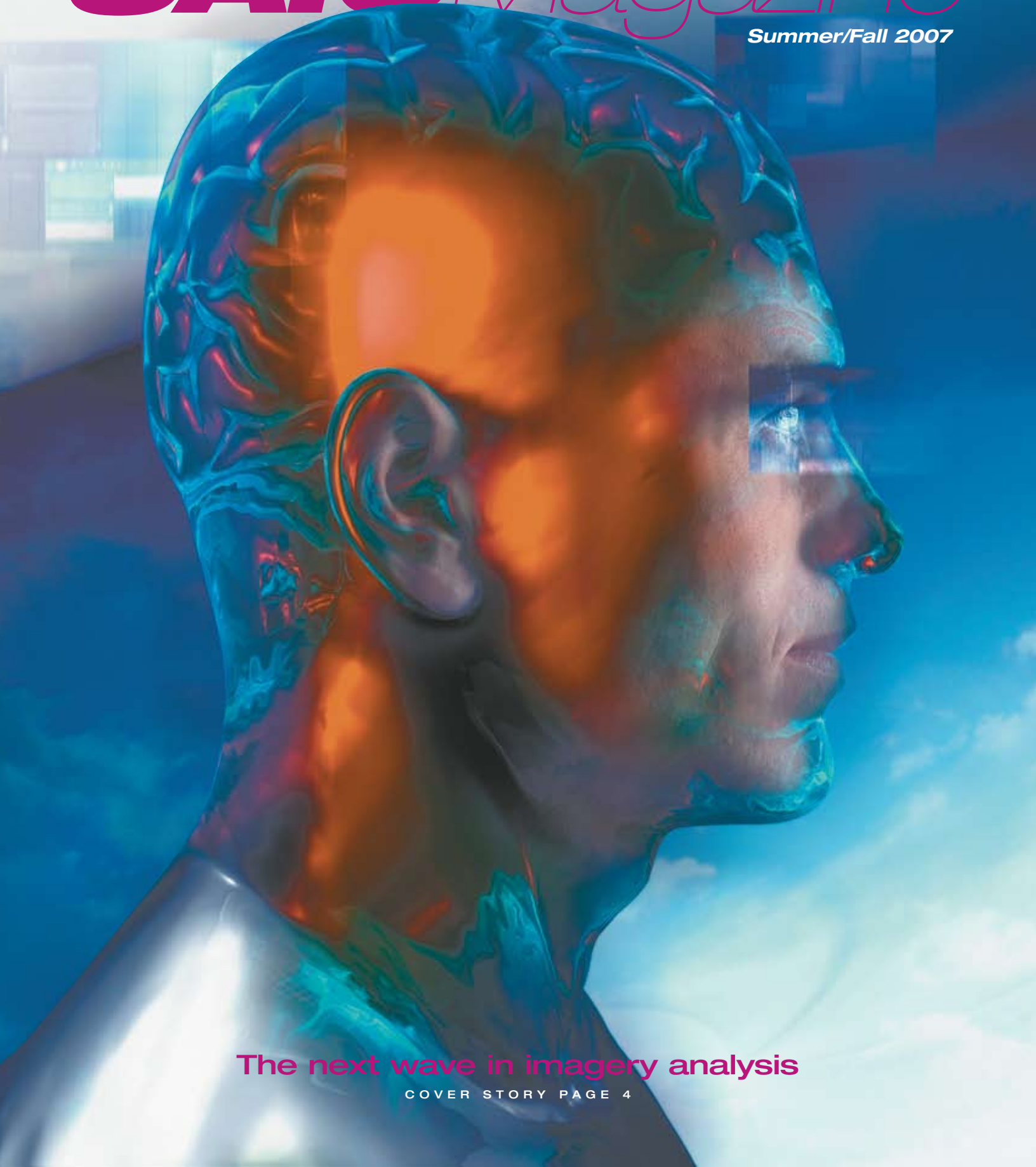


SAIC Magazine

Summer/Fall 2007



The next wave in imagery analysis

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Vernon Guidry, Director, Communications



SAIC employee's research in Niger yields optimism for Africa

What SAIC's Gray Tappan has found in the sub-Saharan nation of Niger is turning conventional environmental expectation on its head.

