

SPACE-AGE TECHNOLOGY

comes down to earth to
improve safety at airports

A Neptec Technologies Corp. OPAL-120 LiDAR, similar to the OPAL-360 LiDAR that will be used in the Technische Universität airport tarmac safety project in Germany, is shown mounted on a van overlooking the Macdonald-Cartier International Airport apron in Ottawa, Canada.

A German airport is the latest example of how 3D laser scanners are increasingly finding new applications beyond traditional survey and mapping. Dresden International Airport, as part of an airport tarmac safety project being conducted by Dresden's Technische Universität, is using space-age technology from Canada to help it improve safety on the airport apron, or ramp.

It's the airport equivalent of finding a needle in a haystack—and the stakes are very high.

An airport apron is where aircraft park and get refueled and loaded with cargo, and where passengers board and exit planes. It's an extremely congested and dynamic area exposed to a wide variety of objects and participants, all very different in size and behavior, concentrated in a very limited space and operating in all types of weather. The risk of an accident, whether between two aircraft or between an aircraft

and a ground vehicle, or an accident or damage caused by foreign objects—such as aircraft parts, tire fragments, mechanics' tools, nails, luggage parts, broken pavement and stones—is high. So, too, are the potential costs.

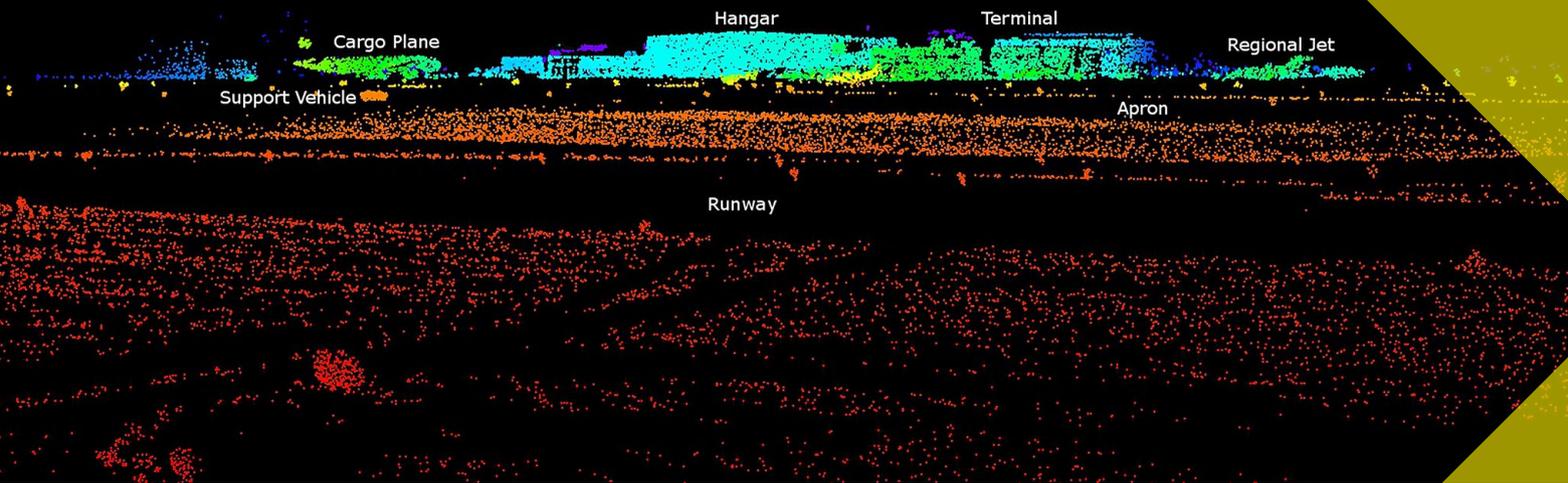
“Ramp accidents cost major airlines at least US\$10 billion every year.”

In 2007, the Flight Safety Foundation estimated that ramp accidents cost major airlines at least US\$10 billion every year in direct and indirect costs, and that about 243,000 people were being injured. Another estimate from the aircraft manufacturer Boeing suggested that damage caused by foreign object debris, or FOD, totals at least US\$4 billion a year, although the consulting group Insight SRI suggests the figure could be considerably higher.

With figures like that, it's easy to see why the U.S. National Transportation Safety Board included airport surface operations on its 2013 most-wanted list of transportation industry improvements and why improving airport surface operations is one of

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A 3D scan of Ottawa's Macdonald-Cartier International Airport acquired with the OPAL-120 LiDAR, showing the runway, apron and associated buildings, aircraft and vehicles.



the top priorities of the U.S. Federal Aviation Administration. It's also easy to see why airports are turning to space-age technology for help.

