# Analysis for Action

**NEW TECHNOLOGY HELPS ANALYSTS SORT THROUGH THE VAST QUANTITIES OF INFORMATION PROVIDED BY VIDEO SENSORS.**

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When Lieutenant General David Deptula, Air Force deputy chief of staff for ISR, warned sometime back about the prospect of "swimming in sensors and drowning in data," he touched a nerve among military intelligence analysts struggling to cope with the burgeoning amount of motion imagery collected, especially in wide area formats.

Today, UAVs alone are producing so much video feed that the intelligence community is finding it increasingly challenging to analyze and draw conclusions to determine "actionable intelligence."


John Bastedo


Verne LaClair

For one, there is the issue of knowing exactly where and when to look, especially since the space beneath an aircraft's flight path can vary between 25 to 100 square kilometers. With traditional EO/IR video, aircraft are limited to watching approximately 1 percent of that area with adequate resolution.

"This means we are not watching the rest of the area, and we are hoping we've got the right spot so that eventually the right time will come along," said John Bastedo, vice president, Security and Surveillance Division, PV Labs.

This can lead to an overwhelming amount of video data coming from essentially dead space. "This is because we are either looking in the wrong place or don't know when the right time is," he added.

It's like searching for a needle in a haystack, observed Verne LaClair, ISR product manager for PAR Government. "To eliminate the scenario of having much of the video data effectively 'fall on the floor,' analysts need to weed out hours of no activity or irrelevant activity to create a 'highlights reel' of pertinent information," he said. "This information needs to be current, relevant to a geographic location and accessible by operational users on mobile devices via efficient data dissemination methods."

With the growing influx of data that is being produced by UAVs, it has become increasingly necessary to bring computers into the loop, noted Jonathan "Michael" Ehrlich, product manager, GEOINT Enterprise Solutions, ITT Exelis Geospatial Systems. "The quantity of data being generated requires computer systems not only to provide a means to collect, store and distribute the data, but also to analyze and catalog the video data for analysts and decision makers," he said.

In pursuit of the most advanced computer processing algorithms, however, ITT Exelis Geospatial Systems has noticed a gap forming between computerized processing algorithms and the analyst.

"While performing advanced computer analytics is an important step in sorting through the flood of data, it is the analyst who is ultimately responsible for forming intelligence products and determining the important aspects of a scene," Ehrlich remarked. "To manage the influx of data and difficult intelligence questions, it is imperative that the analyst be able to leverage the technology to develop better summary products and drive down to the content that solves the problem as quickly as possible."

The IC must also contend with the fact that data collection is decentralized and often remote, and frequently requires resources outside an operator's purview or capacity.

"Functionally, information overload is a real concern for operators. All relevant data input must be matched with support for interpreting, correlating, summarizing and visualizing the data against the existing knowledge base, transforming raw bits of data into actionable intelligence," commented John Mackay, president and chief executive officer of Cloud Front Group.

Video is quickly becoming the most in-demand sensor intelligence on the battlefield, making the ability to transport and mine it a top priority. Video data has been increasing in a variety of ways, including the quantity of sensors and platforms, types of sensors, and the resolution and the frame-rate of data acquired.

## From Platform to Analyst

The increased adoption of UAVs has reduced the cost of data acquisition operations, allowing more frequent and longer duration missions to be executed. But the challenge with UAV video is to quickly and efficiently get it from the platform to the analyst, while also giving analysts the ability to quickly identify priority intelligence requirements in near real-time or later without having to watch hours of unchanging video.

"All of these factors are compounding the sheer volume of data that must be sifted through and analyzed in order to generate actionable intelligence," remarked Bastedo.

In addition, video requires significant bandwidth to deliver, which places demanding network requirements on real-time and tactical applications.

The Cloud Front Group has put together an integrated package of technologies to solve the problem of quickly disseminating relevant video data to tactical or real-time operators. "To achieve this goal, imagery object recognition and search software from piXlogic is used to scan captured video for notions of interest such as certain vehicles or people," Mackay explained.

Once identified, the segment of video surrounding the identified notion is immediately routed to any subscribed operator using Flume, an advanced file transfer and synchronization software solution from Saratoga Data Systems.

"The entire sensor feed continues to be recorded and can be downloaded once its mission completes, but real-time operations can be positively affected by this dissemination of relevant segments, requiring much less bandwidth and providing more resilience to network challenges than actual video streaming," he said.

The ability to collect, store and distribute metadata, as well as tag or mark events or sequences of interest, greatly assists in working with the large quantity of video feeds collected.

