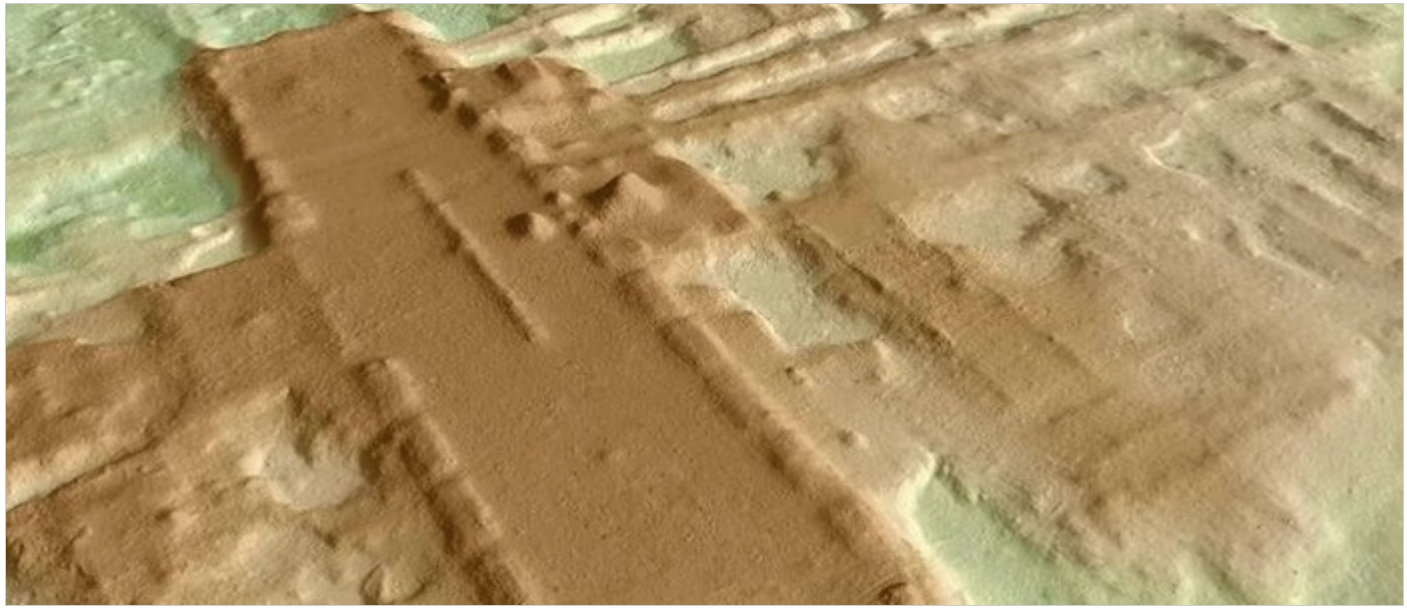
News

Archaeologists Employ LiDAR to Uncover the Secrets of Long-Lost Empires

June 09, 2020 by Gary Elinoff

LiDAR technology in archeology has developed distinctly from LiDAR in ADAS. The most recent find? An ancient Mayan ceremonial site.

Last week, archeologists discovered 3,000-year-old Mayan ceremonial ground, including a 13-foot-high pyramid—the largest and oldest construction in the region. The key to the researcher's discovery? LiDAR.



Maya site in Aguanda Fénix, Mexico. Image used courtesy of the Takeshi Inomata et al. and Smithsonian Magazine

LiDAR has many uses—the one most familiar to electrical engineers being advanced driver assistance systems (ADAS). In this common

application, LiDAR can calculate the distance between vehicles by measuring how long it takes for a pulsed laser beam to travel to its target and return. It then divides that time in half and multiplies it by the speed of light to come to a correct measurement.

But it turns out that LiDAR technology, in general, has developed in unique ways distinct from LiDAR in ADAS—particularly in archeology.