"We're seeing two things," Tappan said. "The areas that are not farmed, such as the savannahs, have a loss of vegetative cover and a loss of species. These are very serious things. But, the

surprise – and this is gaining a lot of attention among our peer scientists – is that we're seeing an increase in tree density and biological diversity in agricultural areas, the areas with most people. This is counter to what you would expect to find."

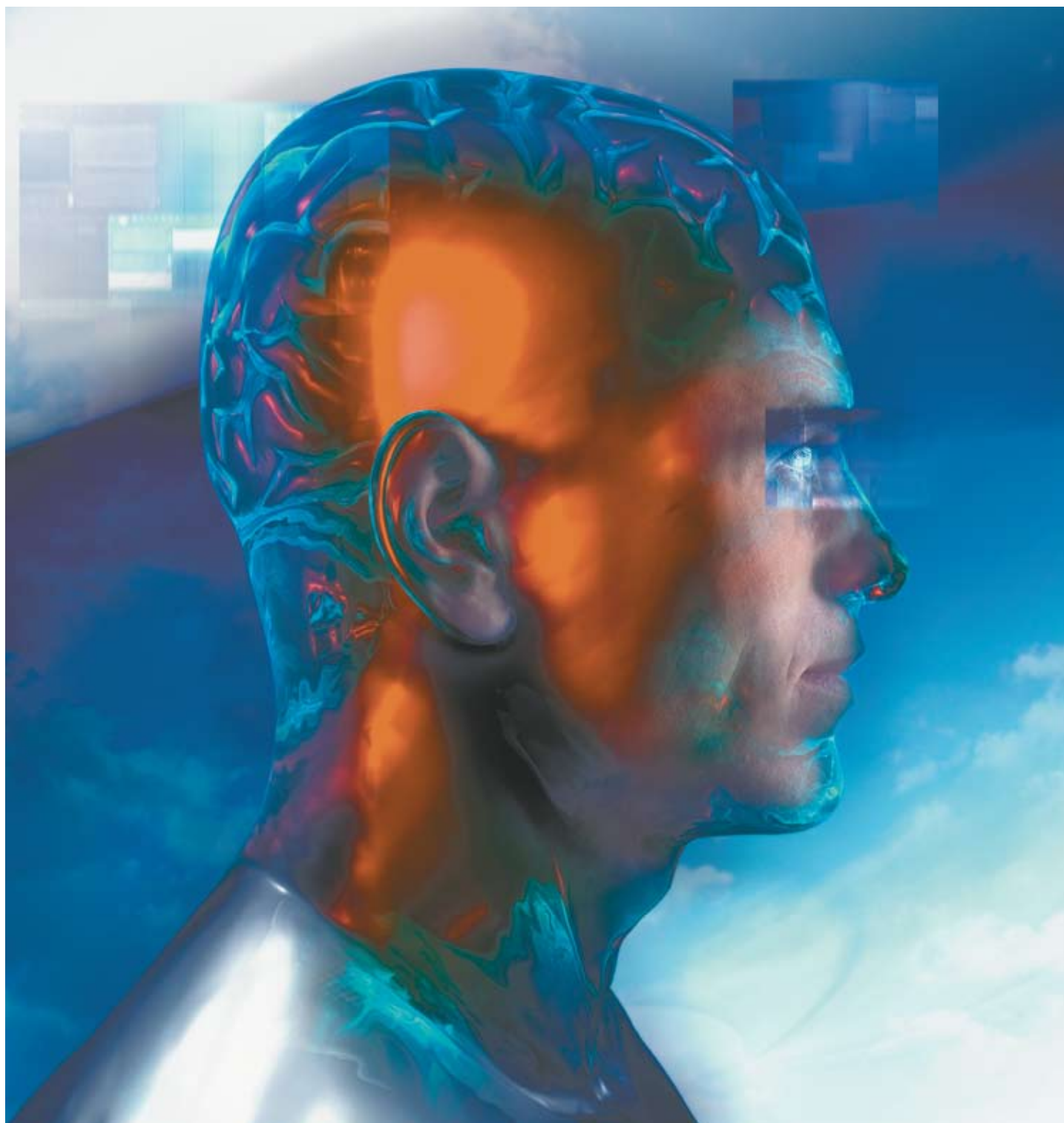
In fact, the tree cover in this area of Niger is five to 20 times more dense than in the 1970s. In addition to the Landsat images provided by the Center for EROS, which SAIC helps run, this determination comes from assembling aerial photos and interviewing local farmers.

