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GSFC NEWS

tech transfer

From Left: Dr. Anthony Yu, Philip Dabney, and Dr. David Harding, with the Slope Imaging, Multi-polarization, Photon-counting Lidar (SIMPL)

Photo Credit: Chris Gunn

Medical Imaging and Health Care Issue

in this issue:

from the chief

Nona Cheeks

In this latest issue of the *Goddard Tech Transfer News*, we look at a number of GSFC technologies that may have significant value in medical and health applications. For some of these technologies, their medical use is already well defined and developed. For others, their utility within the medical field is only just beginning to be explored.

As you read this issue, you'll notice a consistent theme running through these articles: each of these technologies was originally designed to support space science missions, with very little thought given to its possible medical use. But when viewed from a different perspective, a technology invented for one purpose may be equally valuable for another, seemingly unrelated one. Thus an algorithm created as an aid for the development of autonomous control can be used as the core of an effective dietary program, extraction and enhancement techniques designed for planetary and lunar photography can be utilized in medical imaging, and a multi-camera system intended to help planetary probes keep their landing spots in view can be adapted to a pill-sized platform for imaging a patient's digestive tract.

How these and other inventions found their way into the medical arena makes for very interesting reading. For instance, note the article on the Hierarchical Segmentation (HSEG) algorithm, an image enhancement method that now forms the basis of a commercial, FDA-approved medical imaging technology. The key event that brought HSEG to the attention of the medical community was a workshop hosted by my office, the GSFC Innovative Partnerships Program Office. In attendance that day was the CEO of a medical imaging company, who eventually licensed the technology from Goddard. One of the primary goals of the Innovative Partnerships Program Office is to build awareness of GSFC capabilities, thereby creating partnership opportunities between Goddard and industry. The HSEG article describes the sort of "success story" that neatly illustrates how this goal can be achieved.

In this issue we also include a brief article about the Office of Patent Counsel, to stress the importance of protecting Goddard's intellectual property to ensure it is of maximum value to potential licensees. Please read on to learn about these Goddard inventions and their potential use within the medical field. And if you would like to learn more about these or any other GSFC technologies, please feel free to contact the Innovative Partnerships Program Office at 301-286-5810 or by email: techtransfer@gsfc.nasa.gov.

Nona Cheeks
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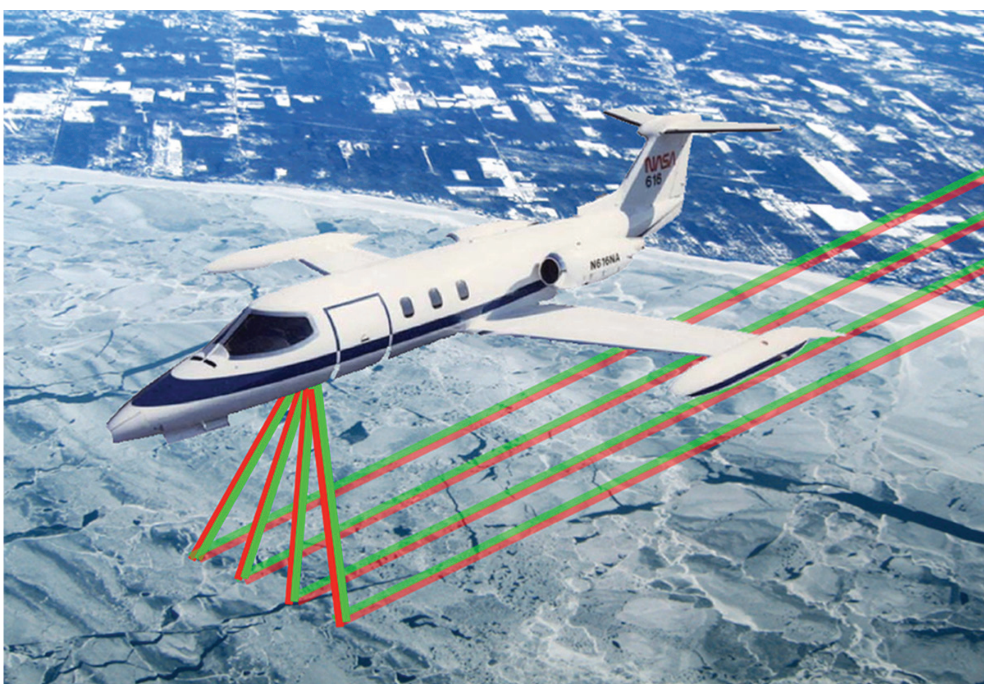


Left: An artist's rendition of SIMPL aboard the NASA Lear-25 collecting multi-beam, two-color altimetry data across ice-covered Lake Erie.

Opposite page: An artist's rendition of the ICESat spacecraft in Earth orbit.

Laser Mapping of Planetary Surfaces

There is a lot of information to be found in even a single photon of light. To take advantage of this fact, scientists and engineers at Goddard Space Flight Center have developed a laser altimeter technology that not only tells where an object is, but also helps identify its physical characteristics. This technology can be used by NASA to map the Earth and planets — or by the medical community to image tissues within the human body.

ICESat

According to physicist Dr. Anthony Yu (Code 554), GSFC has been developing space-flight laser altimeters since the mid-1990's, for example the Geoscience Laser Altimeter System (GLAS) on the Earth-orbiting Ice, Cloud, and land Elevation Satellite (ICESat). Launched in 2003, ICESat helped scientists monitor elevation changes related to ice sheet mass balance, observe changes in sea ice thickness, and measure forest height. Using a diode-pumped Q-switched Nd:YAG laser operating in the near infrared (1064 nanometers), GLAS fired laser pulses from a 600 km orbit. Each energy pulse reflected from the Earth's surface was collected by a telescope and the signal detected using a Silicon Avalanche Photo Diode (Si:APD). Precise measurement of the pulse's round-trip travel time provided a measurement of the distance to the surface.

Combining that data with knowledge of the spacecraft position, and the pointing direction of the laser, determined the elevation of the surface, with an accuracy of about 10 cm, at the laser footprint location. As the spacecraft orbited the Earth, a profile of elevation measurements was created. Building up many of these profiles through time provided maps of ice sheet elevation, sea ice thickness changes, and global forest height.

Next Generation Laser Altimetry

Although revolutionary, GLAS had several limitations. To detect enough reflected laser energy, a strong laser pulse had to be transmitted, limiting the rate at which the elevation measurements could be made. The spacing between laser footprints was almost the length of two football fields. And the instrument only provided information on the elevation and location of the footprint, not the type of surface.

To address these limitations, geophysicist Dr. David Harding (Code 698) led an Instrument Incubator Program project funded by NASA's Earth Science Technology Office. The project developed a more efficient laser altimeter that can acquire surface elevation measurements much more rapidly and provide information on the properties of the surface. The airborne instrument, the Slope Imaging Multi-polarization Photon-counting Lidar (SIMPL), is a pathfinder for future Earth and planetary laser altimeters. Philip Dabney (Code 694) is the instrument systems engineer for SIMPL.

Key to his instrument design is use of detectors and high-speed event timers that record the time of arrival of single photons with respective precisions of 250 (3.75 cm) and 100 (1.5 cm) picoseconds. Because of the single photon sensitivity, a high repetition rate laser firing low energy pulses can be used to make distance measurements spaced less than one meter apart. Furthermore, because such a weak return signal can be detected, the laser pulse can be split to simultaneously measure multiple profiles.

To accomplish these measurements, Dr. Yu developed a novel laser transmitter (GSC-15950-1). It operates at two wavelengths by frequency doubling a near-infrared micropulse laser, thereby also producing green light. The two colors are divided using a dichroic beam splitter and follow separate optical paths. Each color is split into two and then four beams using birefringent calcite crystals. Using quarter and half waveplates, the four beams are linearly polarized with parallel polarization planes. The two colors are then recombined, yielding four plane-polarized beams with co-aligned near infrared and green pulse energy. Lenses define the divergence of the beams and the angle between the beams, establishing

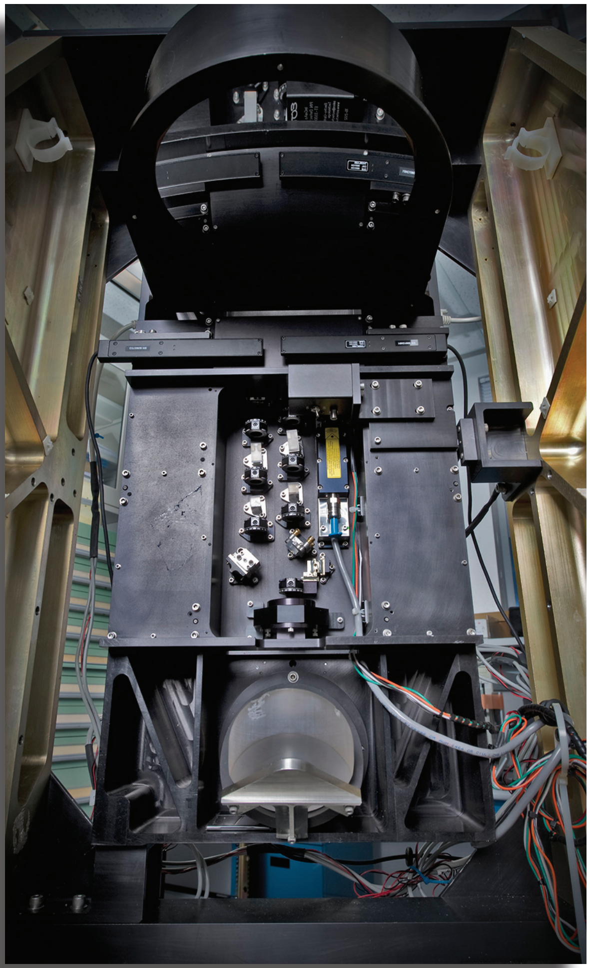
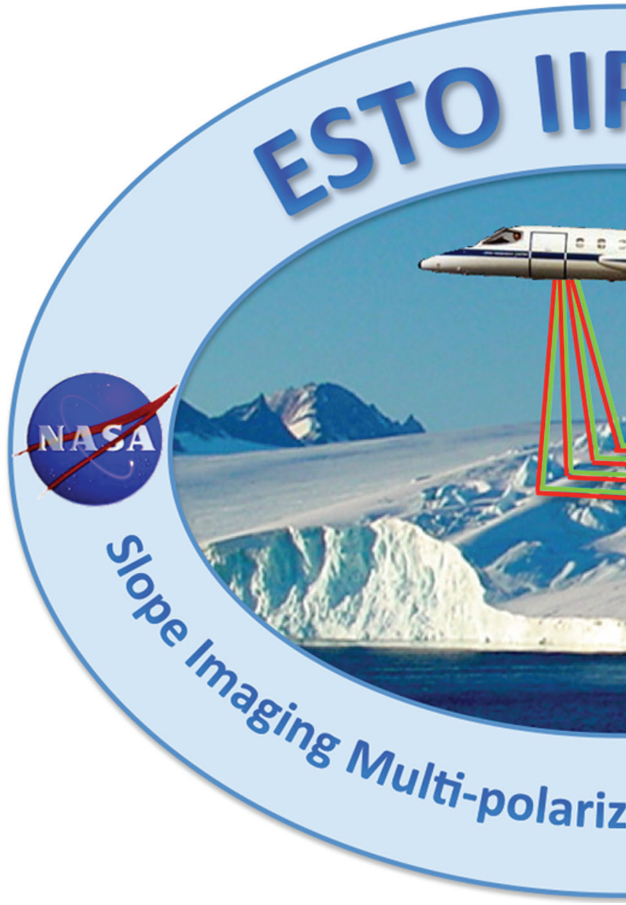


Photo Credit: Chris Gunn

The SIMPL multi-beam laser transmitter mounted in the center of the optical bench and the 20 cm diameter parabolic mirror (top).



the laser footprint pattern on the ground. The beams are transmitted down to the Earth's surface using a parabolic mirror, forming four parallel profiles in the aircraft flight direction.

Using the parabolic mirror, reflected laser energy is collected, and the receiver records photons with polarization states parallel and perpendicular to that of the transmitted pulses for each color and beam, for a total of 16 channels. The way a target scatters and depolarizes the laser pulses controls how much reflected energy is detected at the two wavelengths and two polarization states. This information differentiates surfaces important for monitoring ice sheets and sea ice, including identifying liquid water, ice, and snow. The data can also differentiate vegetation types based on their reflectance and physical properties of the foliage.

