

Automatic Target Recognition

SAR ATR Mission

Synthetic Aperture Radar (SAR), first developed in the 1950's, has become an increasingly critical technology for military applications. SAR sensors play a key role in surveillance and reconnaissance missions because they can image ground targets at extremely high resolutions and long ranges, even through clouds and in darkness. SAR Automatic Target Recognition (ATR) systems are designed to rapidly and reliably identify time-critical military targets in SAR imagery.



A Scud missile launcher is one of the time-critical targets that our ATR has been trained to locate in SAR imagery.

ATR Experience

Sandia's Signal and Image Processing Department has designed ATR algorithms for SAR sensors since 1986. We were the first to demonstrate real-time SAR ATR capability in 1991, on board the Department of Energy's De Havilland DHC-6 Twin Otter aircraft. Since then, Sandia has been the leader in SAR ATR technology, integrating the latest hardware with innovative recognition algorithms.



The system shown above has demonstrated real-time ATR performance in a small, rugged package. (17.5"x17.5"x19.5")

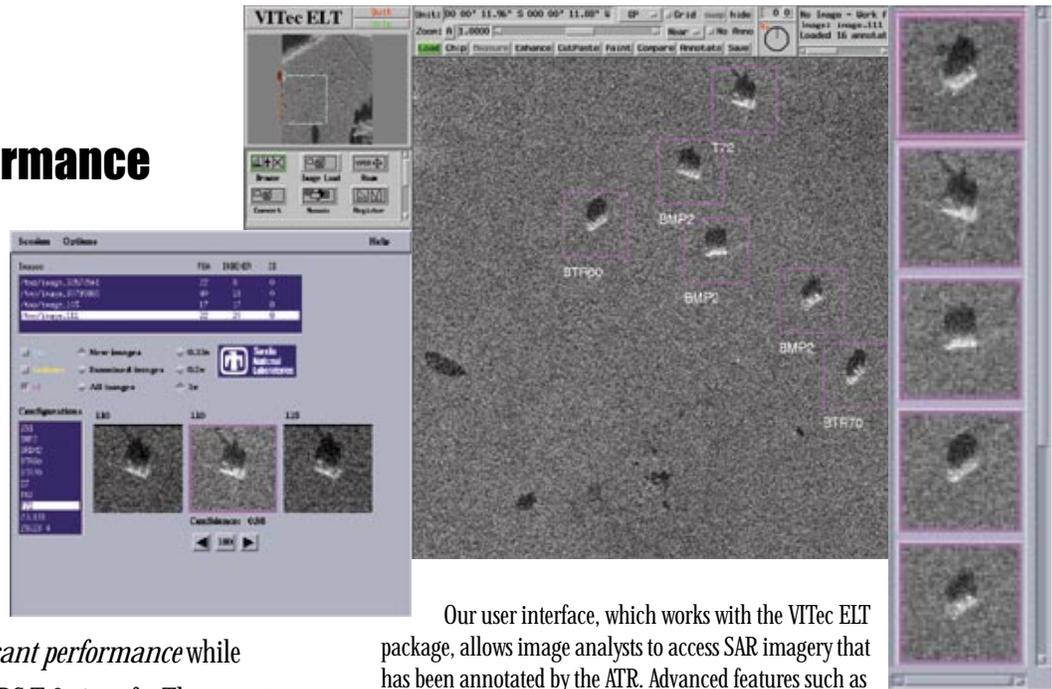
Scalable Real-Time System

ATR real-time requirements include both high throughput rate and low latency. For conventional image sizes, the latency between receipt of the SAR image and ATR results is typically less than 10 seconds. The basic configuration of our all-COTS real-time ATR has 12 PowerPC 300 MHz CPUs and can process imagery at the rate of one Megapixel per second for 10 targets of interest. The CPU requirements of our ATR system scale linearly with respect to pixel rate and number of targets. The 6U VME rack shown above can accommodate 64 CPUs, which enables us to upgrade the system to allow data rates as high as five Megapixels per second for 10 targets of interest or 50 targets of interest at one Megapixel per second without changing the 3.5 ft³ size of the ATR system. Upcoming advances in CPU performance will triple our current capabilities by the end of the year 2000.



Proven Performance

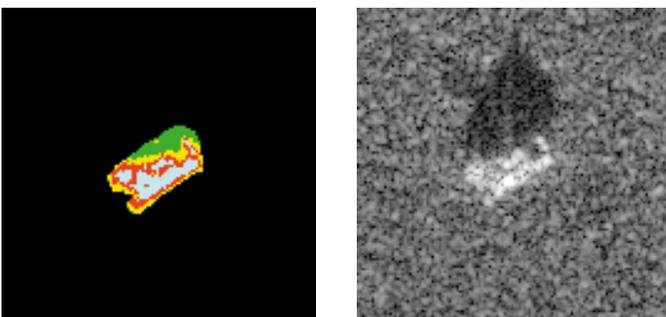
Sandia's ATR systems are designed for operational deployment in rugged environments such as onboard aircraft and in mobile groundstations. In an independent evaluation of the ATR's effectiveness by the Joint Test Force during the EFX '98 exercise, Sandia's ATR system was judged by the JTF to have *operationally significant performance* while running in real-time on the Joint STARS T-3 aircraft. The report stated, "This test proved the feasibility of real-time ATR on Joint STARS. ... in the JTF's opinion, the ID accuracy and false alarm rate are extremely encouraging ..."



Our user interface, which works with the VItec ELT package, allows image analysts to access SAR imagery that has been annotated by the ATR. Advanced features such as softcopy keys help analysts compare objects identified by the ATR with exemplars from our target signature database.

Innovative Algorithms

A cornerstone of our ATR product is the capability to perform in-house development, testing, and real-time implementation of powerful algorithms for target recognition. In the algorithm development phase, the expected appearance of target vehicles in SAR imagery is modeled from available data. The degree to which target images may be expected to vary about this model, under operational conditions, is also quantified.



A statistical target model for one of the ATR's identification algorithms is depicted along with a one foot SAR image of the target vehicle, a T72 tank.

Statistically robust match metrics gauge the level of agreement between target models and unknown objects in new SAR imagery. These metrics are derived from rigorous mathematical principles and are specifically designed to perform well in the presence of target signature variabilities arising from diverse sources such as articulating or rotating target parts; changing background surfaces and vegetation; partial target obscuration; and attempts at camouflage, concealment, and deception.

About Sandia National Laboratories

Sandia National Laboratories is a multi-program laboratory operated for the United States Department of Energy. Sandia's Signal and Image Processing Department's mission is to develop SAR ATR and other image exploitation technologies.