Tappan is a geographer working for the U.S. Geological Survey's Center for Earth Resources Observation and Science (EROS). He is part of a worldwide team conducting research into long-term land cover changes in Niger. Using satellite images from the Center for EROS and decades old aerial photographs, Tappan is mapping and quantifying land use to achieve a long-term view of what is happening to the environment.

"There's a real special thing happening in Niger. When the farmers found themselves in a severe drought in the 1970s and

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Neural nexus with computers ***speeds imagery analysis***



S

atellites and unmanned aerial vehicles are generating vast amounts of imagery, facing analysts with an increasing challenge: how to move quickly through these images to find the intelligence payoff. Despite increasing computer capacity and speed, and

more sophistication in software, efforts to automate information extraction have not succeeded.

SAIC, however, is helping pioneer a way to rapidly prioritize large volumes of imagery by measuring and discriminating brain signals that are triggered when analysts see something interesting in the images. The work has the potential to change the way people interact with computers.

As it turns out, the brain's visual pattern recognition system spots things more quickly than the mind registers them cognitively. Humans notice things before they know it. In fact, neural responses occur within a few hundred milliseconds after an image is presented.

Laurie Gibson, a chief scientist at SAIC, was involved in an experiment that analyzed brain signals of experts who looked for ships in satellite imagery of coastal areas across the world. The images were flashed at a rate of five to 10 per second on a computer monitor, far more quickly than they would normally process imagery. The analysts' brain signals were collected with a neural sensor net and relayed to a computer. The brain signals were automatically classified based on whether or not the neural activity signaled that the imagery experts detected changes in the images. This classification prioritized the most relevant images for further review.

With this method, image analysts searched 65.8 square kilometers of imagery at a rate of 2.21 square kilometers per minute. To compare this to current image analysis techniques, Gibson ran a baseline experiment. This experiment required analysts to

"This has the potential to change the way that people and computers interact."

— Laurie Gibson, SAIC chief scientist

decide which images – shown on monitors in pairs – were potentially relevant and then use software tools to tag them for further review.

The results of the research, done in conjunction with the University of Colorado and sponsored by the Defense Advanced Research Projects Agency, were significant. Analysts using standard techniques searched only .21 square kilometers per minute. This meant that analysts examined 10 times more imagery using the neural change method.

According to Gibson, the research provided a good foundation for a tool to rapidly filter streams of images with significant content. In fact, depending on how fast the imagery can be presented to the analyst and how rapidly the neural response can be processed, this approach has the potential to greatly speed up the review of large volumes of data. The research also demonstrated the feasibility of an image system based on the neural response of experts to visual change.

"SAIC is funding us under IR&D [independent research and development] to look at a number of applications for this technology," Gibson said. "This has the potential to change the way that people and computers interact."

For more information, contact Laurie Gibson at laurie.d.gibson@saic.com

SAIC helps Virginia become a maritime

renewable energy research leader

SAIC is a key business ally and a prime mover behind the Virginia Coastal Energy Research Consortium (VCERC), an effort aimed at renewable marine energy technologies and production.

For several years, SAIC has pursued the concept of marine renewable energy as a logical extension of the company's work in naval undersea and ocean observation applications. SAIC's Neil Rondorf conceived of and led the effort to establish VCERC at Old Dominion University, in Norfolk, Va.

Based on his observation of trends within the European energy industry and their significant use of offshore renewable energy, particularly wind technology, Rondorf began looking for similar

opportunities on the East and West Coasts of the U.S.

VCERC is the East Coast opportunity, and the vision behind it was to join together the expertise and intellect from academia and industry to solve the challenges to renewable maritime energy in North America. A strong supporter of this endeavor was State Sen. Frank Wagner (R), whose district includes the northwestern portion of Virginia Beach.