The very precise elevation measurements made with high spatial resolution, enabled by this micropulse, single photon laser altimeter combined with target identification using the multi-wavelength polarimetry, provide a powerful new remote sensing tool. The SIMPL instrument, aboard a NASA Lear jet, has demonstrated these advanced measurement capabilities flying over ice cover on Lake Erie and the forests of the eastern United States.

The ICESat-2 Mission

The first space-flight use of this new altimeter measurement capability will be the ICESat-2 mission, planned to continue the observations of the Earth's ice sheets, sea ice, and forests begun by ICESat. The mission is scheduled for launch in 2015. The ICESat-2 instrument, the Advanced Topographic Laser Altimeter System (ATLAS), is being developed at GSFC. It will operate in the green by frequency doubling a near-infrared micropulse laser that is split into six beams. For each beam, the arrival of single photons will be detected using a sensor composed of multiple elements arranged in an array. To simplify this first use in space and reduce cost, ATLAS (unlike SIMPL) will only operate in the green and not record polarization information. But it will serve as the beginning of a new chapter in remotely observing the Earth and its changing surface.

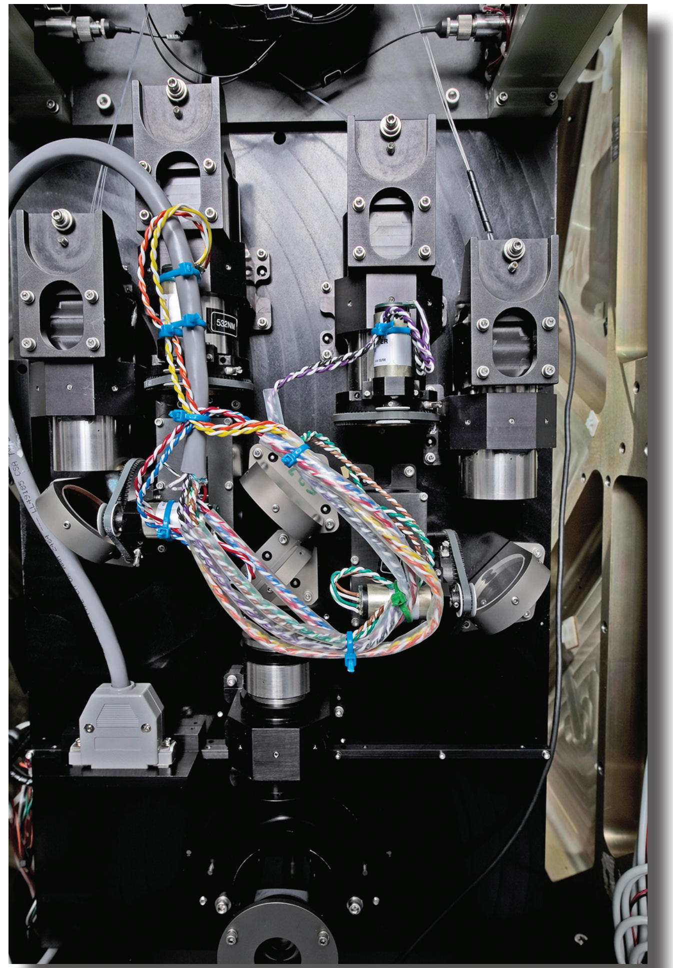


Photo Credit: Chris Gunn

The SIMPL photon-counting receiver, mounted on the optical bench opposite the transmitter, with four optical paths for the two colors with two polarization states.

Medical Imaging

Dr. Harding and his team have also identified another potentially important application for their technology: medical imaging. The approach could probe tissue within the human body, potentially discerning, for example, the difference between non-cancerous and malignant tumors based on the way they scatter and depolarize multi-wavelength laser pulses. Prior prototype laser-based systems have been tested for non-invasive “optical sectioning” using time-resolved reflections from, or transmission through, tissue samples. In one case a polarization sensitive measurement was made, but not by employing single photon detection. Single photon detectors have been used in other cases, but without the polarization information. In all of the cases, only one wavelength was used at a time; and a single laser beam was scanned across a sample to build up an image. The integrated technologies demonstrated in the SIMPL instrument could enable instantaneous, depth-resolved, multi-wavelength, polarimetric imaging with single photon sensitivity.

Of course, a great deal of development needs to be done before the technology would be suitable for medical imaging. For example, the SIMPL instrument is large and cumbersome, designed for use on an aircraft. However, Dr. Harding believes the components could be significantly miniaturized, and thus be more suited for a hospital or clinical setting. If so, this technology could someday offer the medical community a safe, non-invasive tool with which to make important medical diagnoses.

Takeaways

An advanced micro-pulse, multi-beam, multi-channel instrument that times the flight of single photons has been developed as a pathfinder for next-generation laser altimetry. The upcoming ICESat-2 mission will be the first use of this measurement approach in space. While NASA will use this technology to map the Earth and planets, someday doctors may use it to map the intricacies of the human body.

For more information, please contact the GSFC Innovative Partnerships Program Office (Code 504), http://ipp.gsfc.nasa.gov (phone: 301-286-5810, email: techtransfer@gsfc.nasa.gov).

success story

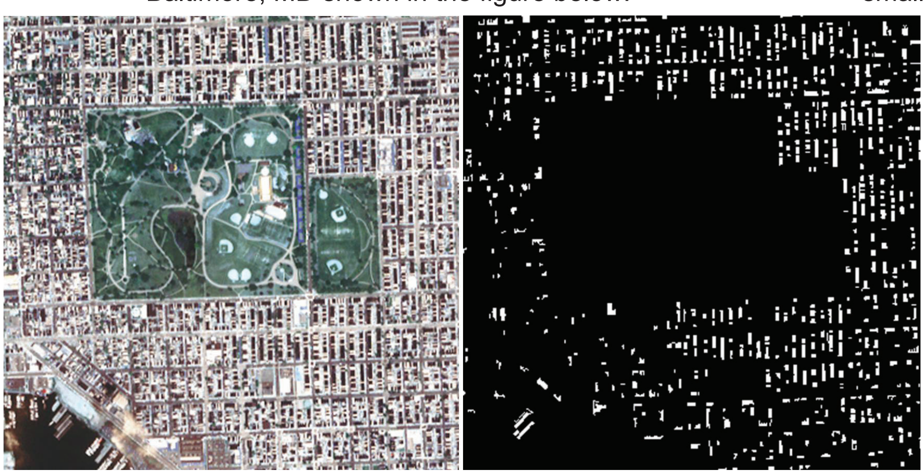
HSEG: A Goddard Tech Transfer Success Story

When Dr. James Tilton started development of his hierarchical image segmentation (HSEG) algorithm for Earth Science image enhancement and analysis over a decade ago, he gave little thought to its possible medical applications. However, a workshop sponsored by Goddard's Innovative Partnerships Program Office brought HSEG to the attention of an entrepreneur in the medical imaging market — and in the process, helped launch a product with the potential of saving a significant number of lives.

The Development of HSEG

The hierarchical image segmentation (HSEG) algorithm (GSC-14305-1) closely intertwines image segmentation via region growing, which finds spatially connected region objects with region object classification, which groups sets of region objects together into region classes. It produces a segmentation hierarchy, or a set of several image segmentations of the same image at different levels of detail. Segmentations at coarser levels of detail can be produced from simple merges of regions at finer levels of detail. This allows an object of interest to be represented by multiple segments in finer levels of detail, merged into a surrounding region at coarser levels of detail.

The region object classification aspect of HSEG groups spatially separated region objects together into region classes. This feature of HSEG provides the potential of using spatial pattern recognition to recognize land use categories. For example, consider a portion of an Ikonos image depicting the Patterson Park area of Baltimore, MD shown in the figure below:



HSEG automatically isolates the roof tops (highlighted in white on right image) from a satellite image of a residential Maryland neighborhood.

An HSEG analysis of this image identified a region class consisting primarily of dark roof tops, as highlighted in white in the figure below. Note a certain regularity of the roof pattern to the southeast, east, and north of Patterson Park. This area is generally an older residential area, with a few businesses interspersed. The roof pattern to the southwest and west of Patterson Park appears somewhat different. This area has a denser concentration of businesses and apartment complexes. Pixel-based analysis could never detect this difference in spatial patterning, whereas detection of such spatial patterning based on HSEG segmentations should be possible with an appropriate analysis approach.

HSEG was originally developed to enhance and analyze images such as those taken of Earth from space by NASA's Landsat and Terra missions. Applications include topographical analysis, such as ice and snow mapping. Another application is "space archeology," where satellite images are examined for subtle signs of previous human activity.

Enter Bartron

About ten years ago, Goddard's Innovative Partnerships Program Office hosted a workshop in which various in-house technologies were showcased for the business community. The primary theme of this particular workshop was medical technologies. Dr. Tilton attended the workshop and gave a presentation for HSEG, even though he did not yet see an immediate medical application for it. Also in attendance that day was Fitz Walker, President and CEO of a small company called Bartron Medical Imaging. Mr. Walker saw immediate potential for HSEG, particularly as a diagnostic tool. HSEG could be adapted to enhance medical imagery, allowing for quicker and more accurate identification for problematic tissues such as cancer.

After the workshop, Mr. Walker approached Dr. Tilton to discuss HSEG. Initially Dr. Tilton was skeptical. However, he began to see his technology's medical potential when he processed cell images and discovered HSEG provided details not readily apparent in unprocessed displays of the image.

Barton subsequently licensed the technology from Goddard, and made further enhancements (in particular, the ability to provide color, and additional analysis software). The technology has now been developed as MED-SEG™, a tool

MED-SEG is a trademark of Bartron Medical Imaging, LLC.

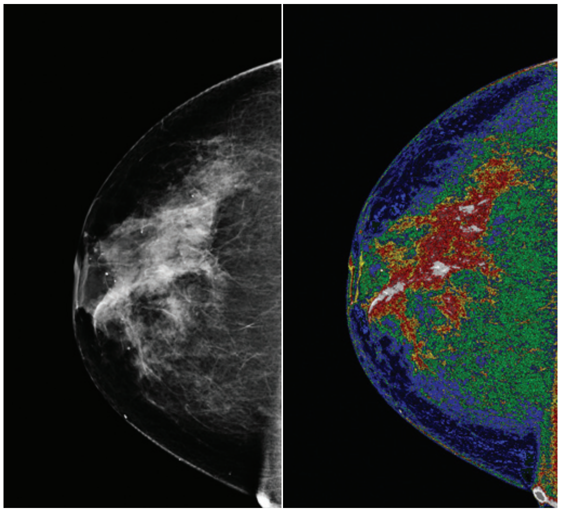


Photo Credit: Bartron Medical Imaging

The left image shows an original mammogram before MED-SEG™ processing. The image on the right, with regions of interest labeled in white, shows a mammogram after MED-SEG™ processing.

Dr. James Tilton

Code: **606.3**

Years with NASA: **26**

Fields of research: **Image Analysis, Image Segmentation, Pattern Recognition and Image Analysis Applications to Remote Sensing, Massively Parallel Computation**

Education: **BA Electrical Engineering, Environmental Science & Engineering, and Anthropology, Rice University; MS Optical Sciences, University of Arizona; MEE, Rice University; Ph.D. Electrical Engineering, Purdue University**

to help specialists interpret medical images. In August of 2010, MED-SEG™ received clearance from the U.S. Food and Drug Administration (FDA) to be sold on the commercial market.

According to the Bartron web site, MED-SEG™ “receives medical images and data from various imaging sources (including but not limited to, CT, MR, US, RF units), computed and direct radiographic devices, and secondary capture devices (scanners, imaging gateways, or imaging sources)…[It] will allow the user to select the desired level of detail with precise control.” In addition, a 3D version of MED-SEG™ is in development.

MED-SEG™ has been installed at the University of Connecticut Health Center, which expressed interest in performing clinical trials with it. The purpose of these trials is to confirm the system’s ability to improve mammography as a diagnostic tool. Currently, mammogram analysis is subject to false negatives; therefore at-risk women are often given expensive and uncomfortable MRI’s — which themselves are subject to false positives. MED-SEG™ offers the potential of making it easier for doctors to detect and identify areas of interest in the mammogram, thereby making the test more useful and potentially avoiding unnecessary MRI’s and/or biopsies. Other possible MED-SEG™ evaluation sites include New York University Medical Center, Yale-New Haven Medical Center, and the University of Maryland Medical Center.