By illuminating the forest floor with laser light and measuring the refection with specialized sensors, scientists are uncovering details of amazingly sophisticated cities that thrived many centuries ago. These researchers measure the time it takes for pulses directed at the ground to return back to the instrument, at which point, they use GPS to plot the data. They then turn to computers to construct those measurements into a 3D map of the area.

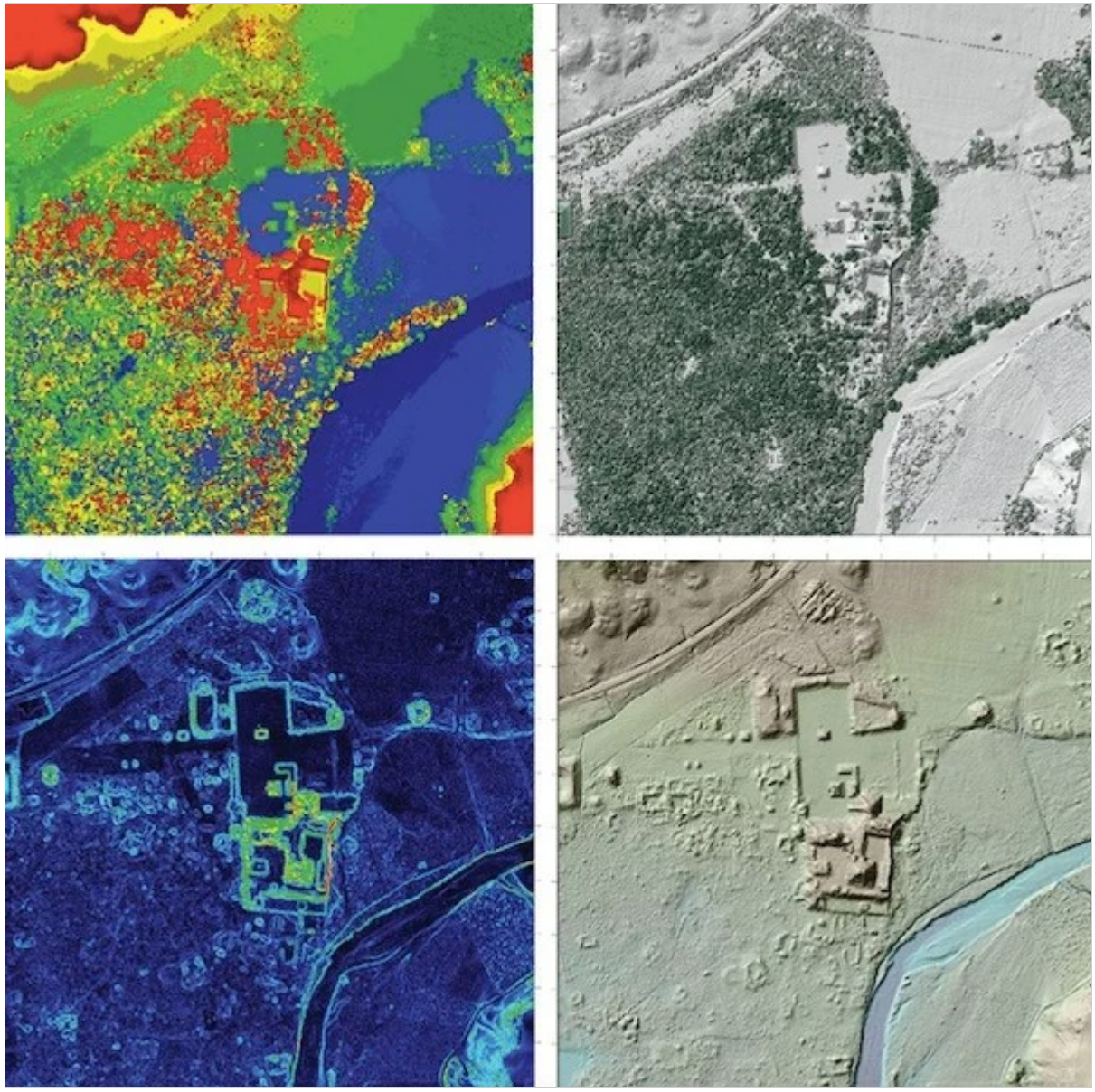
National Geographic points out the strengths and weaknesses of LiDAR in archeological applications—the primary strength being its ability to identify minuscule surface anomalies that may indicate small sites like graves or monumental ones, like the recently-discovered Mayan ceremonial ground. One limitation, however, is that LiDAR sometimes fails to reach the ground, especially through dense foliage.