A promising technology

Rondorf is vice president, maritime technologies, and manager of the Maritime Engineering and Marine Operations divisions in the Defense and Maritime Solutions Business Unit. Rondorf said he felt it was

natural for SAIC to focus on maritime renewable energy technologies given SAIC's strong credentials in naval undersea systems, and "because maritime renewables were among the least mature, but most promising, of the energy industries."

VCERC examines a diverse set of maritime renewable energy sources. The most well-known is wind, but VCERC research priorities also include tidal and wave energy, and the cultivation of marine algae for conversion to biodiesel and other fuels.

"Just looking at what has been accomplished in Europe," Rondorf said, "we felt that renewable maritime energy technologies could supply a significant percentage of the future energy demand on

the U.S. coasts." Initial estimates forecast that offshore wind energy can supply up to 20 percent of Virginia's energy demand. "Therefore," he said, "creating VCERC was essential to establishing Virginia's leadership role."

A renewable energy model

State Sen. Wagner recognized SAIC's support to bring about the VCERC concept: "The Commonwealth of Virginia and those working to address our energy future are grateful for SAIC's vision and commitment to finding workable concepts to bring energy solutions to Virginia. The creation of VCERC and SAIC's contribution to it will go a long way to beginning the

SAIC technology may help spur space exploration

SAIC is helping NASA make a rendezvous with the future. Experts from SAIC's bd Systems subsidiary have developed a simulation package, known as SPARTAN, to test next generation sensor technologies and algorithms involved in automating rendezvous and docking missions – the autonomous joining of two vehicles in space.

In the future, NASA wants to automate rendezvous and docking missions as part of its new Vision for Space Exploration. This initiative involves using the shuttle to complete the space station, then retiring the shuttle and building a new generation of spacecraft to venture out into the solar system. Because technical communications are problematic during lunar operations and not practical for Mars operations, automating rendezvous and docking missions – which allows for significantly less support from the ground – is critical.

"It is very exciting to be working on a system that we believe will help our country get back to the moon," said SAIC's Kevin Betts, an engineering director in Huntsville, Ala. "We live in Rocket City, and the excitement of moving back to an exploration mindset is very tangible in our city. We are happy to play our part in helping make that journey possible."

One of the things that distinguishes SPARTAN, which stands for Simulation Package for Autonomous Rendezvous Test and Analysis, is its ability to run simulations involving all elements of the automated rendezvous and docking system.



"It can be used from cradle-to-grave for space development programs, with front-end use during the concept of operations development and hardware architecture trade studies and back-end use as the simulation environment for algorithm development and ultimately hardware-in-the-loop testing prior to deployment," Betts said.

There also could be significant potential benefits to SAIC based on this work for NASA, according to Betts.

"We're focused on expanding the offerings we can make to vehicle prime contractors," Betts said. "Instead of delivering a single payload or algorithm, we're working to provide intelligent products – hardware and software tied together – that can be used to provide an integrated solution. This would allow SAIC to provide even more value to our current commercial and government customers."

In addition, SAIC's work on SPARTAN may become valuable in the new domain of space superiority.

"The ability to rapidly assess sensor performance and autonomous algorithms that can react quickly to changing threats are highly valuable capabilities to apply to this arena," Betts said. "The U.S. space superiority is focused on situational awareness and potential defensive countermeasures if a U.S. asset is attacked. Since other countries focus significant effort on offensive space capabilities, the ability to simulate offensive space tactics becomes necessary to develop the effective defensive strategies."

For more information, please contact Kevin Betts at kevin.m.betts@saic.com



SAIC promotes cutting-edge research through its SAIC Technical Fellows Council (STFC) publication awards. Since 1984, the STFC (formerly the Engineering Science & Technology Council) has recognized outstanding technical and scientific papers and books written by SAIC scientists and engineers. Here are summaries from two award-winning papers.

SAIC software detects

stealthy asteroids

About 65 million years ago an asteroid six miles in diameter struck what is now Mexico's Yucatan Peninsula. Many scientists contend that the impact, which possessed the energy of 30 million nuclear weapons and created temperatures hotter than the sun's surface, helped kill more than half of the Earth's plant and animal species.