Going Forward

As Dr. Tilton points out, MED-SEG™ is based on a version of HSEG that is now four years old. In the interim, development on HSEG itself has continued. Recently, Dr, Tilton has adapted HSEG for hyperspectral imagery, which can present challenges when there are a high number of smaller objects in the image. Another possibility is the fusing of spot LIDAR data with continuous coverage image data, which appears to be another application for which HSEG is suited. This continued development of HSEG offers some interesting licensing possibilities for markets as diverse as facial recognition, image data mining, and crop monitoring. Such possibilities give some indication of the potential value and versatility of the HSEG technology.

Takeaways

The hierarchical image segmentation (HSEG) algorithm was originally designed for Earth Science imagery. Initial applications included topographical analysis and “space archeology.” More recently, HSEG has been licensed to Bartron Medical Imaging, who has incorporated this technology into their MED-SEG™ product for enhancing medical images. This product recently received clearance from the FDA. Other potential HSEG applications include image data mining, facial recognition, and crop monitoring.

For more information, please contact the GSFC Innovative Partnerships Program Office (Code 504), http://ipp.gsfc.nasa.gov (phone: 301-286-5810, email: techtransfer@gsfc.nasa.gov).

Automatic Extraction of Planetary Image Features

Missions such as the Lunar Reconnaissance Orbiter (LRO) and Chandrayaan will acquire a large number of lunar images, which will need to be analyzed. Although many automatic feature extraction methods have been proposed and used for Earth remote sensing images, these methods are not always applicable to lunar data, which often presents challenges such as low contrast and uneven illumination.

To address this issue, a team led by Dr. Jacqueline Le Moigne, Assistant Chief for Technology in GSFC's Software Engineering Division (Code 580), developed a new method for the extraction of lunar features (GSC-15730-1). This technique, which can be generalized to other planetary images (and even other types of imagery, including medical), is based on a combination of several image processing methods.

The Challenges of Lunar Imaging

Compared to Earth Science remote sensing data, the boundaries of lunar features are often not well defined; it is therefore somewhat difficult to segment and characterize these images. And since a large amount of new lunar data will be collected in the upcoming years, it is important to design an automated method to extract these features and utilize them to perform tasks such as image registration.

Image segmentation and feature extraction are usually performed either by using an edge-based or a region-based method, for example, region-growing. Due to uneven illumination, edges extracted from lunar images do not form closed contours, and post-processing needs to be done to link these edges. In addition, lack of contrast makes regions difficult to characterize — and if a method such as region growing is used, one level of iteration is not sufficient to describe all the features.

Feature Extraction

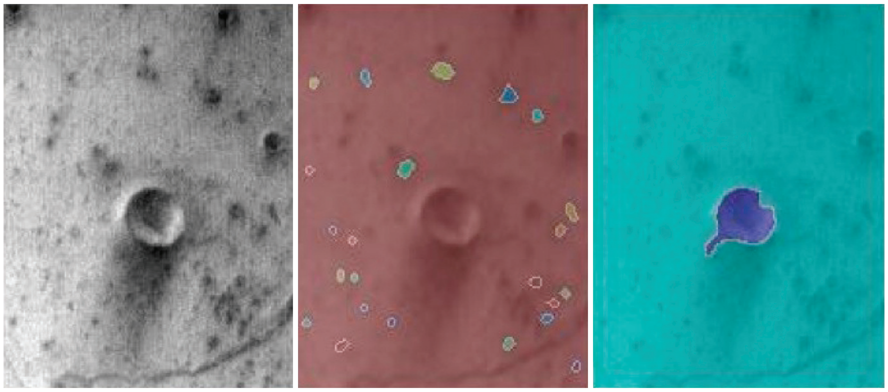
In a typical lunar image, features to be extracted include rocks (generally objects of small elliptic shape), craters (elliptic shape, with shadows), and ridges. To extract these effectively, Dr. Le Moigne's team took the following approach:

- •The image gradient is computed by using the Canny edge detector.

- •To extract the small rocks, a watershed segmentation algorithm is applied to the Canny gradient, so that regions that appear as close contours in the gradient are segmented.

- •To extract larger rocks and craters of elliptical shape, the system first applies a generalized Hough accumulator to detect ellipses in the gradient image and then applies the watershed segmentation using these ellipses as seed points.

- •To detect ridges, a standard Hough accumulator is applied to detect straight lines in the gradient image.



From left to right: Original surface image; Image following segmentation of the binary gradient; Image segmented with ellipse detection.

If this extraction is used to register images, the features above will be extracted from both images and then matched, in order to compute the geometric transformation between the two images.

This method's use of the Hough Transform on lunar images may be unique, as is its image segmentation method that uses a combination of the Hough Transform, the generalized Hough Transform, and the watershed segmentation. The technique also takes advantage of the fact that, in lunar images, the types of features that need to be extracted are already well known.

Since LRO and similar lunar image data is not yet easily available, Dr. Le Moigne's team has successfully tested the proposed method using Mars data. Although Martian features are generally similar to those found on the Moon, some minor adjustments will probably be needed when using lunar data. The spatial resolution of lunar data will also be higher than Martian data.

Note that all code for this technology was developed in MATLAB®. The watershed segmentation and the

MATLAB is a registered trademark of The MathWorks.

standard Hough Transform use open source software. The generalized Hough Transform is loosely based on published algorithms, although the code for this project includes significant innovation.

Other Applications

In addition to lunar images, this feature extraction can also be applied to planetary image data. It can be used for planetary image registration, landing site selection, hazard map creation, and (more generally) for lunar and planetary terrain categorization.

Back on Earth, this novel feature extraction method can be used to supplement existing feature extraction methods already in use for remote sensing, military, and medical applications. For example, this system could be useful for feature extraction in medical images with low contrast, such as mammograms or MRIs. It may also be useful for feature extraction in SAR (Synthetic Aperture Radar) images for defense applications.

Takeaways

A novel feature extraction method has been developed to meet the challenges of lunar imagery, including low contrast and low light. This system applies the Hough Transform on lunar images, and also takes advantage of the fact that the types of objects that generally appear in lunar images are already well known. Other potential applications include low-contrast imaging in fields such as medical, remote sensing, and defense.

For more information, please contact the GSFC Innovative Partnerships Program Office (Code 504), http://ipp.gsfc.nasa.gov (phone: 301-286-5810, email: techtransfer@gsfc.nasa.gov).

Dr. Jacqueline Le Moigne

Code: **580**

Years with NASA: **12**

Fields of research: **Image Processing and Computer Vision**

Education: **BS Mathematics, MS Mathematics, Ph.D Computer Science, Pierre and Marie Curie University**

IMAGE SEER:

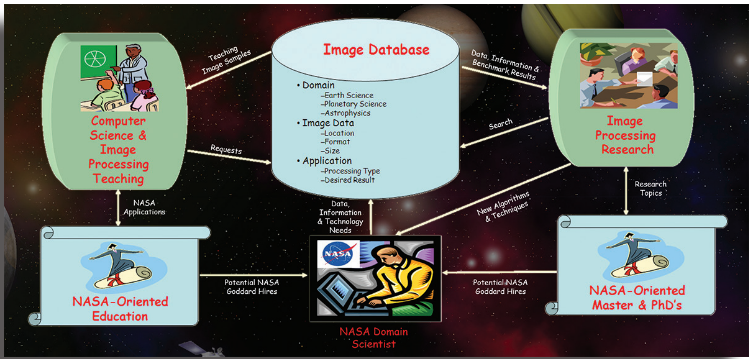
Images for Science, Education, Experimentation and Research

http://imageseer.nasa.gov

There are a number of internet databases designed to provide detailed medical and military images for Image Processing (IP) and Computer Vision (CV) researchers. However, NASA images have traditionally been difficult for researchers to find and are often available only in hard-to-use formats that don't readily lend themselves to CV and IP.

The new IMAGE SEER (GSC-15967-1) database seeks to address this issue. Thanks to the efforts of Dr. Jacqueline Le Moigne and her team, including Tom Grubb and Barbara Milner (Code 583) as well as student interns Jihad Ashkar and Devin Miller, IMAGE SEER provides an easily readable database of NASA benchmark image data. IMAGE SEER enables the teaching of CV and IP on NASA data, and also provides reference data for the validation of newly developed CV and IP algorithms. This database includes a representative sampling of NASA images obtained from various Earth, planetary, and exploratory science. It also offers a web-based front end for easy access.

One of the primary goals of IMAGE SEER is to provide for better distribution, utilization, and understanding of NASA imagery data to the CV and IP university and research community. This in turn will increase the visibility of GSFC, NASA, and its missions. A potential by-product of this effort is that GSFC may be better able to attract top-level college graduates and prepare them for working with NASA data. In addition, IMAGE SEER will enable researchers to develop new CV and IP techniques around this data — research from which GSFC and NASA may eventually benefit.



The IMAGE SEER database includes:

•Satellite imagery from several missions
•Cloud cover masks
•National Land Cover Database images
•Geo-registered satellite data
•"Imagepedia" tutorials and lessons
•Web access via a "point and click" interface

Leveraging Homeland Security Technology for Future Medical Imaging Applications

GSFC technology initially developed for gamma-ray imaging and extended to neutron imaging is now being examined for some potentially important medical applications.

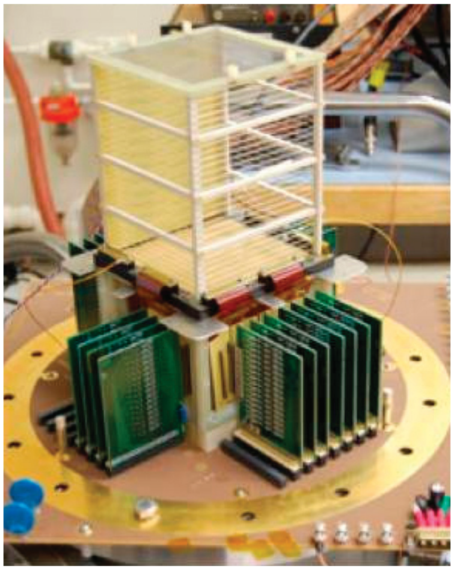
Gamma-Ray Astronomy

The gamma-ray portion of the electromagnetic spectrum is a critical window for understanding the universe. At MeV energies, the universe is nearly transparent to gamma rays, allowing them to probe the entire universe. However, medium-energy gamma rays, from 0.3 MeV to around 300 MeV, are poorly explored by current instruments. This is unfortunate, because medium-energy gamma-ray astronomy has the potential to make important contributions to several long-standing problems central to modern physics, astrophysics, and cosmology. These include the detection of dark matter annihilation processes, the measurement of the extragalactic background radiation fields and the strength of cosmic magnetic fields, detailed information about the astrophysical processes that lead to the growth of black holes, information about the earliest epoch of star formation, and the study of the most extreme particle accelerators in the universe.

For example, exploring the upper end of the medium-energy range, above about 5 MeV, reveals a variety of new phenomena for study, such as micro-quasars and colliding wind binary systems. Other potential areas of study include galactic (and extragalactic) diffuse emission, pulsars, supernova remnants, active galactic nuclei and gamma-ray blazars, and solar flares.

The Three-Dimensional Track Imager (3-DTI)

To more fully explore the medium-energy gamma-ray spectrum, GSFC has developed the Three Dimensional Track Imager (3-DTI). According to GSFC Astrophysicist Dr. Stanley Hunter (Code 661), the 3-DTI is the culmination of over 15 years of gamma-ray imaging detector development to image medium-energy gamma rays from ~5 MeV to 300 MeV that interact via pair-production. The 3-DTI consists of a large volume time projection chamber with two-dimensional gas micro-well detector readout. The third dimension is obtained by measuring the arrival time of the ionization charge as it drifts into (and is amplified by) the micro-wells.



Prototype of the 3-DTI

The 3-DTI instrument is the core of the Advanced Energetic Pair Telescope (AdEPT), along with a Compton telescope being proposed for a future medium-energy gamma-ray mission. These telescopes will be optimized to provide significant improvements in angular resolution and sensitivity. The goal of the AdEPT development is a telescope with a large field of view, uniform sensitivity, high angular resolution, and background rejection to explore gamma rays and enable new discoveries and better understanding of the universe.

Neutron Imaging Camera (NIC)

While developing the 3-DTI, Dr. Hunter realized that the technology could also be adapted to neutron imaging. Imaging neutral particles, such as neutrons and gamma rays, is largely accomplished by measuring the direction, energy, and arrival of charged interaction by-products of these particles. There are two standard approaches to energetic (fast) neutron imaging, both suitable to the 3-DTI technology. These include (1) measuring the momentum of one or more recoil protons from neutron proton (n,p) elastic scattering, and (2) measuring the momenta of the fragments from nuclear vertex interactions.

