Metadata Handling in Rugged Embedded Video Compression Systems

abaco
S Y S T E M S

Metadata Handling in Rugged Embedded Video Compression Systems

Introduction

Video data handling in rugged embedded computing environments has an immensely varied range of applications and requirements. Developing products that enable the effective handling of not just video, but also corresponding audio and metadata, is a significant challenge. Demands on video processing have increased with the proliferation of video technologies, HD cameras, additional sensors, and the necessity of remote sensing in unmanned vehicles. In order for the video data to have optimal value to the various viewers and consumers of the data, it is critical to have more than just the video itself. Audio obviously brings in a complementary element to the video displayed, but sometimes even greater value can be realized from other types of data that are associated with the video information. This 'other data' is generally known by the single term "metadata".

By its very nature, metadata is a non-specific term that can be applied to almost any type of information associated with video or photographic information. There are many types of metadata currently in use, and, predictably, a wide variety of ways in which the metadata is encoded, transmitted, and interpreted by the originators and consumers of the video data.

Abaco's ICS-8580 is a unique product in the rugged embedded computing space with its powerful and flexible video I/O and data handling architecture, supporting up to two HD-1080p video streams or four standard definition inputs while also supporting two HD or SD video outputs. The DAQ-8580 is a rugged stand-alone packaging of the ICS-8580 XMC product.

The ICS-8580 now also provides the same degree of power and flexibility in handling metadata. Abaco's Intelligent Platforms business provides software and firmware that makes it possible to deploy the power and flexibility of the ICS-8580 into many target systems with ease and speed of implementation.

Types of Data and Handling Methods

The three types of data that are generally included in video streaming applications are shown in Figure 3, along with the typical handling method and transmission method used for wide-area distribution over Internet Protocol (IP).

Video and audio data are compressed using a fairly limited number of codecs. Video that is distributed over IP networks, particularly targeted at rugged embedded military and aerospace applications, most commonly uses the MPEG-2 or H.264 codec (future H.265). Audio compression typically uses MP3

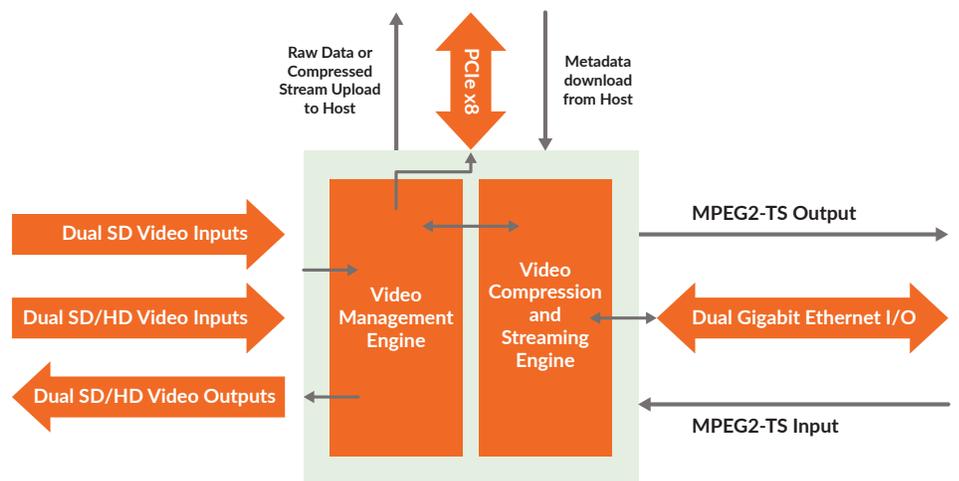*Figure 1 DAQ-8580 Rugged Video Processor*

Figure 2 ICS-8580 top-level data flow

Type Of Data	Data Source	Handling Method	Transmission Method
Video	Numerous options: Camera source – SDI, SDTV, HDTV, STANAG3350, etc.	Compression – MPEG-2, H.264 (AVC), H.265 (HEVC)	Video PES multiplexed in MPEG2-TS
Audio	Mono or stereo audio data	Compression – MP3, AAC	Audio PES multiplexed in MPEG2-TS
Metadata	Camera, sensors, software or firmware: automatically or manually produced.	Encoding technique – KLV, STANAG-4609, CoT, various XML, and many others (some proprietary).	Ancillary PES multiplexed in MPEG2-TS

Figure 3 Data in video streaming applications

or AAC codecs. In the case of metadata, there are many more encoding techniques available than are generally used for video or audio data, due to the multitude of ways that metadata can be generated, transmitted, viewed and interpreted. The purpose of the metadata often directs the preferred encoding technique.

Why Metadata?

Metadata, generally speaking, can be produced in one of three ways: source-generated, added or derived. Source-generated metadata is produced by the video camera unit in connection with the capturing of the video data itself. Added metadata is produced by another entity, either other sensor equipment, computing equipment or even a human being. This data has no inherent connection with the video except that it is produced and added to the video stream as additional peripheral information. Derived metadata is data that is the result of some form of analysis, usually digital signal processing, of the video data, source-generated metadata, or added metadata, or at times a combination of all three in a sensor fusion application. The derived metadata supplies an alternative source of information that can provide great insight into the circumstances surrounding the video stream and greatly improve efficiency in comprehending the significance of the event or scene under observation.

In UAS (unmanned aircraft systems) applications, the availability of metadata can have significant impact in enabling high-level situational awareness that would be impossible without information

Figure 4 Aerial video image capture

in addition to the video itself. For example, consider a video image that shows a vehicle travelling in the field-of-view, as shown in Figure 4.