While the need to detect such "killer asteroids" is obvious, smaller "near-Earth asteroids" (NEA) can also cause devastation. In fact, NASA set a goal to identify 90 percent of the NEAs that measure one kilometer in diameter or larger by 2008. As this deadline approaches, the search has become increasingly difficult since many of the larger and brighter asteroids have already been discovered.

To increase the discovery rate of near-Earth asteroids, researchers need to survey a deeper volume of space, including densely cluttered star fields. As described in his STFC Award-winning paper, SAIC's Peter Gural (and colleagues) developed software that used matched filter image processing to better detect asteroids.

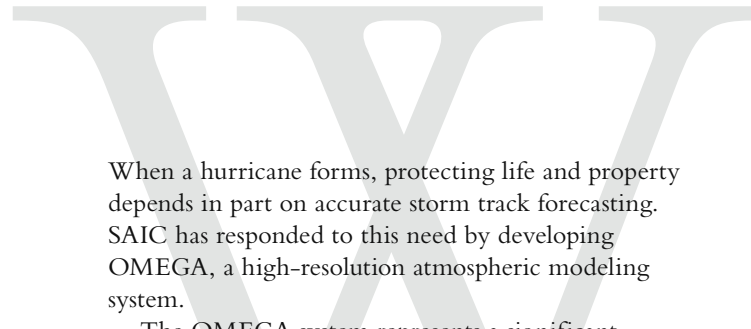
This software – SAIC Algorithmic Testbed for Asteroid Detection (SALTAD) – extends detection ranges to distant asteroids to better help identify asteroids in densely cluttered starfields (most asteroids orbit in the main belt between Mars and Jupiter). The University of Arizona has incorporated SALTAD into its Spacewatch project – in fact, SALTAD's matched filter approach has been shown to detect 40 percent more asteroids in Spacewatch imagery than their existing software

implementation. (The goal of Spacewatch is to study the statistics of asteroids and comets to better understand the dynamical evolution of the solar system.)

In addition, applying matched filtering to near-Earth asteroid recovery and tracking operations is, according to the authors, an application of this technology that can be fielded with minimal processing capability. In fact, Gural and associates have developed a software package – available from SAIC with NASA approval for release – that scientists can use to detect near-Earth asteroids.

The paper, "Matched filter processing for asteroid detection," was published in the October 2005 issue of *The Astronomical Journal*.

For more information, contact Peter Gural at peter.s.gural@saic.com.



When a hurricane forms, protecting life and property depends in part on accurate storm track forecasting. SAIC has responded to this need by developing OMEGA, a high-resolution atmospheric modeling system.

The OMEGA system represents a significant departure from traditional weather prediction methods because it melds modern grid generation technologies from the computational fluid dynamics realm with the state-of-the-art numerical weather prediction techniques (which use mathematical models to predict weather).

OMEGA dynamically adapts its computational grid during a simulation to provide high resolution in regions where storms can potentially develop, and it resolves important features of atmospheric circulation and cloud dynamics as they appear.

In fact, OMEGA can provide continuously variable resolution from 100 kilometers over the oceans to less than 10 kilometers over other regions of interest. This flexibility helps enable more accurate forecasts in a computationally efficient manner.

A central element of OMEGA is its hydrodynamic solver. SAIC researchers applied the solver – multidimensional positive definite advection transport algorithm (MPDATA) – to the unstructured triangular grids that OMEGA generates.

The MPDATA improves the efficiency of OMEGA's real-time atmospheric flow simulations, which require a lot of computer processing time for calculations related to planetary boundary layer physics, atmospheric radiation heat transfer, and cloud microphysics.

In their STFC Award-winning paper, SAIC authors Nash'at Ahmad, David Bacon, Mary Hall, and Ananthakrishna Sarma implemented MPDATA on an unstructured grid and demonstrated its accuracy and efficiency using analytic and idealized test cases.

The paper, "Application of multidimensional positive definite advection transport algorithm (MPDATA) to environmental modeling on adaptive unstructured grids," was published in the on-line December 2005 edition of the *International Journal for Numerical Methods in Fluids*.

For more information, contact Nash'at Ahmad at nash'at.ahmad@saic.com.



SAIC ALGORITHM IMPROVES

weather
forecasting

SAIC helps Virginia CONTINUED FROM PAGE 7

process of researching our maritime resources in an environmentally responsible way.”