Working with Dr. Noel Guardala, a nuclear physicist at the Naval Surface Warfare Center (NSWC), Dr. Hunter and his team extended the 3-DTI technology to neutron imaging and developed the Neutron Imaging Camera (NIC) (GSC-15024-1). The NIC is an instrument designed to detect small quantities of Special Nuclear Material (SNM) at moderate standoff distance via both passive and active interrogation. SNM emits a continuous spectrum of neutrons with a broad peak between ~0.2 MeV and ~5 MeV, either spontaneously (where it can be detected with passive interrogation) or when irradiated with low energy neutrons (this is defined as active interrogation).

The goal of the NIC development is a device that can be scaled to fit in vehicles, ships, or aircraft and can provide a means for detecting SNM on ships at standoff distances.

A 30 cm prototype of the NIC was tested this past September, with results that Dr. Hunter describes as “very successful.” He also notes that future prototypes will have larger active volume and greater sensitivity.

Another possible application for the 3-DTI technology is gamma ray imaging for improvised explosive devices (IED) and other high explosive (HE) devices in active mode. Dr. Hunter is currently looking into this jointly with the Army Research Lab, with possible funding by JIEDO, Joint IED Office.

During testing, the NIC is placed on a floating dock with a radioactive source on an adjacent boat.

Neutron Imaging and Medical Applications

In recent years, there has been considerable attention devoted to using neutrons for medical imaging. Neutrons possess some significant advantages in this application. For example, they are highly penetrating, offering the potential to image structures deep within the body. They can also be used to identify virtually any chemical element that naturally appears in the human body.

Another significant advantage is that neutrons interact very weakly with matter, and thus can be relatively non-destructive to complex or delicate biological tissues. This allows internal organs and other body structures to be examined more safely than with other forms of radiation, such as X-rays. In this way, neutron imaging may eventually be developed as a complementary option among other medical imaging techniques.

Dr. Hunter notes that the NIC was not developed with medical imaging in mind, and a great deal of further development and testing would need to be done to achieve this goal. He has engaged in early discussions with a medical school concerning NIC and its potential for neutron imaging applications. In the interim, Dr. Hunter and his team will continue to develop this technology for Department of Defense applications — as well as for its original purpose in supporting future space science missions.

Takeaways

The Neutron Imaging Camera (NIC) leverages technology developed for the Three-Dimensional Track Imager (3-DTI) device created for gamma-ray imaging. The NIC will initially be developed for maritime detection of SNM. The technology may also offer potential in neutron medical imaging.

For more information, please contact the GSFC Innovative Partnerships Program Office (Code 504), http://ipp.gsfc.nasa.gov (phone: 301-286-5810, email: techtransfer@gsfc.nasa.gov).

Dr. Stanley Hunter

Code: **661**

Years with NASA: **30**

Fields of research: **Gamma-ray Astrophysics, Galactic Diffuse Gamma-ray Emission, Detector Development**

Education: **BS Physics, BS Mathematics, University of Arizona; PhD Physics, Louisiana State University**

Nutrition: The (Artificially) Intelligent Diet

At first glance, the connection between autonomous control systems and human obesity may not be obvious. However, Dr. Steven Curtis (Code 695) has applied a technology originally created for the former to address the latter — and in doing so, may be in the process of developing a potentially important new tool to combat one of the more pressing health needs in the U.S. (and increasingly, the world).

SANE Autonomous Control Systems

Autonomous control systems comprise an important area of study for NASA. This involves the use of artificial intelligence (AI) to perform autonomous decision-making in environments where the presence of a human would be difficult or dangerous, or where remote Earth-based control would be time consuming or otherwise infeasible. As Dr. Curtis explains, the key characteristics of an effective system include self control, resilience, adaptability, and stability. This last characteristic is particularly critical, since it determines how reliably and predictably the AI behaves given a certain set of circumstances.

In general, human behavior has evolved to be stable — that is, a person tends to act in a more or less consistent way when dealing with the same situation, based upon previous experience and knowledge. As a person acquires new knowledge, their behavior may be modified accordingly. However, the chances that such a change will become a permanent, stable component of a person's behavior are greatest when the change is incremental and long-term. Radical changes, implemented too quickly, tend to be unstable and not result in permanent behavioral change — as many of us may currently be discovering for ourselves as we try to keep overly ambitious New Year's resolutions.

To help ensure that NASA's AI systems behave and perform in stable ways, Dr. Curtis developed the Stability Algorithm for Neural Entities (SANE) algorithm. The purpose of SANE is to identify "psychological instabilities" in these systems. This involves examining how the AI reacts to a broad range of conditions, and flagging areas in which the system performs in a way that significantly deviates from its "normal" behavior. Such large-magnitude changes, invoked too quickly, could lead to instability and the eventual collapse of the entire system. By correcting these "over-optimizations," an AI system could be designed to be more reliable and "human like."

A patent application has been filed for SANE (US 20090083201, "System and Method for Determining Stability of a Neural System," published 2009).

ADAPTing a New Dietary Approach

With the development of SANE, Dr. Curtis began to explore ways in which the algorithm might also be useful within the realm of human behavior, since any viable AI solution has to encompass humans as a special case of autonomous systems. Therefore the same stability criteria exist for both autonomous machines and autonomous humans.

One of the applications Dr. Curtis examined concerned weight loss and diet. As he explains, many "fad" weight loss programs, which rely on large-scale and immediate changes in the subject's eating habits and/or exercise routine, are often doomed from the start. They may result in some short-term loss, but they commonly fail even before weight targets are reached, often with an even higher final BMI (body mass index) than at the beginning. The reason for this is that these regimens require the subject to make changes that are too large and too quick to have a permanent effect — in other words, these changes are too unstable to be easily adopted into the average person's overall long-term behavior.

To overcome this problem, Dr. Curtis utilized the SANE algorithm to devise what he terms a "psychologically and temporally stable" diet, the Asymptotic Diet Algorithm with Psychological and Temporal Stability (ADAPTS) (GSC-16070-1). Basically, ADAPTS implements a dietary program in which behavioral changes are relatively small and implemented slowly, thereby falling within the SANE criteria for stability.

According to Dr. Curtis, "the fundamental reason for the incremental approach in all stages is to avoid triggering a psychologically destabilizing starvation response, defined here as a caloric intake below the level needed to sustain a BMI in the 20 to 25 range. I know of no other diet approaches that do not violate this criterion sometime in their implementation."

ADAPTS targets the BMR (basal metabolic rate) of the desired BMI. This avoids the aforementioned "starvation response" often associated with severe dieting. The BMR target provides a natural, low perturbation solution for life-long eating levels at the end of the diet by providing an asymptotic approach to the final diet and BMI. This asymptotic approach also continues the eating patterns under the BMR constraints over a long time, further meeting the SANE criteria for adaptive perturbations and increasing the likelihood of permanent behavioral modification. And finally, the ADAPTS diet is a long-term process, avoiding large destabilizing perturbations typical of almost all other diets.

For example, ADAPTS might initially require nothing more than to have the subject eat within a certain regular time period each day. There is no other restriction on consumption; during this phase subjects are still free to eat whatever they want, so long as they adhere to the schedule. Many dieters would likely consider this a small, even trivial change to their eating habits. Then after several months of following and permanently adopting this routine, the second change is implemented, in which the subject is required to eat a certain amount of specified low-calorie foods. After these foods are consumed, subjects can eat whatever they choose without limitation. Again, according to the SANE criteria, dieters are likely to find this an incremental (rather than radical) change to which they can permanently adapt. This stage of the program would continue for a number of additional months.

The final step is the implementation of the low calorie diet, and the elimination of high calorie and otherwise unhealthy foods. This last phase is often the first step in a new diet, and as such would represent a major behavior change to the dieter. But by implementing smaller, gradual changes over a longer time period, ADAPTS helps ensure that this entails a much smaller behavioral adaptation on the part of the subject, and therefore is far more likely to result in life-long weight control.

ADAPTS has yet to be tested in clinical trials. However, it has been applied to one test subject, Dr. Curtis himself, with dramatic results. Dr. Curtis initially weighed 230 pounds when he began his ADAPTS program in late May 2008; by October 2009 his weight had fallen to 150 pounds (a level he still maintains, and in fact is slightly under). During this time, Dr. Curtis's BMI dropped from 33 to 22. Note that these results were achieved with a relatively small decrease in caloric intake, and no additional exercise program.

"The final actual stage of caloric restriction is based on the difference in calories between the stable weight level obtained in the initial phases and the final target weight based on the BMRs of the starting and final (target) weights, with a BMI greater than 20," states Dr. Curtis. "I do not assume any significant difference in calories due to enhanced mobility owing to weight loss. You are simply moving less mass more often for a yield of approximately equivalent caloric expenditures in almost all cases. It is very difficult to significantly increase caloric expenditures due to activity over a significant span of time. Hence, almost all of the New Year's resolution would-be gym rats will fail due to the underlying psychologically unstable approach they are taking." Dr. Curtis further notes that even the very small percentage who are initially successful are subject to the destabilizing influence of injuries, time constraints, sustained interest, and so on; since they are exercising to eat (unstable) rather than eating to exercise (stable). "I experienced this myself in the previous decade when I had a weight close to what I have now, but spent hours in the gym daily to burn off the calories that I ate. When scheduling did not allow that to continue, that eating continued with a rather rapid climb to my immediate pre-ADAPTS weight."

Dr. Steven Curtis

Code: **695**

Years with NASA: **42**

Fields of research: **Multiscale Structure of Plasmas and Simulations, Autonomy and Space Structures**

Education: **BS, MS, and PhD Physics, University of Maryland**

Of course, the efficacy of any dietary program needs to be confirmed via testing performed on a group of subjects with varying weight loss goals and needs. Nevertheless, if Dr. Curtis's personal results are any indication, the ADAPTS program could offer significant value to applications as specific as maintaining healthful BMIs for human crew during long-term space flights — or as general as offering a new, stable approach to human dieting in a calorie rich environment.

Takeaways

The Asymptotic Diet Algorithm with Psychological and Temporal Stability (ADAPTS) is a dietary program based on the Stability Algorithm for Neural Entities (SANE) algorithm (patent pending). ADAPTS takes a psychologically stable approach to weight loss by implementing relatively small, long-term steps that result in permanent changes in the subject's dietary habits. Applications include general public weight control and health, as well as maintaining the health of personnel in long-term isolated environments.

For more information, please contact the GSFC Innovative Partnerships Program Office (Code 504), http://ipp.gsfc.nasa.gov (phone: 301-286-5810, email: techtransfer@gsfc.nasa.gov).

A Chemistry Laboratory on a Chip

As we've described in numerous articles, many GSFC technologies offer significant value in applications far beyond the ones for which they were initially designed. In many cases, a single technology can be leveraged to form the core of a commercial product. In other cases, multiple technologies, created for various purposes, can be bundled together to meet a new need.

Such is the case with the proposed In Situ Wet Chemistry Laboratory, a portable lab-on-a-chip device designed for the chemical analysis of organic molecules. This combines multiple GSFC technologies into a compact, lightweight unit designed for exobiology analysis on Mars, Titan, Europa, or any New Frontiers or Discovery Program missions that focus on the search for biologically relevant organic materials. And by offering the promise of portable, quick identification of DNA, this technology may also be useful in important health applications, such as testing drinking water in the field.

According to µLC-ESI project Principal Investigator Yun Zheng (Code 553), the In Situ Wet Chemistry Laboratory incorporates several separate GSFC technologies, including sample preparation/extraction/derivation, liquid chromatograph/chemical separation, the ChemFET detector, electrospray ionization, and mass spectrometer. Collectively, these help solve a significant challenge facing exobiology: How do you analyze a sample taken from a non-Earth object, in a way that does not destroy the organic molecules it may contain, using equipment that is sensitive, accurate, robust, and (critically for space missions) lightweight?

Electrospray Ionization (ESI) Chip

One of the major problems Mr. Zheng needed to address was how to deliver a test sample to the mass spectrometer for analysis while preserving its potential organic material. Usually, a test sample is delivered as a plasma. However, converting organic material to plasma often destroys it.

To solve this issue, Mr. Zheng and his colleagues developed the Electrospray Ionization (ESI) chip. The ESI, (GSC-15970-1) as the name indicates, uses a process called electrospray ionization, which is especially useful for producing ions from organic macromolecules (such as amino acids and nucleobases) because it avoids fragmenting the molecules during ionization.

