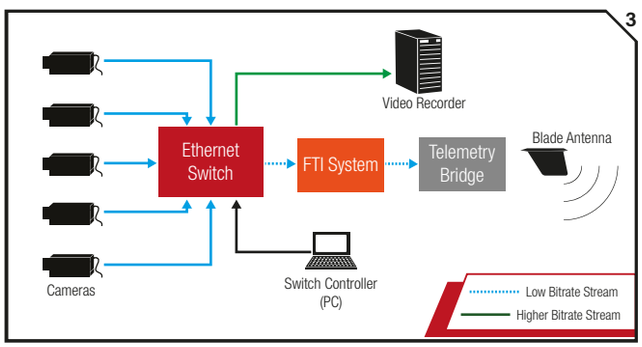

3 // Multiple compression of FTI cameras

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Axonite
Ethernet Recorder
Real-Time Display
Transmitter
High-Speed Camera
Ethernet Switch and IEEE PTP Grandmaster
Data Server and Recorder
DAU
Video Camera
AXON
The newest, fastest, most feature rich DAU is now in production
+ Future-proof design protects investment
+ Lightweight and compact, high channel density
+ Outstanding reliability means minimal data loss
+ Flexible installation and fast reconfiguration saves time
+ Axonite remotely mounts modules away from chassis
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