SAIC’s collaboration with State Sen. Wagner, “the Virginia energy guru,” resulted in the Energy Policy Act of 2006, which established VCERC as an interdisciplinary study, research, and information resource on coastal energy issues. Earlier this year, Virginia Governor Tim Kaine signed the budget that provided VCERC with \$1.5 million in initial research funding to begin to address coastal energy issues.

“We wanted to establish credibility and define issues,” Rondorf said. “We’re looking to establish a broad base of information for engagement so we can keep the discussions factual and not emotional, so that we don’t run up against the sort of issues that derailed the Cape Wind project in Massachusetts.”

The Cape Wind project faltered in part due to a poor understanding of the interrelated issues associated with maritime renewable energy generation, and the impact on the other traditional users of the ocean space. Part of the VCERC mission is to identify those concerns and develop ideas on how to address them constructively.

The VCERC approach accounts for factors that may not be obvious to a company whose sole goal is the development and promotion of a single technology.

“SAIC brings a technology-neutral and science-based perspective to find the right technology solutions for the future,” Rondorf said. “We don’t have a product we’re selling – we’re trying to find the most cost-effective and efficient energy solution, with the least amount of impact.”

With VCERC, Rondorf said, “what we’ve tried to establish is a resource available to the Commonwealth of Virginia, but it will apply to the state agencies up and down the East Coast and businesses interested in engaging in maritime energy development. We have huge offshore resources on the East Coast, but little resident expertise in maritime energy development. This was a way to provide that expertise. We want other states and businesses to be able to come to Virginia and say, ‘Hey, they’ve done their homework.’”

Environmental compatibility

That homework includes “being out there in an environmentally compatible way,” which means looking at the impact to all stakeholders – migratory fowl, the fishing industry, other marine species that might be impacted, the military, and the ocean

biosphere as a whole.

“If we do that,” Rondorf said, “then we’ve also created the possibility for aquaculture or other resource development,” including wind turbines that are designed to last for decades, built on artificial reefs that could support fisheries. There are ways to develop energy resources that can help the nation that enhance the environment that traditional users are trying to protect.”

Looking at offshore energy from every angle and developing the issues and their solutions could result in more than just maritime energy generation.

For example, using algae as an energy source is an example of the significant potential for creative energy solutions. Certain kinds of algae produce considerable quantities of oils, which can then be converted to bio-diesel or solid fuels that could replace coal. And not only does algae consume carbon dioxide and produce oxygen during photosynthesis, it can also absorb other greenhouse gasses, such as nitrogen oxides. An extremely hardy plant form, it can grow nearly anywhere, even in sewage, and in temperatures that range from boiling to frozen.

Rondorf’s knowledge of the maritime environment run – you might say – deep. An oceanographer by training and a submariner by vocation, he spent 27 years on active duty in the Navy before coming to SAIC six years ago. His experience gives him unusual and valuable insight. “My experiences with physical oceanography and living in a controlled, deepwater environment have influenced my every day life,” he said of his long Navy experience.

One piece in the energy puzzle

Rondorf is quick to point out that there is no one single energy source that is going to make this country energy independent. But marine renewable energy is attractive for a variety of reasons. One of those is that the other primary energy sources in Virginia, nuclear, coal and natural gas, are experiencing increasing demand by industry, but their current output is not increasing to match that demand.

The demand pressure on the natural gas industry due to its clean production capability is in turn putting tremendous pressure on manufacturing sectors, which is why the Virginia Manufacturers Association has embraced the maritime renewable energy concept.

For further information, contact Neil Rondorf at neil.e.rondorf@saic.com. Also, visit: www.vcerc.org www.odu.edu/ao/research2/vcerc/ www.odu.edu/ao/instadv/vol36issue11/news.htm#energy

Research in Niger CONTINUED FROM PAGE 3

again in the 1980s, there was crop failure and food shortages and extreme hardship,” Tappan said. “They realized that they had to do something different because drought is part of the story of this land. So, they began to protect the trees that naturally regenerate their fields. This is not a story of an outside agency coming in and planting trees for them.”