One of the key innovations of the ESI is the ionization nozzle. Electrospray ionization nozzles for commercial liquid chromatographs/mass spectrometers tend to be complicated, and need a precise mechanical fixture to hold them in place. They also usually require nitrogen gas to perform ionization. The nozzle developed by Mr. Zheng is much smaller and lighter, and consists of MEMS technology on a silicon wafer. A novel feature of the design is the fact that the nozzle column is perpendicular to the chip surface, allowing for easy integration with other existing miniaturized components.

The vertical ionization nozzle can be fabricated via photolithography patterning and deep reactive ion etching, optimized to obtain a straight and smooth hole and column. Nozzle holes range from 5 microns to 20 microns, with hole size selected according to microfluidic pressure and flow rate to ensure the optimum electrospray. The nozzle has been successfully tested using a commercial mass spectrometer.

Yun Zheng

Code: **553**

Years with NASA: **11**

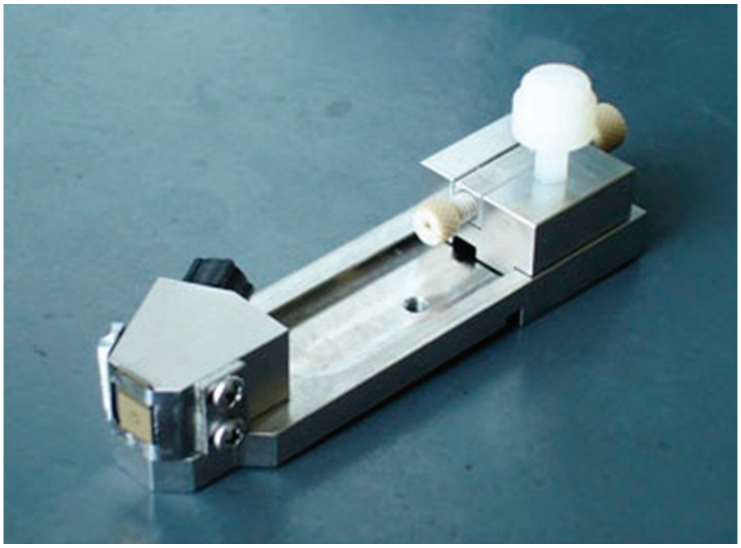
Fields of research: **MEMS, Nanotechnology, and Detectors**

Education: **BS Physics, Zhongshan University; MS Materials Science and Engineering, University of Maryland**

ChemFET

Another critical component of the In Situ Wet Chemistry Laboratory is the ChemFET nano-scale biological detector. ChemFET's role in this system is to identify specific biomarkers in the sample being tested. This technology, developed by GSFC Technologist Dr. Stephanie Getty, is composed of nano-components and offers fully electronic detection, providing the ability for miniaturization and quick analysis of data.

Note that ChemFET has already attracted the attention of the medical community. Under a grant from NIH, Dr. Getty is working with the University of Maryland, Catholic University, and the National Cancer Institute to adapt this technology to the detection of biomarkers associated with breast cancer.

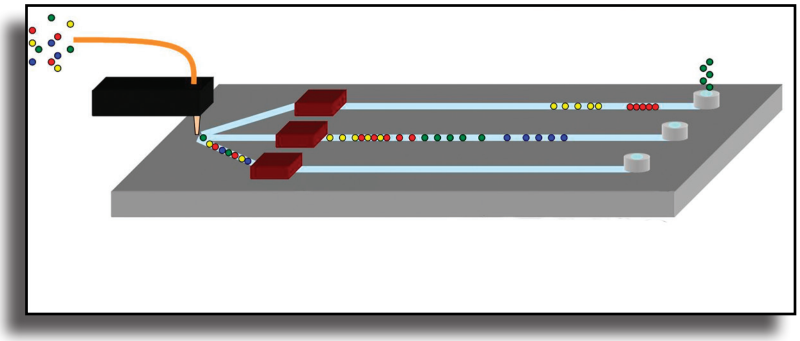


The ESI nozzle (left end) is fitted onto a standard capillary nozzle holder for testing in a lab-scale, commercial LC-Mass Spectrometer.

Mass Spectrometer

As Mr. Zheng points out, commercial liquid chromatography/mass spectrometry systems, although offering an excellent method for analyzing and identifying the molecular structure of complex organics, are usually "very big and heavy," and thus do not lend themselves to being launched into space very easily. Therefore LC/MS systems need to be miniaturized for exobiology missions.

To achieve this, the In Situ Wet Chemistry Laboratory will connect to miniaturized mass spectrometer (MS) technology currently being developed by Dr. Daniel Glavin and Dr. Getty. Such an instrument could be used to search for evidence of chemical biomarkers on Mars or other planetary bodies, including amino acid chirality, which is a fundamental characteristic of life on Earth.



In this diagram, the sample passes through liquid chromatographic separation and the ChemFET detector, which tests for biomarkers, and finally is sent to the mass spectrometer via the electrospray ionization nozzle.

Putting It All Together

In the proposed design, the In Situ Wet Chemistry Laboratory will operate as a full-featured lab-on-a-chip device. Samples will initially be analyzed to detect electrical activity that could be associated with biological matter. If such activity is detected, the sample will then be processed and sent to the ChemFET and mass spectrometer components for further analysis and identification.

According to Mr. Zheng, this technology not only offers the potential of detecting whether or not a sample is biological; it could also be eventually developed to the point where it may actually be able to identify whether or not certain DNA is present. This immediately raises a wide spectrum of possible health and medical related applications. For example, in theory this capability could be used to analyze a sample of drinking water, to detect a variety of dangerous microbes or pathogens. And the fact that this unit is potentially portable means it could be used in the field, for example in remote parts of the developing world where consuming contaminated drinking water is often the most common means for contracting disease.

To some, exobiology — the search for life in space -- may seem the most esoteric of pursuits, interesting from a purely intellectual standpoint, but of little apparent practical value to everyday living. The In Situ Wet Chemistry Laboratory proposes to bridge this perceived gap, addressing the unique needs of exobiology in a way that could also offer valuable service in maintaining public health back here on Earth.

Takeaways

The In Situ Wet Chemistry Laboratory is a lab-on-a-chip device designed for detecting and analyzing biological molecules in a sample. Its primary purpose is to support exobiology-related missions. It includes several GSFC technologies: sample preparation/extraction/derivation, liquid chromatograph/chemical separation, the ChemFET detector, electrospray ionization, and mass spectrometer. Potential commercial applications include health and medical related tasks, such as water quality testing and monitoring.

For more information, please contact the GSFC Innovative Partnerships Program Office (Code 504), http://ipp.gsfc.nasa.gov (phone: 301-286-5810, email: techtransfer@gsfc.nasa.gov).

Stabilizing Video from a Tumbling Platform

What do a planetary lander, a soccer ball in play, and a pill swallowed by a patient have in common? All three present interesting imaging opportunities and challenges — which could potentially be addressed by a rotating camera technology being developed at GSFC.

Venus Probe

This technology was originally conceived to solve a problem with a Venus planetary probe. Due to the thick Venusian atmosphere, a probe landing on Venus does not use a parachute to control its decent to the surface. Instead, it falls slowly through the thick atmosphere. This creates a challenge to any onboard camera that attempts to stay focused on the probe's landing spot — it would be very difficult (if not impossible) for a single camera to stay steadily aimed on a single spot or object while the lander is rotating or otherwise moving in unpredictable ways.

To address this challenge, GSFC Senior Engineer Tupper Hyde preliminarily designed a multi-camera system for the probe (GSC-15708-1). The cameras would have wide fields of view that overlap, thereby ensuring that the desired view would be within the view of at least one camera at all times.

The desired view would remain focused and in frame at all times, irrespective of how violently or unpredictably the probe rotated. In addition, Dr. Hyde's system could make use of many small, readily available image chips (such as those used in cell phones) rather than a single expensive unit equipped with heavy, large field-of-view "fisheye" optics. Thus it could be fairly easy and inexpensive to build.

A Sports Application

In contemplating other potential uses for this technology, Dr. Hyde eventually considered a very novel one — with an important assist from his son J.T. While talking football and soccer, Dr. Hyde and J.T. discussed the innovation and possible uses for it. J.T. suggested placing multiple small cameras on a soccer ball, and then processing the data to create an image of interest. Thus the progress of the ball across the field could be tracked from a specific perspective — for example, the view could focus on the goal or goalkeeper, or the forward direction of motion, thereby offering unique perspectives difficult or impossible with current camera and video technologies.

This system could also be adapted to other sports where the addition of small imaging chips would not impact the performance of the ball or otherwise affect the game. For example, imagine this technology providing images of a football while it is being passed or punted. The video sequence could give the viewer the impression of actually riding on the football, with images of the punter receiving the hike, the punter's foot meeting the ball, a "bird's eye" view of the field as the punt follows its trajectory, a view from above of the receiver awaiting and catching the ball, and finally from the receiver's arms returning the kick. And the resulting images would be stable, clear, and easy to view, providing sports fans with unprecedented views of game activities. The images could be replayed on TV and the web and shown live on the "jumbotron" screen at the stadium.

Dr. Tupper Hyde

Code: **590**

Years with NASA: **9**

Field of research: **Dynamics and Control**

Education: **PhD Aeronautics and Astronautics, Massachusetts Institute of Technology**

Although sports applications may be of only cursory interest to non-fans, they do offer some indication of the potential uses of Dr. Hyde's technology.

Medical Imaging: A Voyage through the Body

One application of potential interest to the medical community could be internal imaging of the digestive tract. For example, micro-scale imaging chips could be attached to the surface of a pill-sized probe. When the patient swallows the pill, its on-board cameras would provide raw imaging data that could be synthesized into images useful for later analysis by medical specialists. The pill could record and/or transmit the data for later (or even real-time) viewing. In this way, a single pill could image the entire digestive tract; the specialist could then select specific areas to inspect, effectively replaying the journey down the intestines while "joy-sticking" the view to examine areas of interest. This could provide a relatively inexpensive and

non-invasive method for internal examination.
Although Dr. Hyde's technology is still in a relatively early stage, it's easy to imagine many possible other applications for it, including undersea, underground, airborne, or any other environments in which it would be difficult to ensure a stable platform from which to record video, even though the unit carrying the cameras may be rotating or tumbling.

Takeaways

This technology processes multiple image feeds from a rotating or unstable platform. It uses small, inexpensive image chips and computer processing to synthesize a stable image from raw video data that might otherwise be difficult or impossible for a human to view. The system was originally conceived for a Venus probe. Other applications currently being considered include sports broadcasting, where action video is captured from a ball in play. Another potential application may be medical imaging, in which micro-scale cameras are affixed to a pill swallowed by the patient.

For more information, please contact the GSFC Innovative Partnerships Program Office (Code 504), http://ipp.gsfc.nasa.gov (phone: 301-286-5810, email: techtransfer@gsfc.nasa.gov).

Protecting Goddard's Investments in Innovation

To ensure that GSFC retains strategic control of all its critical technological innovations and inventions, the GSFC Office of Patent Counsel (OPC) works with the Innovative Partnerships Program Office (IPPO) to make certain that all NASA GSFC Intellectual Property (IP) is fully protected. This allows GSFC to more effectively manage its IP, which provides, among other advantages, the ability to license this IP to industry. The Office of Patent Counsel (Code 140.1) is part of the GSFC Office of Chief Counsel (Code 140).

Chief Patent Counsel Bryan Geurts and his office are responsible for identifying, protecting, and managing GSFC IP. According to Mr. Geurts, every year OPC files between 20 and 30 patent applications in the United States Patent and Trademark Office and provides other IP legal services that "run the gamut," for example trademark, copyright and trade secrets services. OPC has expertise and renders services in both the technical and administration worlds.

According to Mr. Geurts, many inventors are not fully aware of OPC and the IP related assistance they provide. All too often, the Office of Patent Counsel is called upon only after an IP issue elevates to a crisis level and therefore can only contribute as a "problem solver." Ideally, OPC is engaged early on before major IP issues become problematic, thus allowing OPC to function as a "problem preventer" as well. However, he also notes that this situation appears to be improving in recent years, with more inventors proactively approaching OPC for legal advice and guidance.