Without metadata information such as GPS location, direction of travel of UAS, orientation of camera (often cameras are not statically mounted, but are in a turret or on a swivel), it would be impossible to determine if the vehicle was moving toward a sensitive location or not.

Metadata Encoding

Examples of metadata that may be associated with military and aerospace applications include: data from secondary sensors such as sonar or radar; camera zoom; GPS location; direction of travel; air speed, altitude; and many others.

These data elements may be described in various manners, according to the specific data encapsulation standards and application requirements. A widely used metadata encoding standard is the NATO standard, STANAG 4609, which

is a derivative of a broadly defined KLV (Key-Length-Value) standard. The KLV standard is included in certain SMPTE (Society of Motion Picture and Television Engineers) and MPEG (Motion Picture Experts Group) metadata standard definitions. Other encoding methods, such as CoT (Cursor on Target), can use a variety of XML data structures to define the metadata, which provides great flexibility, but can present significant challenges to any system architect attempting to provide a "one-size-fits-all" metadata handling solution.

To meet these needs, Abaco has implemented a powerful and flexible metadata engine to meet the needs of a very broad range of customers and applications. It enables the specific requirements of an application to be satisfied with the same hardware and firmware package available from Abaco, the ICS-8580. Abaco also has example implementations we can provide to customers for the more common encoding techniques, and can assist customers with standards that require custom implementations.

Metadata Capture and Insertion with Video Data Stream: SDI Example

The ICS-8580 provides the capability to extract metadata from the input video stream. As an example, the SDI standards – SMPTE-292M and SMPTE-291M – together define a high definition video imagery standard combined with ancillary metadata. The diagram below illustrates how the ancillary data is interleaved with the video data for progressive and interlaced video streams.
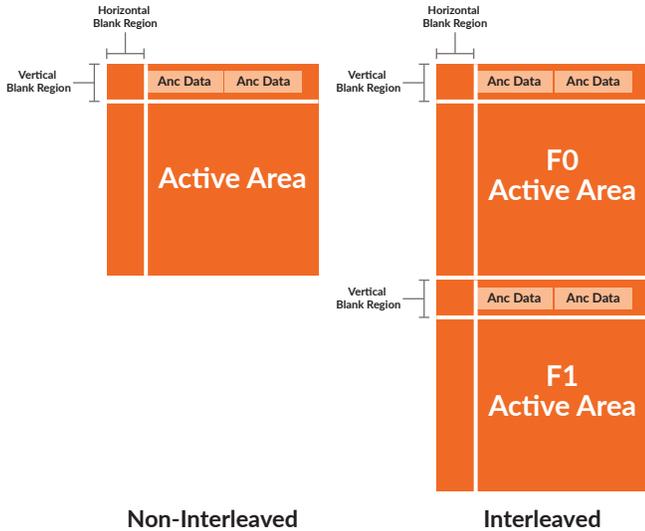
Figure 5 SDI video with ancillary data

The ICS-8580 implements the capability to extract ancillary data from an input SDI video stream. The extracted metadata can be sent to the host or added to the compressed video distribution. The video information and the metadata can be encapsulated in separate primary elementary streams which are then separately multiplexed into the MPEG2 TS (transport stream) for distribution over Ethernet. The recipients of the MPEG2 TS then have the flexibility to look at the stream(s) of specific interest and process or display accordingly. Thus, a recipient of the MPEG2 TS could extract and view only the video information, and as needed, or on demand, extract the metadata and provide that to the operator in conjunction with the video data.

In the reverse direction, as a decode implementation, data from a previously compressed and encoded MPEG2 TS stream can be de-multiplexed and decompressed for display. In this case,

the ICS-8580 can extract the metadata and insert it into the SDI ancillary data region, ignore it, or send it to a host processor.

The ability of the ICS-8580 to perform bi-directional metadata extraction and insertion is a unique feature in the rugged embedded computing marketplace, and sets it apart as the most feature-rich product available.

Additionally, the metadata handling is extendable to allow data generated from other sources to be inserted into the video data stream. Other data sources could be additional sensors, produced on-board the ICS-8580, or downloaded from a host computer. This approach makes it possible to insert additional derived metadata into the transport stream, by uploading the raw video data to a host computer simultaneously with the compression processing by the ICS-8580. The derived metadata can then be downloaded back to the ICS-8580 and included in the metadata elementary stream for distribution as part of the MPEG-2 transport stream.

Metadata for All

The ICS-8580 is the most powerful and flexible video streaming product for rugged embedded computing applications. With the added features for handling metadata of all types, it provides unparalleled functionality and configurability, while making the features easy to use and customize as required.

For system integrators looking for a video handling solution to support many different programs, the ICS-8580 is the ideal choice. By using the same platform on multiple programs, the ICS-8580 can reduce integration time, speeding new deployments and reducing the number of different products that must be supported in the field.

Contact Abaco's Intelligent Platforms business for more information or for help determining how the ICS-8580 can solve your video handling challenges.

WE INNOVATE. WE DELIVER. YOU SUCCEED.

Americas: 866-OK-ABACO or +1-866-652-2226   **Asia & Oceania:** +81-3-5544-3973

Europe, Africa, & Middle East: +44 (0) 1327-359444

Locate an Abaco Systems Sales Representative visit: abaco.com/products/sales

abaco.com   🐦 **@AbacoSys**