# Computer Vision for Homeland Security:
## *A Perspective on its Promise and Pitfalls*

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In a matter of only about three decades, Computer vision as a discipline has made a significant impact on a number of diverse application domains. Beginning from the seventies through the nineties, computer vision started proving its practical value in a wide range of diverse application domains including medical diagnostics, manufacturing, environmental monitoring, space exploration, and military systems such as automatic target recognition, precision weapons, and reconnaissance.

It was therefore no surprise that when the very first set of request for proposals (RFP) from the Combating Terrorism Technology Office of the Technical Support Working Group (TSWG), managed by the U.S. Secretary of Defense was announced on October 23, 2001 (about five weeks after the September 11th attacks), several computer vision related research topics were prominently listed in the new research thrust areas[1]. Research projects were solicited with specific objectives of rapid prototypes to be developed in less than two years. The RFP had an overwhelming response with over 12,500 initial proposal submissions. After three levels of reviews, TSWG issues about 10 research contracts seeking novel computer vision concepts in late 2002. The newly established Department of Homeland Security (DHS) also recognized the importance of computer vision field, when one of its very first set of RFPs issued in April 2004, was titled "Automated Scene Understanding".

In addition to the above Department of Defense and Homeland Security programs, many other science and technology related agencies in the Government, including the National Research Council, encouraged realignment of research agendas and programs to support homeland security applications [2]. For example, National Science Foundation sponsored a number of workshops to identify and encourage research in cyber-infrastructure and sensor networks fields[3]. Computer vision was once again identified as an important topic and in the NSF report highlighted the need for developing "ubiquitous vision" with networked and cooperative arrays of cameras.

Computer vision, thus promises to play a significant role in a wide range of Homeland Security applications. The objective is to apply computer vision techniques and algorithms under various environmental conditions for security, surveillance, and protection of physical infrastructures under human and vehicular threats. Our team, over the past several years, has stayed involved in a number of research projects dealing with the above listed topics. A key element of our activities

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[1] USD (AT&L)/TSWG, Board Agency Announcement 02-Q-4665, Oct. 2001.

[2] Making the Nation Safer: The Role of Science and Technology in Countering Terrorism, National Research Council Report, *US National Academics Press*, 2002

[3] Cyber infrastructure Research for Homeland Security, National Science Foundation Workshop Report, February 2003.

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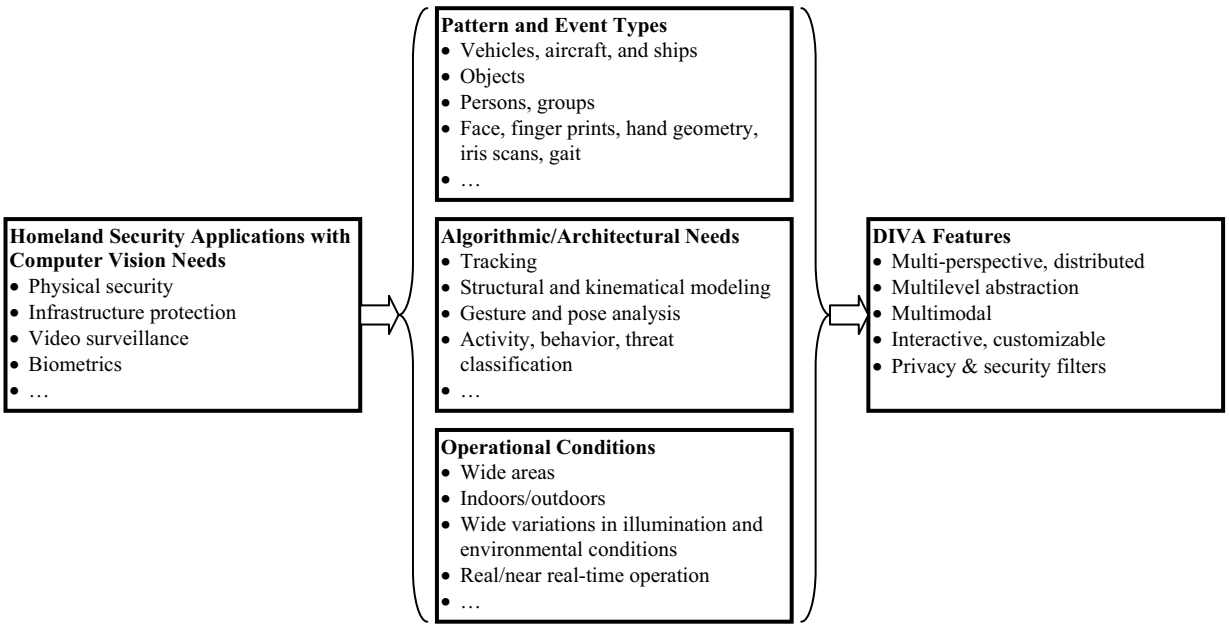
is the utilization of arrays of video cameras, distributed over a wide area, which can provide multiple levels of semantically meaningful information ("situational awareness") to match the needs of multiple remote observers. Key Homeland Security applications where computer vision plays critical role are highlighted in following figure, along with the algorithmic and operational requirements. Distributed Interactive Video Array (DIVA) is a framework we propose to effectively support the development and deployment of powerful vision and visualization systems. The Distributed Interactive Video Array (DIVA) system is developed to provide a large-scale, redundant cluster of video streams to observe a remote scene and to supply automatic *focus-of-attention* with *event-driven servoing* to capture desired events at appropriate resolutions and perspectives. Installing multiple sensors introduces several new research issues related to the system design, including handoff schemes for passing tracked objects between sensors and clusters, methods for determining the "best view" given the context of the scene, and sensor fusion algorithms to best employ the strengths of a given sensor or modality. Utilizing overlapped coverage, DIVA also performs 3-D tracking and human gesture and face analysis.




**Computer vision for Homeland Security: Application drivers, Algorithms, Operational conditions, and DIVA-based implementation framework.**

In this presentation, we will start with a discussion of the role of computer vision in Homeland Security. We will present an overview of the DIVA framework and its key features, describe experimental results of DIVA for observing roads, bridges and perimeters, present DIVA-based person tracking, face capture, and gesture analysis modules, as well as an integrated situational awareness system. These DIVA applications have been successfully deployed and tested at the

SuperBowl 2003 (the most popular football match in the USA)[4], Coronado Bridge[5], and roadways of San Diego for almost four years, proving the relevance and initial value of computer vision based systems in Homeland Security. The presentation will conclude with a discussion of the key, outstanding research issues which demand careful examination before reliable, robust, and practical solutions for Homeland Security applications are found and adopted. These issues not only deal with important scientific and technology matters, but more importantly with some fundamental issues such as the rights of individuals and those of the society at large[6] .

[4] Researchers Work With Public Agencies to Enhance Super Bowl Security
http://www.calit2.net/news/2003/2-4_superbowl.html

[5] Researchers Demonstrate Potential of Multi-use Sensor Networks for Homeland Security and Other Monitoring on Coronado Bridge http://www.calit2.net/events/2002/7-17-bridge.html

[6] Legal and Technical Challenges to Video Surveillance. March 29, 2004.
http://www.calit2.net/technology/features/3-29_trivedi.html