According to Tappan, trees increase soil fertility, which leads to higher crop production. In fact, trees are becoming a permanent secondary crop to help survive drought years. They can be harvested for fruit or sold for firewood.

“We’re seeing these incredible behavior changes,” said Tappan. “The farmers are very aware of the threat posed by the desert advancing on them and by the steep rise in population.”

Although Tappan has talked to farmers about past

conditions and how they reacted to them, he said that more research is necessary.

“We have more work to do in the field to get down to the specific reasons why this is happening,” Tappan said. “We see it, but the reasons are more theory at this point.”

In addition, Tappan said that nailing down the specifics of what has happened in Niger may have far-reaching benefits.

“We’re interested in how to replicate the spread of this positive transformation to other countries in West Africa, such as Mali, Burkina, and Senegal,” said Tappan, whose team has given cabinet-level presentations to Niger’s government.

For more information, contact Gray Tappan at g.gray.tappan@saic.com

Urban Reality CONTINUED FROM BACK COVER

Division, which also developed a ruggedized version of the system for the military.

“As we supported numerous requirements for airborne imagery missions in the post 9-11 era, it quickly became apparent with the global war on terror and urban warfare that we needed something that captured the immense details down on the ground. Things you couldn’t normally see from various altitudes,” said Turner. “This new generation of 3D data could support mission rehearsal, counter sniper, situational awareness, robotic navigation, vulnerability assessments, things like that.”

The ruggedized version of the system, which can be mounted in a Humvee turret, is designed to help provide warfighters patrolling an urban environment with an up-to-date, high-resolution model of the urban terrain that can be viewed, manipulated and analyzed.

“For example, it can help with mission rehearsals and plan convoy routes. Where am I most vulnerable? If I’m standing on this building, what would I see? Who can see me? Where are the potential sniper locations? What’s the best route for a robot or unmanned vehicle to take through a city to avoid obstacles?” Turner says.

Building on lessons learned from that effort, Turner is currently managing an SAIC-funded internal research and development project to commercialize the system.

“That’s how Urban Reality was born,” he says, adding that state and local governments and commercial

customers can benefit from a system like Urban Reality that can help them to better plan and coordinate engineering, utility, and construction operations, including “as built” analysis, site and damage assessment, and site re-engineering, to cite just a few examples.

A key component of Urban Reality is a hardware synchronization box. “We call it the ‘heart beat system.’ It’s basically a device that synchronizes the cameras, the lasers, the GPS, and the inertial navigation system,” Turner said.

The 3D databases can be exported into numerous formats or viewed and analyzed directly with SAIC’s custom 3D visualization software. Mission processing software uses post-processed differential GPS to turn the LIDAR data and imagery into georegistered colored point clouds with 5-10cm resolution and sub-meter georeferencing.

Turner came to SAIC in 2006 when Geo-Spatial Technologies, Inc. (GSTI), was acquired by SAIC and transitioned to SAIC’s Technology and Advanced Systems Business Unit.

A leader in high-resolution 3D mapping, imaging, and visualization technology for the Department of Defense, GSTI worked with revolutionary laser sensor and video technology hosted in unmanned aerial vehicles, land vehicles, and man-portable operations.

For more information, contact Jeff Turner at jeff.turner@saic.com

URBAN REALITY

taking 3D mapping to the street



At first glance, it looks like your average luggage carrier case sitting on top of a car roof. But packed inside is a state-of-the-art mobile mapping system that can rapidly capture and process the three-dimensional (3D) detail of a city for interactive visualization and analysis.

By providing more accurate and precise 3D models of urban features at ground level, the mobile system is designed to surpass the capabilities of current airborne and terrestrial tripod collection systems.

SAIC's Urban Reality™ system consists of

lightweight LIDAR (Light Detecting and Ranging) sensors, high-end digital cameras, GPS, inertial navigation, sensor control software, and other components that can be mounted on the top of virtually any vehicle. As the vehicle navigates a city, the system rapidly collects high-resolution 3D models of the urban features and structures that can be used for a broad spectrum of operations.

In addition to military, homeland security, and law enforcement applications, the system has widespread applications for the commercial world, said Jeff Turner, chief technology officer of SAIC's Geospatial Technologies

CONTINUED ON PAGE 15