"These techniques enable effective collaboration, but still require analysts to sift through large quantities of data and tag areas and objects for further analysis," Bastedo noted.

Wide area motion imagery (WAMI) and other large volume data sources require an even larger number of analysts to monitor activities if the current paradigm is extended. WAMI, unlike full motion video (FMV), is high-resolution imagery over large ground footprint areas for long periods of time, allowing persistent surveillance over city-scale regions, and enabling intelligence to be gathered from motion patterns and locations of many simultaneous targets over a large region of interest.

"If analysts can be freed from monitoring segments of video or image streams, their focus can be shifted to higher-level analysis and intelligence collection," he commented. "Hence a key benefit of automation is not to replace analysts, but rather to allow them to focus on the generation of actionable intelligence."

The current solution, where an analyst watches hours and hours of video streams, relies solely on human capital, which can be costly, not scalable and prone to errors, said Jim McHugh, vice president of capabilities and service for NuWave Solutions.

But new technology can alleviate this challenge, he said. Software solutions such as piXserve by piXlogic can create a searchable index of images and videos, as well as the text read from visual objects in the background of images and videos.

"This software can provide the analysts with only relevant video segments, which will assist them in making better decisions while understanding situational awareness," McHugh said. "The increased performance and precision of the analyst creates a cost-effective, scalable solution, which provides a better analysis of an increasing velocity of video data in a shorter amount of time with a higher degree of confidence."

## Automated Recognition

A number of companies offer automated systems to help the intelligence community find nuggets of information, observe patterns over time, and other trends.

Nuware Solutions, for example, focuses on providing rapid dissemination of high-priority video data to support real-time tactical operations. "Our solution addresses the biggest challenges facing today's UAV video review process: automated recognition of objects, automated tagging of the video segments with an intelligence based lexicon for search and discover ability, and the alerting of analysts of the video segments needing human review," McHugh said.

For this concept of operations to work, the video processing must occur as close to real-time as possible. This temporal proximity requirement suggests that the video processing needs be in physical proximity to the collection device in order to reduce transmission delay. The reliability of such recognition improves with the quality of the imagery being processed, which generally translates to being closer to the capture source so that compression, recoding and transmission do not degrade the data. Hence, the video processing system must be deployed on the same local area network as the sensor itself.

"Using our UAV example, the UAV should have on-board object recognition processing as well as video capture capabilities," Mackay described.

The information provided by the alert must include the sensor data that caused the alert. This video segment then needs to be delivered with the highest-possible resolution to ensure operators can interpret the video accurately and make the best recommendation for the success of the mission.

Given the network challenges in tactical environments, an efficient compression and transmission protocol must be leveraged to provide the maximum possible video resolution over the available network conditions. Such a protocol must be resilient against network latency, intermittency, and the error rates common in tactical conditions so that missions can rely on the alerts being delivered.

"To address this technology challenge we use Saratoga Data System's Flume, a 100 percent software solution to file transfers," Mackay reported. "In recent testing by the Air Force and Army, Flume has proven significant improvement over standard network file transfer protocols."

## Linking Disparate Data

PV Labs has a long history of integrating sensors of various types into its stabilization platforms with fielded and demonstrated capabilities. In addition, the company is active in WAMI technology. "WAMI is the fabric that links disparate data sources, such as FMV, SAR and SIGINT, in both space and time by providing the context," Bastedo explained. "WAMI is the narrative connecting seemingly disjointed vignettes."

In essence, WAMI enables both manual activities and automated algorithms to piece together these disparate data sources to identify relationships, patterns, and trends. Although WAMI produces a great deal more data, its contextualizing ability makes it possible for an analyst to filter only the relevant streams of FMV, reducing the overall quantity of video to sort through. WAMI is also able to guide in the targeting of FMV assets if there are currently no FMV resources in a potential area of interest.

"The situational awareness and contextual information provided by WAMI not only assists in sifting through the mountains of FMV collected, but can also tell you where you need to be looking," Bastedo reported.

The ability to cue other sensors based on patterns or events from a wide-area view can provide a tangible tactical benefit by guiding the assets currently available, and thereby maximizing their value.

PV Labs' PSI Vision product line offers complete WAMI solutions that measure in the hundreds of megapixels and allow for the collection of large area footprints (25-100 square kilometers) at sufficient resolution to permit automated motion detection and tracking of vehicles and people. Large quantities of data from a variety of sources can be stored in the company's Tactical Content Management System (tCMS), which provides a data repository and processing engine for the acquisition, storage and distribution of multi-INT data. The tCMS offers the ability to simultaneously monitor multiple areas or movers, from any data subsets, either in real-time or forensically, including over bandwidth-constrained links.