The TU Dresden recently selected Neptec Technologies Corporation's OPAL-360 3D laser scanners—which use technology originally developed for the International Space Station and the U.S. Space Shuttle—for the airport tarmac safety project. The research project, led by Professor Dr. Hartmut Fricke, Dean of the Faculty of Transportation and Traffic Sciences at TU Dresden, is looking at innovative ways to improve the safety level of airport operations with a real-time 3D point cloud surveillance and visualization system for the airport apron controller.

Apron management is usually performed by the airport ground or apron controller, who relies on a direct line-of-sight to the apron, sometimes enhanced by video cameras or high-precision radar. The controller's view, however, tends to be sensitive to weather and lighting conditions, or—with radar—is affected by shadowing effects, multipath propagation and unwanted reflections.

The researchers at TU Dresden will use 3D point clouds and real-time processing to automatically classify and track objects on the apron. A key requirement of any such system is the ability to generate these high-resolution 3D point clouds in real-time

“A key requirement is the ability to generate these 3D point clouds in real-time without gaps in the data.”

without significant gaps in the data. The system must also be able to integrate data from multiple sensors over a range of 200 meters in order to cover the airport's core zones—where the widest range of safety-critical activities usually takes place (such as aircraft turnaround, aircraft movements and apron taxiing). Conventional 360-degree LiDAR sensors targeted at the autonomous car markets do not have this level of performance, but the Neptec OPAL-360 scanner selected by TU Dresden does.

Automated airport surveillance systems also need to be able to operate in harsh environments, extreme temperatures and poor visibility caused by all types of weather conditions, including snow, rain, fog and dust. While other vision systems using conventional video cameras and laser scanners cannot penetrate very far in these obscurants, the OPAL-360 scanner can.

OPAL (“Obscurant Penetrating Auto-synchronous LiDAR”) is a dust-penetrating technology originally developed for helicopters landing in the desert where dust or sand thrown up by the rotors can quickly reduce pilot visibility to zero. But OPAL also works for other obscurants such as fog, rain, snow and smoke, which makes it ideally suited for use at airports which must operate in a wide variety of weather and other conditions. Neptec Technologies' OPAL uses a patented detection method based on LiDAR waveform and advanced temporal and spatial filtering and is the only true “see through dust” LiDAR technology in the market today that operates in real-time with no post-processing.

As a rule of thumb, the OPAL sensor performance in obscurants typically corresponds to a penetration distance equivalent to two to three times the visibility range of the naked eye within the area of interest. The advantage of the sensor over the eyes or a video camera is that it provides 3D data that can then be used for higher-level processing, such as measuring the dimensions of an object, using 3D information to identify changes in an environment and tracking an object with high-precision based on its 3D shape. These advantages are key for the apron controller, who needs to be able to identify potential hazards that could result in either the collision of aircraft with vehicles or pedestrians, or damage caused by FOD left on the tarmac.

The TU Dresden research project is developing methods to provide the apron controller with a 3D visualization of the apron along with alerts of potential hazards using real-time 3D LiDAR data.

In a first step, the data collected will be compared to a 3D mapping of the apron's plan surface and associated terminal buildings in order to detect the 3D changes seen in the current scan. In a second step, the detected 3D changes are assigned to a class. This is done by comparing the 3D characteristics of extracted changes with a knowledge database containing dimensions and contours information of objects typical of the area of interest, such as vehicles and aircraft. For each detected object entering the area, a timeline is initiated and the object is tracked until it leaves.

The surveillance concept envisaged for detection of foreign object debris will, in part, use a 3D LiDAR scanner mounted on a mast or a roof of a terminal building. A major criterion to attain a high probability of detection in the area of interest is a thorough analysis of the optimal field of view. A LiDAR can only detect objects that

are within its line-of-sight. The field of view should be such that it minimizes shadowing, including shadowing caused by aircrafts.

TU Dresden selected Neptec's OPAL-360 sensor because of its large, panoramic field of view, longer range options and, in particular, its non-overlapping scan pattern that avoids creating "blind spots" when the scanner is stationary compared to conventional 360-degree laser scanners designed for autonomous vehicles.

The importance of having automated scanning systems for foreign object debris at airports cannot be underestimated. According to Insight SRI, airports conducting only mandatory visual inspections of runways tend to find one piece of foreign object debris on the runways every 60-70 days, while those that use automated systems find one piece every two days. That's because the debris moves, particularly if it's blown about by the wash from a jet engine, so it's essential that airports are able to locate it in real time, track it and remove it before it has a chance to cause an accident or injury. And they need to be able to do that at any time, in any weather.

That's what the TU Dresden researchers are testing at Dresden airport, using a sensor suite including the Neptec OPAL-360 3D LiDAR. It's not just an example of another new application for 3D laser scanners; it's also an example of how Neptec Technologies is continuing to adapt mission-critical space technologies for terrestrial applications. ■

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