The Office of Patent Counsel's involvement in IP typically follows these steps:

- An invention or other type of IP is created.
- The inventor files a New Technology Report (NTR) with the IPPO.
- IPPO and OPC work together to determine the best course of action to protect and transfer the IP to other government agencies and/or the US public.
- OPC takes steps to legally protect the IP.

Mr. Geurts encourages all inventors to contact him early in the creative process to ensure that their inventions are fully protected — and to avoid possible legal pitfalls in the future.

Photo Credit: Chris Gunn

GSFC's Chief Patent Counsel, Bryan Geurts

Goddard IPP Office's Networking and Outreach Events

events

The 2nd Annual Space Entrepreneurship Forum
September 15, 2010, Washington DC

The objective of the forum was to raise awareness of entrepreneurial opportunities and areas of growth for African-American businesses interested in the space industry. Nona Cheeks, Chief of NASA Goddard's Innovation Partnerships Program Office participated in a panel discussion on the topic of "Opportunities in Government and Commercial Space Industry." An emphasis was placed on NASA technology commercialization partnering practices. Opportunities resulted in meetings with several conference attendees about NASA technology transfer, SBIR/STTR, and licensing opportunities.

IPP Office Chief Nona Cheeks (far right) networks with other attendees of the 2nd Annual Space Entrepreneurship Forum

The 2nd Annual Open Innovation Summit
August 11 – 13, 2010, Chicago, IL

The focus of the "2nd Annual Open Innovation Summit" was to discuss best practices and outcomes in open innovation within industry and government. Presentations were given by a diverse group of industry and government laboratories. Nona Cheeks presented on "NASA Goddard's Open Innovation Experiences." She also participated in a focused group discussion on the nexus of open innovation models in government and high tech and non-high tech industries. New business contacts and example of open innovation resulted from the summit.

Licensing Executive Society USA/Canada Annual Meeting
September 26-29, 2010, Chicago, IL

Members of the NASA Goddard Innovative Partnerships Program Office attended the Licensing Executive Society (LES) USA/Canada Annual meeting. The meeting, themed "Deals, Deals and more Deals," focused upon how intellectual property (IP) is critical to managing new business strategies and touched on ways to use IP to maximize opportunities for licensing deals. There were many workshops that delved into legal and business matters that could impact structuring the best and worst approach for seeking and perfecting licensing deals.

As Nona Cheeks (Chief, Innovative Partnerships Program Office, Code 504) notes in her latest "From the Chief" message, the central theme of this issue of the Goddard Tech Transfer News is medical technologies and applications. But there's another important underlying theme running through all these articles, not only in this issue but all others we publish: GSFC technologies developed for space science often have great value in fields far removed from the ones for which they were originally developed. In many cases, a technology's potential utility in other applications may not seem obvious to those who develop it. So a full appreciation of all the ways a GSFC technology may be of use across multiple markets and disciplines often requires a fresh set of eyes, viewing the technology from a variety of perspectives.

The Goddard Innovative Partnerships Program (IPP) Office plays an important role in this process. The IPP Office organizes, hosts, and attends a broad range of networking and business outreach activities throughout the year. The purpose of these events is to engage and educate innovators, program managers, and potential partners about the collaborative opportunities that IPP provides. This in turn can offer a variety of benefits — creating strategies for making GSFC-developed technologies available for licensing, leveraging technologies and capabilities from one NASA mission/project to another, and defining technology transfer best practices, to name a few. In this way, we help ensure the maximum return for the public's investment in GSFC and NASA, as space science technologies are leveraged into the private sector, fueling new products and markets that can both benefit society and create significant revenue and business opportunities.

Of course, communication is key to the success of these programs. The IPP Office encourages Goddard scientists and inventors to feel free to contact them at any time with questions, even if they feel the development of their technology is still in its relatively early stages. This can help ensure that the tech transfer process operates as smoothly and efficiently as possible, through IP protection, eventual promotion within the business community, identification of partnering opportunities, and ultimately licensing and commercialization.

To find out more about the programs and services offered by the Goddard Innovative Partnerships Program Office, please visit the web site at: http://ipp.gsfc.nasa.gov

Special Announcement

The Goddard Innovative Partnerships Program Office was awarded the Outstanding Technology Transfer Professional Award for 2010 by the Mid-Atlanic Region of the Federal Laboratory Consortium for Technology Transfer.

This award is given annually to recognize the efforts of a technology transfer professionlal or team who has demonstrated outstanding work in transferring technology in a manner significantly over and above what was called for in the normal course of their work.

NASA Inventions and Contributions Board Awards

Third and Fourth Quarter of FY10

icb awards

3rd Quarter Patent Application Awards: 8

Low-Temperature Radiometer by Thomas Hair (Code 552)

Compact Planar Microwave Blocking Filters by Edward Wollack (Code 665)

Passively Q-switched, Side-Pumped Monolithic Ring Laser by Steven Li (Code 554)

Detector for Dual Band Ultraviolet Detection by Bing Guan, Laddawan Miko, David Franz, Diane Pugel (Code 553) and Carl Stahle (Code 550)

Composite Primary Structures Subjected to Cryogenic and Ambient Loading Environments by James Pontius (Code 542)

Directed Flux Motor by Andrew Wilson, Katherine Strausser, Neil Parikh (Code 600)

System and Method for Transferring Telemetry Data between a Ground Station and a Control Center by Vuong Ly, Timothy Ray (Code 583)

System and Method for Embedding Emotion in Logic Systems by Steven Curtis (Code 695)

3rd Quarter Software Release Awards: 23

International Polar Orbiter Processing Package (IPOPP) by Zhangshi Yin, James Rice, John Bane, Kelvin Brentzel, Patrick Coronado, Glen Gardener, Swarvanu Dasgupta (Code 606.3)

Core Flight Software System (CFS) Memory Manager Application Version 1 by David Hardison (Code 583)

Core Flight Software System (CFS) Checksum Application Version 1 by Nicholas Yanchick (Code 583)

GSFC Mission Services Evolution Center (GMSEC) System Agent 2.0 by Chiu Yeung, Waka Waktola (Code 583)

Core Flight Software System (CFS) File Manager Application Version 1 by Susanne Strege (Code 583)

Core HSEG Software Package by James Tilton (Code 606)

Core Flight Software System (CFS) Scheduler Application Version 1 by David Kobe (Code 583)

SLE Forward CLTU Service by Timothy Ray (Code 583)

Core Flight Software System (CFS) Data Storage Application Version 1 by Robert McGraw (Code 583)

Core Flight Software System (CFS) Health and Safety Application Version 1 by Alan Cudmore, Maureen Bartholomew, Alexander Schoening (Code 583)

Goddard Mission Services Evolution Center Architecture Application Programming Interface (GMSEC Architecture API) v. 3.0 by Eric Martin, Vuong Ly, Rick Woods, Robert Wiegand, Matthew Handy (Code 583)

Core Flight Software (CFS) Memory Manager Application v.1 by Maureen Bartholomew (Code 580)

Core Flight Software (CFS) Stored Command Appication v.1 by Nicholas Yanchik, Maureen Bartholomew (Code 583)

Core Flight Software (CFS) Limit Checker Appication v.1 by David Hardison (Code 583)

Core Flight Software (CFS) Housekeeping Appication v.1 by Robert McGraw (Code 583)

LIS 5.0 by Tian Yudong (Code 614)

System and Method for Transferring Telemetry Data between a Ground Station and a Control Center by Vuong Ly, Timothy Ray (Code 583)

Ground and Space Radar Volume Matching and Comparison Software by Kenneth Morris, Matthew Schwaller (Code 422)

Core Flight Software (CFS) Scheduler Application v.1 by Maureen Bartholomew (Code 580)

Core Flight Software (CFS) Checksum Appication v.1 by Maureen Bartholomew (Code 583)

Core Flight Software (CFS) Housekeeping Appication v.1 by Maureen Bartholomew (Code 580)

Range Safety Algorithm Software Module for an Autonomous Flight by Raymod Lanzi (Code 598) and James Simpson (Code 591)

Scalable Integrated Multi-Mission Support System (SIMSS) Simulator Release 2.0 for GMSEC (Goddard Mission Services Evolution Center) by Taylor Casey, John Kim, Sarma Velamuri, Travis Bemann (Code 452)

3rd Quarter Tech Briefs Awards: 27

Cryogenic Pupil Alignment Test Architecture for Aberrated Pupil Images by John Hagopian (Code 551)

Ku Telemetry Modulator for Suborbital Vehicles by James Bishop, David Newman, Nazrui Modhzaki (Code 452) and Steve Bunkdick (Code 569)

Loosely Coupled GPS Aided INS for Range Safety by Raymond Lanzi, Scott Heatwole (Code 598)

Cryogenic Scan Mechanism for Fourier Transform Spectrometer by John Brasunas, John Francis (Code 552)

GlastCam: A Telemetry-Driven Spacecraft Visualization Tool by Dean Chai (Code 600) and Eric Stoneking (Code 591)

Optimal Padding for the Two-Dimensional Fast Fourier Transform by David Aronstein, Jeffrey Smith (Code 551)

Sampling Theorem in Terms of the Bandwidth and Sampling Interval by Bruce Dean (Code 551)

Method of Fabricating Radial Groove Gratings Using Projection Photolithography by Dmitri Iazikov, Thomas Mossberg, Christoph Greiner (Code 600)

Adaptable Gratings with Wavefront Transformation Functionality by Dmitri Iazikov, Thomas Mossberg, Christoph Greiner (Code 600)

Superconducting Millimeter-Wave Bolometer Array by James Chervenak, Christine Jhabvala (Code 553), Samueal Maoseley (Code 660) and Edward Wollack, Suzanne Staggs (Code 665)

Orbit Determination Toolbox by Kate Gregory, Keith Speckman, Sun Hur-Diaz, Derek Surka, Dave Gaylor, Russell Carpenter, Kevin Berry (Code 595)

Gratings Fabricated on Flat Surfaces and Reproduced on Non-flat Substrates by David Content (Code 551)

Systems, Methods, and Apparatus of a Nitinol Valve by Rebecca Gillespie (Code 695)

Reaction Wheel Disturbance Modeling Extraction Software (RWDMES) by Carl Blaurock (Code 600)

Perl Module for Constructing Date Time Iterators by Curt Tilmes (Code 614.5)

Godddard Mission Services Evolution Center Message Bus (GMSEC MB), R2 by Michael Butschky, John Bristow, Arturo Mayorga (Code 581)

GMSEC ANSR by Everette Cary, Robert Antonucci, Peter Hitchener, Joseph Gurganus (Code 583)

The Small Deflection Energy Analyzer (SDEA) by Fred Herrero (Code 553)

Cloud Water Content Sensor for Sounding Balloons and Small UAVs by John Bognar (Code 600)

Small Bolt Torque Tension Tester by Alan Posey (Code 543)

Agora: A Comprehensive General-Purpose Simulation of Attitude and Trajectory Dynamics and Control of Multiple Spacecraft by Eric Stoneking (Code 591)

Ground and Space Radar Volume Matching and Comparison Software by Kenneth Morris, Matthew Schwaller (Code 422)

Focusing Diffraction Gratings Element with Advanced Aberration Control and Wavefront Transformation Properties by Thomas Mossberg, Christoph Greiner, Dmitri Iazkiov (Code 600)

Discrete Fourier Transform (DFT) Analysis in a Complex Vector Space by Bruce Dean (Code 551)

Perl Module for Constructing Iterators from Hashes by Curt Tilmes (Code 614.5)

Optimal Padding for the Two-Dimensional Fast Fourier Transform by Bruce Dean (Code 551)

Hybrid AlGaN-SiC Avalanche Photo-Diode (APD) for Deep UV Photon Detection by Fred Herrero (Code 553) and John Sigwarth, Shahid Aslam, Akin Akturk (Code 670)

4th Quarter Patent Application Awards: 3

Joint Assembly by Katherine Strausser, Andrew Wilson (Code 600)

Walk and Roll Robot by Andrew Wilson, Katherine Strausser, Neil Parikh (Code 600)

A Two-Axis Direct Fluid Shear Stress Sensor Suited for Aerodynamic Applications by Sateesh Bajikar (Code 600)

4th Quarter Software Release Awards: 3

Core Flight Software (CFS) Limit Checker Appication v.1 by Maureen Bartholomew (Code 580)

Core Flight Software (CFS) Data Storage Appication v.1 by Maureen Bartholomew (Code 583)

Core Flight Software (CFS) File Manager Application v.1 by Maureen Bartholomew (Code 580)

4th Quarter Tech Briefs Awards: 10

Gratings Fabricated on Flat Surfaces and Reproduced on Non-flat Substrates by Thomas Mossberg, Christoph Greiner, Dmitri Iazkiov (Code 600)

Large Format AlGaN P-I-N Photodiode Arrays for UV Imagers by David Franz (Code 553) and Shahid Aslam (Code 693)

Visualization in Real-Time Experiment (VIRTEx) by Benjamin Cervantes (Code 589)

Global Precipitation Mission (GPM) Visualization Tool for Validation Network Geometrically-Matched Ground- and Space-based Radar Data by Kenneth Morris (Code 613)

Null Lens Assembly for X-ray Mirror Segments by David Robinson (Code 543)

Continuous Integration Laser Energy Monitor by Jeremy Karsh (Code 564)

Micro-Slit Collimators for X-ray/Gamma-ray Imaging by Michael Appleby, Iain Fraser, Jill Klinger (Code 682)

Magnetometer for Calibrating Jovian Fields by Eric Corsini, David Hovde (Code 600)

A Novel Volumetric 3D Display System with Static Screen by Jason Geng (Code 600)

Thermally Conductive Tape Based on Carbon Nanotube Array by Ali Kashani (Code 600)

4th Quarter Board Awards: 1

International Polar Orbiter Processing Package (IPOPP) by Zhangshi Yin, James Rice, John Bane, Kelvin Brentzel, Glen Gardener, Swarvanu Dasgupta (Code 606.3)

Partnership Profiles

The IPP Office is pleased to announce the recent signing of these agreements.