Here are a few milestones of how LiDAR has been used to advance archeology, illustrating the potential of this technology.

LiDAR and Archeology: A "Serendipitous" Pairing

LiDAR Magazine writers Andrew Moller and Dr. Juan C. Fernandez-Diaz describe the first use of LiDAR for archeological exploration as "serendipitous."

In response to a hurricane in Honduras in 1998, the Bureau of Economic Geology at the University of Texas and the US Geological Survey employed an Optech ALTM 1225 airborne LiDAR to derive topographic data for flood risk maps.



LiDAR survey images a Mayan site in Copán, Honduras. Image used courtesy of LiDAR Magazine

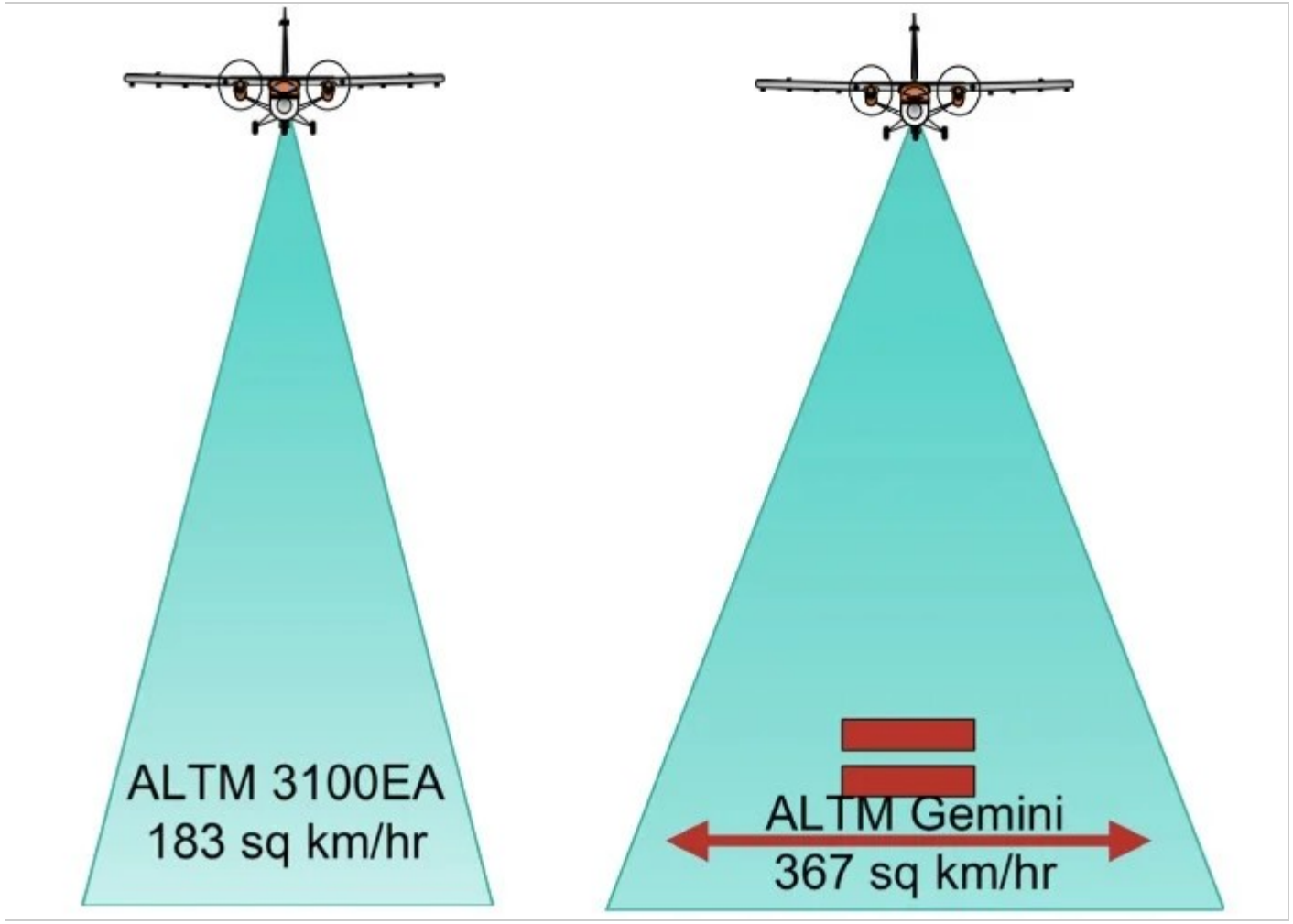
The Optech ALTM 1225 had recorded both the first and last returned pulses. The earlier pulses corresponded to the foliage, and the last pulses to the actual ground. Through this effort, huge swaths of jungle floor could be cataloged without large teams of human surveyors spending months trekking through the rainforest.