"This approach empowers algorithms and analysts to retrieve and exploit spatially and temporally relevant intelligence directly onboard the airborne platform," Bastedo explained. "Effectively, we are pushing the processing and fusion as close to the data sources as possible in a manner that allows us to reduce the overall quantity of data by immediately distilling it into actionable intelligence."

PV Labs has worked closely with Signal Innovations Group, for example, in demonstrating the ability to detect and track tens of thousands of moving targets simultaneously across the entire field-of-view of a WAMI sensor.

"This information is currently used to identify patterns of motion over large sections of an urban area," Bastedo said. "The PSI Vision system, using the real-time processing capabilities of the tCMS, enables real-time decision-making based on intelligence from WAMI data. The high quality and accuracy of the WAMI data collected combined with a robust tracking solution improves the analyst's operational efficiency and effectiveness by converting the pixels acquired in video and imagery into intelligence suitable for decision and action."

In addition to Jagwire—enterprise software for the management and dissemination of FMV, WAMI and static imagery—ITT Exelis is developing a video synopsis product that enables rapid and efficient data exploitation and reduces the discovery and exploitation time of WAMI. This wide-area video exploitation system is designed to fill the gap between advanced processing algorithms and the imagery analyst.

"The core of our video synopsis solution is the decomposition of geospatially consistent wide area aerial imagery," Ehrlich said.

Since wide area persistent surveillance video is characterized by long collections over a fixed region of interest on the earth, it is desirable to decompose the source video into background and foreground components. When separated into components, the data is less redundant, highly compressible, and may be used to drive advanced visualization.

"The decomposed imagery drives efficient visualization of the captured content," Ehrlich explained. "This is due to the capability being developed for recomposing a selection of the input data driven by a user query on a sub-frame basis. In the query, specification of a spatiotemporal region of interest is combined with parameters for determining the data of interest and composition instructions. The system is able to respond with video generated on-demand that is specific to the user's needs."

## *Video Standards*

PAR Government develops and distributes a software solution called GV3.0, which is free to U.S. government and authorized contractors. It is a lightweight, Java-based, platform-independent raster imagery and FMV viewing software application that supports management and playback of National Imagery Transmission Format and NATO Secondary Imagery Format raster imagery, and MPEG2 transport stream video data.

"GV3.0 is recognized in the DoD community as a go-to application for viewing imagery and video data in a myriad of DoD and commercial formats," LaClair added. "GV3.0 employs open video standards as defined by the Motion Imagery Standards Board and has been certified for fielded use."

PAR has also developed a commercial video framework as a software development kit (SDK) called Gv2F. Gv2F facilitates custom development of desktop and mobile solutions to ingest and manipulate compliant FMV with metadata.

"The SDK has been designed to efficiently and effectively embed support for FMV and imagery for commercial geospatial analysis software solutions such as Esri's ArcGIS 10.1," he said.

2d3 Sensing offers TacitView v3.1 and Catalina v2.1, which are modular, standards-based, COTS, service-oriented architecture/cloud-enabled motion imagery products designed to reduce workload and accelerate production timelines through an efficient and user-friendly architecture, explained Danny Proko, vice president of business development.

"We are continually adding modular capabilities through our internal R&D efforts to address the gaps identified during mission execution, which highlights our decreased time-to-field and the agility of a COTS solution," remarked Proko. "The architecture we have designed and built enables us to rapidly add new capabilities and technologies as they become available without having to refactor our existing codebase, and this open system architecture allows the rapid integration of third-party components, such as detection, tracking and characterization algorithms."

## *Future Directions*

For FMV technology to grow and mature to the point of real-time exploitation, LaClair maintained, the temporal aspect of motion video information needs to be addressed. "We do not need to treat the source as a static image. Much of the pertinent information is limited in its useful time to support actionable decisions."

As FMV collection sources continue to grow exponentially, so will the need for robust data management, processing, archive, retrieval and visualization.

"Adhering to existing and new metadata standards as well as developing secure applications are critical to the sustained, effective use of video data by analysts attempting to extract actionable information in real time," he said.

FMV is currently being utilized in many disciplines, including military, border patrol, public safety, emergency response, wildfire response, law enforcement and animation studios.

"Providing solutions to these diverse user requirements will require propagation of an architecture that readily allows the user organization to develop their own custom desktop, web based, or mobile application suite," LaClair concluded. "Being able to readily insert new application specific solutions into operations will be the key to continued effective use of FMV." ✭

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