Partner	Technology/Focus	Type	NASA Goals/Benefits
Johns Hopkins University	Development and Testing of Detectors for Joint NASA/JHU research for CLASS	Reimbursable Space Act Agreement	This Space Act Agreement will be initiated to fund the production of high-sensitivity, feedhorn-coupled, TES-based sensors for the Cosmology Large Angular Scale Surveyor (CLASS), a JHU-led, NSF-funded instrument designed to measure the polarized component of the cosmic microwave background to search for evidence of inflation. CLASS represents a key step in positioning Goddard as a leader for a space mission designed to measure the cosmic microwave background to search for and characterize the small polarized signal from an inflationary epoch early in the history of the universe. Both technologically and scientifically, CLASS along with PIPER set up the Explorer PIXIE which will lead to a probe-sized CMBPol mission for which the detectors and techniques that will be tested on CLASS will be critical. In order to demonstrate that Goddard detectors are the best choice for such a mission, it is essential to field-test them. In this critical area, CLASS represents an enormous opportunity for Goddard, since in this collaboration, the NSF and Johns Hopkins are providing funding to develop and field an instrument that is compatible with detectors developed at GSFC for this purpose. Beyond cosmic microwave background work, this effort will help to sustain the Detector Development Laboratory. In addition to providing funding for DDL work in the near term, success in delivering detectors for CLASS will enhance Goddard's ability to bring in future work. Other detector foundries are actively developing competing technology and are also actively pursuing platforms for testing their detectors.
Astronaut: Moon, Mars & Beyond Albuquerque, NM	Education/ Learning Technologies Office MMO Game	Non-Reimbursable Space Act Agreement	This Space Act Agreement covers the development of a NASA-themed Massively Multiplayer Online game as a tool to address NASA's three major education goals: 1) Strengthen NASA and the Nation's future workforce 2) Attract and retain students in STEM disciplines 3) Engage Americans in NASA's mission. A NASA-themed MMO game built with the goal of engaging young people will enhance STEM (Science, Technology, Engineering, and Mathematics) education by using NASA-themed content that draws and holds their attention with fun and challenging game play. This novel collaboration will involve no exchange of funds between the parties. NASA will provide resources to its partners in the form of access to internal subject matter experts, facilities, data, and technologies, which will be crucial to development of the game environment and missions. NASA will also coordinate the engagement of educational design and evaluation experts consisting of curriculum content support, game design feedback, and access to the most current research pertaining to use of MMO games for educational purposes. NASA's partners are responsible for research, development, testing, marketing, distribution, and maintenance of the game with a target audience of students (13 and older) from the middle school level through college.

Call for *NASA Tech Briefs* Magazine "Tech Needs" Article Ideas

NASA Tech Briefs (http://www.techbriefs.com) is a monthly magazine with a readership of approximately 450,000 that features the latest NASA-developed technologies. The magazine also features a "NASA Tech Needs" article that addresses a technology need for which NASA is seeking a solution.

Goddard Space Flight Center is continuously seeking ideas for Tech Needs articles to submit for publication in *Tech Briefs*. This is a great opportunity for Goddard researchers to reach a broader audience to find viable solutions from industry and academia.

If you are a Goddard civil servant or contractor and have an idea for a Tech Needs article, please e-mail your idea to Brent.P.Newhall@nasa.gov. For the submission, please summarize in 400 words or less:

1. A statement of the problem that requires a technology solution
2. Solutions previously explored
3. Specific applications that would benefit from this "new" technology

Feel free to include any graphics or pictures that would help explain the technology need.

Correction

In the Summer 2010 issue of *Goddard Tech Transfer News,* we published an article entitled, "Advanced Cryogenic Fluid Management," which contained errors.

The story claimed that liquid helium was used to "subcool" the liquid hydrogen propellant to below its 20 Kelvin boiling point at one atmosphere pressure. In fact, liquid helium is not used to subcool the cryogenic propellant.

The thermodynamic cryogen subcooler (TCS) actually uses a small fraction of the liquid hydrogen supplied to the propellant tank for launch to "subcool" the bulk hydrogen in the propellant tank that will be launched. Using the cryogen that is already being cooled as the coolant reduces the footprint required to "subcool" the cryogenic propellant. Cold gaseous helium is used as a pressurant to maintain the pressure in the tank at 1 atmosphere while the cryogen is being "subcooled."

To read the full, corrected version of this story, please visit our online archives at:

http://ipp.gsfc.nasa.gov/tech_transfer_magazine.shtm

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New Technology Reports: 132

Methods and Algorithms for Solving a Broad Class of Optimization Problems by James Rash (Code 585)

Reliability Risk Reduction of LISA MOPA by Al Piccirilli (LGS Innovations LLC)

Sapphire Viewports for a Venus Probe by Stephen Bates (Thoughtventions Unlimited LLC)

Prototype Genomics Based Keyed-Hash Message Authentication Code Protocol by Harry Shaw (Code 567)

Ultra-low Dropout Linear Regulator by Trevor Thornton (Arizona State University)

Computer Controlled Automated Safe to Mate for both Flight Hardware and Ground Support Equipment by Phuc Nguyen (Code 561)

Innovative Low CTE, Lightweight Structures by Dean Baker (Code 551)

Lunar Reconnaissance Orbiter (LRO) Command and Data Handling Flight Electronics Subsystem by Quang Nguyen (Code 561)

Nanoscale Electric Field Sensor Using the Change of Carbon Nanotube Electrical Resistance with Applied Strain by Stephanie A. Getty (Code 541)

Flight Software Math Library by David McComas (Code 582)

Lunar Reconnaisance Orbiter (LRO) Spacecraft Flight Software by Michael Blau (Code 582)

Sonic Thermometer for High Altitude Balloons by John Bognar (Anasphere Inc.)

Molecular Adsorber Coating by Sharon Straka (Code 546)

The ACS Fastener Capture Plate for Repair of Advanced Camera for Surveys (ACS) by Torchia Kelly (Code 540)

ASIC Readout Circuit (ROIC) Architecture for Large Geiger Photodiode Arrays by Stefan Vasile (Code 553)

Dynamic Monitoring of Cleanroom Fallout using an Air Particle Counter by Radford Perry (Code 546)

Selectable Internet Protocol Slaving (SIPS) by Charlotte S. Teter (Code 589)

Labor Pricing Template by Angela Schuler (Code 153)

HEXPANDO: Expanding Head for Fastener Retention Hexagonal Wrench by John Bishop (Code 540)

Method of Bonding Optical Elements with Near Zero Displacement by David Robinson (Code 543)

Verilog: A Device Model for Cryogenic Temperature Operation of Bulk Silicon CMOS Devices by Akin Akturk (Code 564)

Innovative Low CTE, Lightweight Structures, Higher Strength by Dean Baker (Code 551)

GREAT: GMSEC (Goddard Mission Services Evolution Center) Reusable Events Analysis Toolkit by Tina Tsui (Code 583)

Miniature Laser Magnetometer (MLM) by Robert Slocum (Code 549)

X-Ray Detection and Processing Models for Spacecraft Navigation and Timing by Sheikh Suneel (Code 595)

Radiation Resistant Hybrid Lotus Effect Photoelectrocatalytic Self-Cleaning Anti-Contamination Coatings by Taylor W. Edward (Code 540)

Photo-Thermo-Refractive Glass Co-Doped with Luminescent Agents as a Complex Medium for All-Solid-State Microchip Lasers by Leonid Glebov (Code 554)

An Ultraminiature Fully Integrated High Resolution Spectrometer for the Submillimeter and Millimeter Spectral Region by Samuel H. Moseley (Code 553)

Monolithic Dual Telescopes for Compact Biaxial LIDAR by David Lawrence (Code 613.1)

Apparati and Methods to Enable Sub-MHz Precision in Fast Laser Frequency Tuning by Jeffrey R. Chen (Code 554)

Software Tools for Rapid Algorithm Development of HPC, Data-Processing Hardware by Paul Mullowney (Code 564)

Core Flight Software System (CFS) Scheduler Application, Version 2 by Maureen Bartholomew (Code 582)

A Cryptographic Approach to MicroRNA Target Binding Analysis by Harry Shaw (Code 567)

Wedged Planar Waveguide Laser and Amplifier by Steven Li (Code 554)

Sub-Nanosecond, Compact, Low-Power, Low-Cost, Time Interval Measurement by Richard B. Katz (Code 564)

Core Flight Software System (CFS) CFDP, Version 2 by Medina Barbara (Code 582)

Core Flight Software System (CFS) Data Storage Application, Version 2 by Robert McGraw (Code 582)

Core Flight Software System (CFS) Housekeeping Application, Version 2 by Maureen Bartholomew (Code 582)

Laser Mode Beating Suppression Using a Monolithic Coupled Etalon by Steven Li (Code 554)

The Core Flight Executive (cFE) Application Program Interface (API) by Robert McGraw (Code 582)

Fabrication of a Cryogenic Bias Filter for Ultrasensitive Focal Planes by James Chervenak (Code 553)

Fabrication of a Cryogenic Terahertz Emitter for Bolometer Focal Plane Calibrations by James Chervenak (Code 553)

A Lightweight, Mini Inertial Measurement System for Position and Attitude Estimation on Dynamic Platforms by Liang Tang (Code 569)

A Magnetic Thermometer for High-Resolution 10 mK Scale Thermometry by Robin Cantor (Code 552)

Three Mirror Afocal Telescope Automatic Design Algorithm by Joseph M. Howard (Code 551)

Optical Mass Gauging System for Measuring Liquid Levels in a Reduced Gravity Environment by Azer P. Yalin (Code 552)

Micromachined Active Magnetic Regenerator for Low Temperature Magnetic Coolers by Michael Jaeger (Code 552)

Single Photon Sensitive HgCdTe Avalanche Photodiode Detector (APD) by Andrew Huntington (Code 554)

Simultaneous Amplitude nd Wavefront Control with MEMS Deformable Mirror and Spatial Filter Array by Richard Lyon (Code 667)

Controlling Ion Beams with Inhomogeneous Electric Fields by Fred Herrero (Code 553)

The Aperture Ion Source by Fred Herrero (Code 553)

Wafer Level Microchannel Fabrication Process for Lab-on-a-Chip Devices by Yun Zheng (Code 553)

Germanium Lift-Off Masks for Thin Metal Film Patterning by Ari D. Brown (Code 553)

Graphene Transparent Conductive Electrodes for Next Generation Microshutter Arrays by Mari Li (Code 553)

Resonance-Actuation of Microshutter Arrays by Mari Li (Code 553)

30 Convergent Ion Beam by Federico A. Herrero (Code 553)

Core Flight Software System (CFS) Health and Safety Application, Version 2 by Maureen Bartholomew (Code 582)

Measurement via Optical Near-Nulling and Subaperture Stitching by Greg Forbes (Code 551)

White, Electrically Dissipative, Thermal Control Coating by Mark M. Hasegawa (Code 546)

White, Electrically Conductive, Radiation Stable, Thermal Control Coating by Mark M. Hasegawa (Code 546)