In this endeavor, the Optech ALTM 1225 surveyed widespread archeological sites without human surveyors, photography, or synthetic-aperture radar (SAR).

Other Developments in LiDAR from Surveying Projects

The next significant iteration of the Optech ALTM 1225 was the ALTM Gemini, which could not only fire more pulses than its predecessor but also shorter ones. More pulses mean that more lasers can pass through the forest canopy.

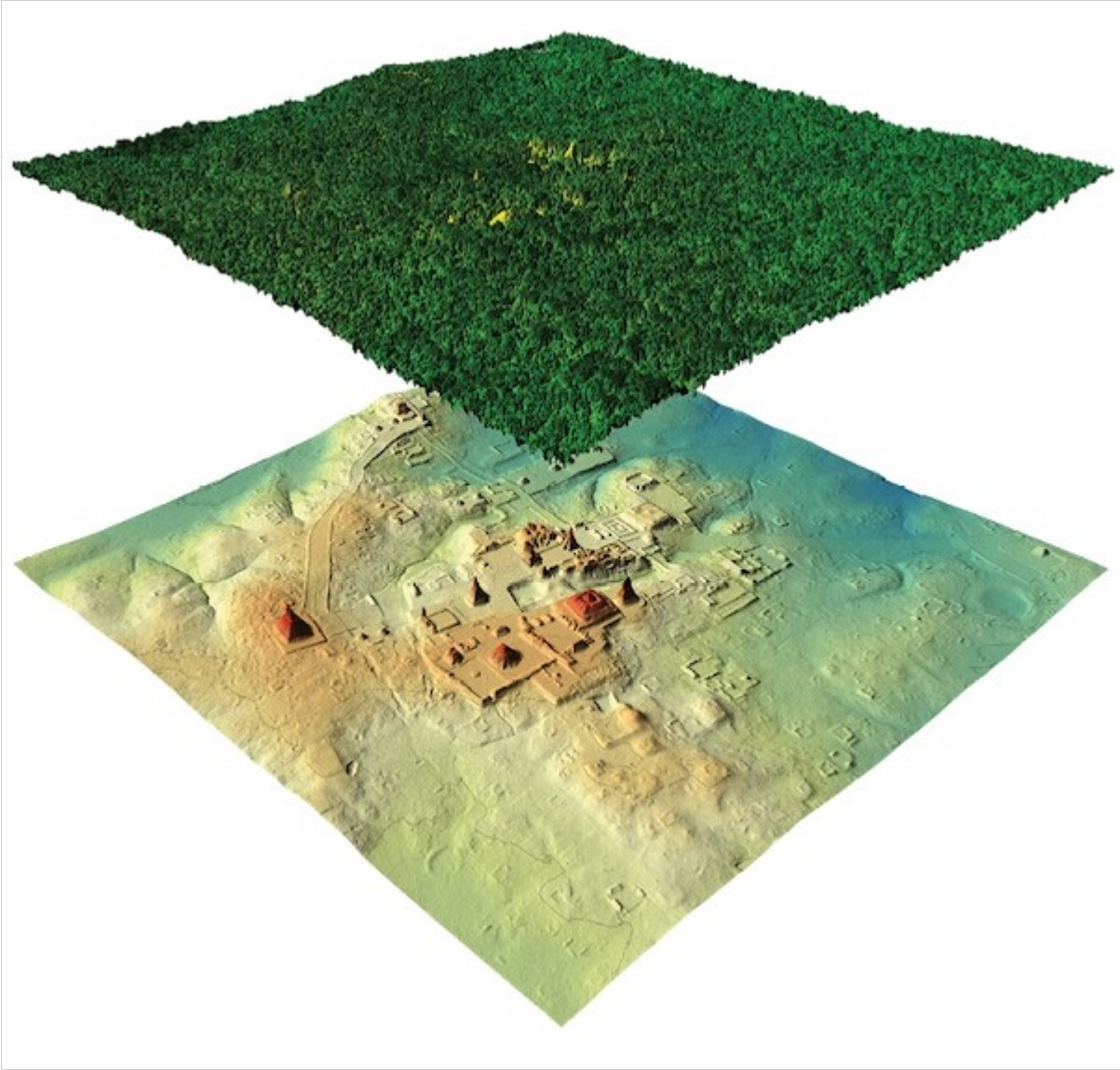
Another advantage of the ALTM Gemini was its shorter pulses, providing finer resolution and allowing it to distinguish objects that were between two and three meters apart (as opposed to five meters from the ALTM 1225).



