

Video Analysis and Content Extraction (VACE)

Disruptive Technology Office



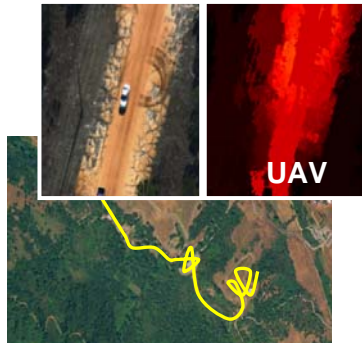
Exploiting all video in the 21st century

Program Overview

The Video Analysis and Content Extraction (VACE) program, an advanced research and development program in the Disruptive Technology Office (DTO) under the Director of National Intelligence (DNI), develops cutting edge technologies that automate the analysis of video for intelligence purposes. The proliferation of video has created a "tsunami of data" whose volume continues to expand exponentially thus requiring robust, automated video tools to support today's intelligence analysts. In addition the increasing military operational tempo results in diminished time for decision making. The VACE program objective is to develop innovative technologies to perform autonomous analysis on large volumes of video content that enables an intelligence analyst to efficiently use video as a source for multi-INT fusion. Video, while voluminous, is equally rich in content, both spatial and temporal. While one can extract "noun" descriptors from imagery, one can extract "verb" descriptors from video.

Video is an ever expanding source of imagery and open source intelligence such that it commands a place in the all-source analysis. Video content domains such as, surveillance, Unmanned Aerial Vehicles (UAV), meetings/conferences, ground reconnaissance, and broadcast news are sources of rich intelligence data that offer key insights into the context of particular actions and events. VACE technologies will

increase the effectiveness of analysts who now must spend valuable time manually extracting, annotating,



and analyzing an ever-increasing amount of video content in the pursuit of obtaining useful intelligence information.

The VACE is to achieve automated intelligence discovery from video at least equal to human accuracy and at speeds greater than real-time. Two guiding precepts that drive the VACE research are the ability to perform today's analyst tasks more accurately and more quickly and form the foundation of VACE's primary evaluation metrics - accuracy and speed. Thus, the intent of this research is not only to enable capabilities that did not exist before, but also to allow the automation of video analysis activities to achieve a DNI mission to *"analyze and disseminate accurate, timely, and objective intelligence..."* Accordingly, placing the VACE mission in that context, it is recognized that there is a great



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disparity between the current state-of-the-art and the necessary enabling technologies.

Early Successes

The VACE program provides funding for innovative, creative, high-risk research to achieve significant advancements in video content extraction technologies.

VACE technologies are already impacting the Intelligence Community via transfer into analyst applications.

- VACE UAV technology transferred to the Joint Warfare Analysis Center enables UAV exploitation.
- VACE-funded face detection technology was transferred to NSA, who is providing additional funding to move to a PDA.
- Many VACE funded video research technologies are feeding the commercial market. Technologies are being integrated into existing commercial products, such as *InforMedia*, *TerraSight*, *VideoFOCUS*, *MARVEL*, *AlertVideo*, *Digital Video Manager* by companies including CMU, IBM, Honeywell, Salient Stills and Sarnoff Corporation. For example video resolution enhancement technology was transferred to the FBI Forensics via *VideoFOCUS*



Moving Motion Imagery Video into All-source Analysis

Technical Challenges

The VACE Program investigates innovative algorithms and implementations that represent revolutionary advances in automatic video content extraction, multi-modal fusion, event recognition and understanding – all leading to automatic machine reasoning. These technologies are being applied across a broad front of motion imagery video sources: Broadcast News (domestic & foreign), Meeting/Conference, Surveillance, Ground Reconnaissance, and Unmanned Aerial Vehicle (UAV). While each video source represents unique challenges there is also common ground to provide:

- Significant improvement in indexing and retrieval performance for video data
- Autonomous video understanding
- Ancillary improvement for still image processing of key frames extracted from video stream
- Enabling the development of advanced applications/processing functions for video query/retrieval, video browsing, video monitoring, video mining, and content-based routing
- A drastic reduction in volume for video storage and forwarding mechanism by pushing processing to the sensor

International Collaboration

In recent years, VACE has expanded the community-of-interest participating in the advancement of

video analysis technologies that spans the globe. Evaluation of video technologies is primarily an international activity, which has established a structured process and standard algorithms and metrics to evaluate video analysis technology. International partner nations have also performed extensive data collection that can be leveraged as a valuable data source by U.S. video technologies. For these reasons, the VACE Program continues to build relationships with international partners resulting in increased collaboration opportunities.



Relationships have been established with the UK Ministry of Defence, the European Commission, and the Canadian National Research Council (NRC). Collaboration with the



international community will facilitate the sharing of data and technology for the mutual advancement of state-of-the-art video analysis technology.

The Road Ahead

Phase III of the VACE Program kicked off in November 2006 and will continue through September 2009. This phase of the program is focused on extending and enhancing the capabilities that are specific to video – such as developing techniques that exploit the temporal and motion properties of video image sequences. It will also focus on the longest-range goals of video exploitation, such as the understanding of the video content and recognition of specific events. This research will build on and expand the research successes of previous VACE phases that provided the core foundation for video extraction and analysis technologies. In addition the research will expand to encompass new, emerging video sensors and to meet the ever evolving intelligence needs.

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