A Device for Life Detection and Preparation for In Situ Genomics on Solar System Bodies by Timothy A. Stephenson (Code 541)

Methods for Construction of a High Capacity, Electrically Dissipative/Conductive, Molecular Adsorber System for Spacecraft Surfaces by Mark M. Hasegawa (Code 546)

Electrically Conductive Primer for Silicate Thermal Control Coatings by Mark M. Hasegawa (Code 546)

Data Downloader by Brian M. Duggan (Code 614.5)

ISFS: Invasive Species Forecast System by Neal F. Most (Code 606)

Binding Causes of Printed Wiring Assemblies (PWA) with Card-Loks, and Extravehicular Activity (EVA) Extraction Requirements and Methodologies for PWA Removal by Hans Raven (Code 540)

ACS Anchor Guide Stud and Caddy Technology used in the Repair of the Advanced Camera for Surveys (ACS) Instrument on the Hubble Space Telescope (HST) Servicing Mission 4 by Thomas L. Riggleman (Code 540)

Imaging System Aperture Masks for Image Plane Exit Pupil Characterization: New Functionality by Brent J. Bos (Code 551)

Visible Nulling Coronagraph by Richard Lyon (Code 667)

Null Control Breadboard by Richard Lyon (Code 667)

Advanced Lightweight Metal Matrix Composite Segmented Optic Manufacture by Vladimir Vudler (Code 551)

NASA Experiment Designer: A Client-Server GUI Tool for Running Generic Workflows by Megan Damon (Code 610.3)

Room Alert Adapter, Version 1.0 by Marylin Mix (Code 583)

GMSEC API Performance Testing Utility, Version 3.2 by Vuong T. Ly (Code 583)

Integrated Trending and Plotting System (ITPS), Release 6.0 by Sheila Ritter (Code 583)

GRASP: GMSEC Remote Application Service Provider by Matthew Handy (Code 583)

Integrated Trending and Plotting System (ITPS), Release 7.0 by Sheila Ritter (Code 583)

Integrated Trending and Plotting System (ITPS), Release 8.0 by Sheila Ritter (Code 583)

Resin Impregnated Carbon Ablator (RICA): A New Ablative Material for Hyperbolic Entry Speeds by Jaime Esper (Code 592)

Extra-Vehicular Activity (EVA) Hardware and Procedure Modifications to Minimize Anthropogenic Dust Contamination at a Planetary Analog by Brent J. Bos (Code 551)

Leica Wild T3000 CCD Camera Lens Interface for Real Time Theodolite Alignment with Simultaneous Alignment Ability with Multiple Theodolites by Shane W. Wake (Code 551)

Rapid Process to Generate Beam Envelopes for Optical System Analysis by Joseph Howard (Code 551)

Novel, Low Impact Ecocomposite Material: Sustainably Sourced "Green" Radiation-and Heat-Insulating Zone of Organic Material (RHIZOM) for Shielding and Protection Purposes by Diane Pugel (Code 553)

Aerogel Embedded Carbon Nanotubes for Stray Light Control and Other Applications by John Hagopian (Code 551)

Hypergaussian Nanotube Spoiler for Stray Light and Diffraction Suppression by John Hagopian (Code 551)

Epoxy Embedded Carbon Nanotubes for Stray Light Suppression and Other Applications by John Hagopian (Code 551)

CREAM Flight Software by Susannah Warner (Code 589)

Implementation Platform for New Methodology of Reducing Sensor and Readout Electronics Circuitry Noise in Digital Domain Using Reference by Semion Kizhner (Code 564)

Null Diversity for Coronagraphy by Richard Lyon (Code 667)

A High Event Rate, Zero Dead Time, Multi-Stop Time-to-Digital Converter Application Specific Integrated Circuit by George Suarez (Code 564)

A Sphere Recognition Algorithm for Localization and Tracking of Objects in LIDAR-Generated Point Clouds by Gabriel Trisca (Code 400)

Detection of Methane for Pipeline Leak Detection and Greenhouse Gas Detection by Haris Riris (Code 694)

Filtering Etalon Fringes in Lidar Measurements using Ensemble Detection and Analysis by Paul E. Racette (Code 555)

Non-destructive Method for Photoresist Residue Removal from Metallic Thin Films by Ari D. Brown (Code 553)

A Systematic Method for Robust Multivariable Optimization and Performance Simulation for Application Specific Integrated Circuit Design by Jeffrey J. DuMonthier (Code 564)

Digital Beamforming Synthetic Apeture Radar (SAR) Multi-Mode Operation (DBSAR) by Rafael F. Rincon (Code 555)

Flip Around Sub-Ranging (FASR) Quantizer by Gerard Quilligan (Code 564)

Receiver Gain Modulation Circuit (RGMC) by Hollis Jones (Code 555)

Novel Hollow Cathode Design Utilizing C12A7 Electride by Laureen P. Rand (Code 553)

A Lunar Electromagnetic Launch System for In-Situ Resource Utilization by Michael R. Wright (Code 455)

A Technique for Absolute Position of Targets Measured Through a Chamber Window Using LIDAR Metrology Systems by David Kubalak (Code 551)

Fine Control and Maintenance Algorithm for Visible Nulling Coronagraphy by Richard Lyon (Code 667)

Software Suite for Modeling and Simulation of Visible Nulling Coronagraphs and Interferometers by Richard Lyon (Code 667)

Software Suite for Modeling and Simulation of Shaped External Occulters by Richard Lyon (Code 667)

Expedite the Processing of Experiments to the Space Station (ExPRESS) Logistics Carrier (ELC) Flight Software (FSW) by Daniel L. Berry (Code 582)

Time-Voltage Digitizer by Gerard T. Quilligan (Code 564)

Cold Weather Technology Development for Low Altitude Ultra-Long Endurance Applications by Daniel Hatfield (Code 614.6)

885nm Pumped Ceramic Nd:YAG Master Oscillator Power Amplifier Laser System by Anthony W. Yu (Code 554)

SpaceCube Mini by Michael Lin (Code 561)

Hybrid Free Space/Fiber Demultiplexor for Dual Polarization, Multicolor Lidar by Christopher T. Field (Sigma Space Corporation)

Passive Aerosol Cloud Suite (PACS) by Lorraine Remer (Code 613.2)

Fabrication of an Absorber-Coupled MKID Detector and Readout for Sub-Millimeter and Far-Infrared Astronomy by Ari D. Brown (Code 553)

Large Area Mosaic Polarizer by Eugene Waluschka (Code 551)

SpeckleCam, Electronic Speckle Pattern Interferometer (ESPI) for Testing Large Diffuse Structures by Michael North-Morris (Code 551)

MicroProbe - A Small Unmanned Aircraft System (UAS) with Electric Propulsion Tailored for In-Situ and Remote Sensing Measurements by Geoffrey L. Bland (Code 614.6)

Goddard Mission Services Evolution Center Architecture Application Programming Interface (GMSEC Architecture API) v. 3.2 by Robert E. Wiegand (Code 583)

SuperAeroPod - A Significant Enhancement to the AeroPod Instrument Package Used for Kite-based Airborne Observations by Geoffrey L. Bland (Code 614.6)

GISS GCM ModelE by Gary Russell (Code 611)

Space Operations Learning Center (SOLC) Facebook Application by Ben Lui (Code 581)

Integrated Lunar Information Architecture for Decision Support Version 2.0 (ILIADS 2.0) by Stephen J. Talabec (Code 587)

Integrated Lunar Information Architecture for Decision Support Version 3.0 (ILIADS 3.0) by Stephen J. Talabec (Code 587)

Lightweight Magnetic Cooler With a Reversible Circulator by Mark Zagarola (Creare Incorporated)

Lunar Path Planning Assistant (LPPA) by Jacqueline Le Moigne (Code 580)

Required Assurance and Reliability Estimator by Donna Smith (Code 589)

LandTrendr v0.4xxx by Robert Kennedy (Oregon State University)

GREAT: GMSEC (Goddard Mission Services Evolution Center) Reusable Events Analysis Toolkit, Version 1.8 by Tina Tsui (Code 583)

Minnow - A Tool for Determining an Average Pointing Given an Attitude History by Robert Wiegand (Code 583)

Cryogenic and Radiation Modeling for Silicon-on-Insulator Devices and Technology by Neil Goldsman (CoolCAD Electronics)

Dispersion-engineered Travelling Wave Kinetic Inductance Parametric Amplifier by Jonas Zmuidzinas (Caltech)

Miniature Thermoelectric Ice Core Extractor and Pressure Chamber for Retrieving Icy Regolith Samples on Extraterrestrial Surfaces by Alvin G. Yew (Code 596)

Data Capture, Storage, and Distribution for the Scientific Visualization Studio at Goddard by Jocelyn Thomson (Code 610.3)

Anomaly Precursor Potential Dispositioning (APPD) Form by Gaspare Maggio, Chris Everett, Anthony Hall (Information Systems Laboratories)

Patent Applications Filed: 17

Method for Utilizing Properties of the Sinc(X) Function for Phase Retrieval on Nyquist-Under-Sampled Data by Jeffrey Smith, David Aronstein, Bruce Dean (Code 551)

System and Method for Command and Data Handling in Space Flight Electronics by Quang Nguyen, William Yuknis, Noosha Haghani, Scott Pursley (Code 561) and Omar Haddad (Code 560)

Imaging Device by Michael Krainak (Code 554)

Radiation-Hardened Processing System by David Petrick, Alessandro Geist, Gary Crum, Manuel Buenfil, Jeffrey Hosler, Tom Flatley, Daniel Espinosa (Code 587)

Expandable and Reconfigurable Instrument Node Arrays by Lawrence Hilliard (Code 550), Manohar Deshpande (Code 555)

System and Method for Multi-Scale Image Reconstruction Using Wavelets by Bruce Dean (Code 551)

Ion Source with Corner Cathode by Federico Herrero (Code 553), Patrick Roman (Code 560)

System and Method for Determining Phase Retrieval Sampling from the Modulation Transfer Function by Bruce Dean (Code 551)

System and Method for Progressive Band Selection for Hyperspectral Images by Kevin Fisher (Code 581)

LIDAR Luminence Quantizer by Gerard Quilligan, Jeffrey DuMonthier, George Suarez (Code 564)

Phase Retrieval System for Assessing Diamond-Turning and Other Optical Surface Artifacts by Alex Maldonado, Matthew Bolcar, Bruce Dean (Code 551)

Radiation-Hardened Hybrid Processor by Alessandro Geist, David Petrick, Tom Flatley (Code 587) and Michael Lin (Code 561)

Widely Tunable Optical Parametric Generator Having Narrow Bandwidth Field by Steven Li (Code 554)

ADR Salt Pill Design and Crystal Growth Process for Hydrated Magnetic Salts by Edgar Canavan, Peter Shirron, Michael DiPirro (Code 552)

System and Method for Phase Retrieval for Radio Telescope and Antenna Control by Bruce Dean (Code 551)

Low Power, Automated Weight Logger by John Cavanaugh (Code 554), Wayne Esaias (Code 614.2)

Low-Noise Large-Area Quad Photoreceivers Based on Low-Capacitance Quad Photodiodes by Abhay Joshi (Discovery Semiconductors Inc.)

Patents Issued: 5

Miniaturized Double Latching Solenoid Valve by James Smith (Code 554)

Reconfigurable Structure by Steven Curtis (Code 695)

Systems, Methods and Apparatus for Verification of Knowledge-Based Systems by Michael Hinchey (Code 585), Christopher Rouff (Code 500), James Rash, John Erickson (Code 588) and Denis Gracanin (Virginia Polytechnic Institute and State University)

Gear Bearings by John Vranish (Code 554)

System and Method Of Self-Properties for an Autonomous and Autonomic Computer Environment by Michael Hinchey, Roy Sterritt (Code 585)

Lunar Reconnaissance Orbiter (LRO) Mission Update

We covered the LRO mission following its launch in the Summer 2009 issue of *Goddard Tech Transfer News.* In December 2010, Goddard scientists unveiled a new topographic map of the moon which is unprecedented in both its complexity and completeness.

Using the Lunar Orbiter Laser Altimeter (LOLA), GSFC scientists have recorded nearly 3 billion data points over the last year, and hope to continue collecting data at that current rate over the next two years.

Ultimately, they expect to be able to develop near-GPS quality navigational capabilities on the surface of the moon from the measurements that LOLA is taking.

Goddard Tech Transfer News **http://ipp.gsfc.nasa.gov**

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