The pulse density and coverage of ALTM 3100EA vs. ALTM Gemini. Image (modified) used courtesy of Optech

The National Center for Airborne Laser Mapping (NCALM), used this improved capability to uncover the Sky-Palace pyramid at the Caracol Maya site in Belize.

Teledyne Optech's ALTM Titan was the next improvement. This device not only fired faster with a shorter pulse width, but it also sported three separate lasers, each pointing at a slightly different angle. This made it more likely for at least some of the pulses to make it through the canopy to the forest's floor.



Titan LiDAR can distinguish mapping data of the forest canopy from hidden landscapes beneath. The above image depicts the ancient Mayan city of Tikal. Image used courtesy of LiDAR Magazine

The Titan also had another significant upgrade; it could map sites in color. Each of the Titan's lasers operated at different wavelengths—532 nm,

1064 nm, and 1550 nm. Because different materials react more strongly to different light wavelengths, the ground reflected a colorized image.

Similar to “colorized” electron microscope images, “colorization” in archeological maps is extremely helpful in visualizing boundaries and gradations within and between structures.

This technique was used to survey a 2,100 km^2 area in Guatemala to reveal the Mayan city of Tikal.

Hiding in Plain Sight

In a recent airborne LiDAR survey (the findings of which were published last week), archeologists discovered monumental architecture at Aguada Fénix in the Mayan area. This site was "hidden in plain sight," unknown even to locals. The obvious question is, Why did it take an advanced electronic study to discover something so seemingly obvious?

Archaeologist Takeshi Inomata of the University of Arizona shared his thoughts in a National Geographic article: “It’s fairly hard to explain, but when you walk on the site, you don’t quite realize the enormity of the structure...It’s over 30 feet high, but the horizontal dimensions are so large that you don’t realize the height.”

Optech's ALTM-Gemini equipment. Image used courtesy of Direct Industry

Using LiDAR via aircraft dramatically speeds anthropology efforts, too, according to Colorado State University anthropology professor Christopher Fisher. "In 45 minutes of flying, the LiDAR team accomplished a decade's worth of archaeological survey," he remarked.

Interdisciplinary Work of EEs

Even in fields as divergent electronics, anthropology, and archaeology, advances in one field are sure to lead to progress in many others. Have you ever worked on a project that intersected in interesting ways with other fields? Share your experiences in the comments below.