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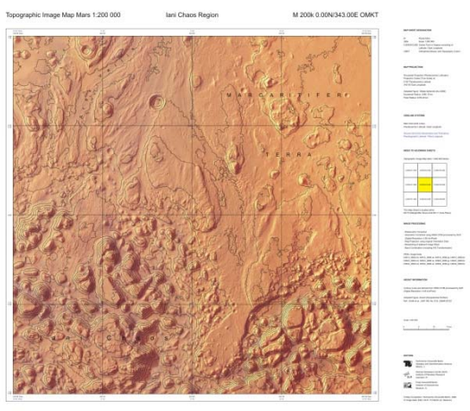
Summary (May 21, 2008): Technology that could someday provide 3D roadmaps of other planets and moons is now in development. The information the maps provide would help in designing future scientific missions to locations in the solar system.

Interplanetary Road Maps

Based on a *Rochester Institute of Technology* news release

Technology that could someday "MapQuest" Mars and other bodies in the solar system is under development at Rochester Institute of Technology's Rochester Imaging Detector Laboratory (RIDL), in collaboration with Massachusetts Institute of Technology's Lincoln Laboratory.



Data from Mars Express is already being used to produce topographic maps of Mars. The image above is at a scale of 1:200 000. The new technology being developed at RIT will provide more than just 2D maps. Click for larger view. Credit: *ESA*

Three-Dimensional "super roadmaps" of other planets and moons would provide robots, astronauts and engineers details about atmospheric composition, biohazards, wind speed and temperature. Information like this could help land future spacecraft and more effectively navigate roving cameras across martian or lunar terrain. The technology could prove invaluable in future human missions to locations like Mars, where scientists will play a key role in the search for signs of past or present life on the Red Planet.

RIT scientist Donald Figer and his team are developing a new type of detector that uses LIDAR (LIght Detection and Ranging), a technique similar to radar, but which uses light instead of radio waves to measure distances. The project will deliver a new generation of optical/ultraviolet imaging LIDAR detectors that will significantly extend NASA science capabilities for planetary applications by providing 3-D location information for planetary surfaces and a wider range of coverage than the single-pixel detectors currently combined with LIDAR.

The device will consist of a 2-D continuous array of light sensing elements connected to high-speed circuits. The $547,000 NASA-funded program also includes a potential $589,000 phase for fabrication and testing.

The new LIDAR device will also be used to study the composition and physical properties of comets, asteroids and moons.
Credit: *NASA*

"The imaging LIDAR detector could become a workhorse for a wide range of NASA missions," says Figer, professor in RIT's Chester F. Carlson Center for Imaging Science and director of the RIDL. "It could support NASA's planetary missions like Europa Geophysical Orbiter or a Mars High-resolution Spatial Mapper."

LIDAR works by measuring the time it takes for light to travel from a laser beam to an object and back into a light detector. The new detector can be used to measure distance, speed and rotation. It will provide high-spatial resolution topography as well as measurements of planetary | atmospheric properties—pressure, temperature, chemical composition and ground-layer properties. The device can also be used to probe the environments of comets, asteroids and moons to determine composition, physical processes and chemical variability.

Working with Figer are Zoran Ninkov and Stefi Baum from RIT and Brian Aull and Robert Reich from Lincoln Laboratory. The team will apply LIDAR techniques to design and fabricate a Geiger-Mode Avalanche Photodiode array detector. The device will consist of an array of sensors hybridized to a high-speed readout circuit to enable robust performance in space. The radiation-hard detector will capture high-resolution images and consume low amounts of power.

The imaging component of the new detector will capture swaths of entire scenes where the laser beam travels. In contrast, today's LIDAR systems rely upon a single pixel design, limiting how much and how fast information can be captured.

"You would have to move your one pixel across a scene to build up an image," Figer says. "That's the state of the art of LIDAR right now. That's what is flying on spacecraft now, looking down on Earth to get topographical information and on instruments flying around other planets."

The LIDAR imaging detector will be able to distinguish topographical details that differ in height by as little as one centimeter. This is an improvement in a technology that conflates objects less than one meter in relative height. LIDAR used today could confuse a boulder for a pebble, an important detail when landing a spacecraft.

"You can have your pixel correspond to a few feet by a few feet spatial resolution instead of kilometer by kilometer," Figer says. "And now you can take LIDAR pictures at fine resolutions and build up a map in hours instead of taking years at comparable resolution with a single image."

The imaging LIDAR detector will be tested at RIDL in environments that mimic aspects of operations in NASA space missions.

In addition to planetary mapping, imaging LIDAR detectors will have uses on Earth. Other applications include remote sensing of the atmosphere for both climate studies and weather forecasting, topographical mapping, biohazard detection, autonomous vehicle navigation, battlefield friend/foe identification and missile tracking, to name a few.

The new technology will also be used on Earth to provide important data in studies ranging from climate and atmospheric science to biohazard detection.
Credit: *NASA Goddard Space Flight Center*

"There is an increasing demand for highly accurate three-dimensional data to both map and monitor the changing natural and manmade environment," says Ninkov, professor of imaging science at RIT. "As well as spaceborne applications there are terrestrial applications for LIDAR systems such as determining bridge heights, the condition of highways and mapping coastal erosion as sea heights rise."

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Note: *Moon to Mars*

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