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Everything you need to know About LiDAR Surveying

What Is LiDAR Surveying?

LiDAR surveying is a fast and effective way to capture 3D data. Using laser pulses to calculate distances, capture precise measurements and measure ranges is growing in popularity. This simple way to collect data is accurate, quick, and flexible.

Find out more about LiDAR mapping, and how using light detection and ranging has transformed surveying.

All About LiDAR

It's ground-breaking mapping technology that takes surveying mobility, accuracy, time-saving and cost-effectiveness to greater heights. That's how LiDAR was seen when it kick-started most of its development in the early 1960s, shortly after the invention of the laser. The good news is that it has continued to play an essential role in making life easier for engineers and surveyors – and more appealing for CEOs across a wide range of industries.

What's all the fuss about LiDAR? Well, let's find out. However, before going into what LiDAR does, let's start by telling you what LiDAR actually is.

LiDAR is an acronym for Light Detection and Ranging. It's essentially a remote sensing method that uses rapid light pulses to map out the surface of the earth. It uses the pulse from a laser to collect measurements to create 3D models and maps of objects and environments. In a nutshell, the system calculates how long it takes for beams of light to hit an object or surface and reflect back to the laser scanner. The distance is then calculated using the velocity of light. Depending on the sensor used, LiDAR scanning units can fire hundreds of thousands of pulses per second. Each of these pulsed laser measurements, or returns, can be processed into a 3D visualisation known as a 'point cloud.'

So, what is a point cloud?t

A point cloud is made up of a multitude (often millions) of points within the scans captured by a 3D laser scanner. These points represent a point on the surface of, for instance, a scanned building. The scanner automatically combines the vertical and horizontal angles created by the laser beam to calculate a 3D XYZ coordinate position for each point to produce a set of 3D coordinate measurements.

The point cloud data can then be transformed into a digital 3D model that gives you an accurate detailed picture of your building. The denser the points, the more detailed the representation, which allows smaller features and texture details to be more clearly and accurately defined.t

What is a point cloud used for?

Point clouds are a non-intrusive way to accurately measure buildings or object properties in 3D. Sites such as hospitals, schools, and sporting venues don't have to be shut down in order to be measured. Instead, those measurements can be taken after closing time – during downtime or out of hours. Measurements on 3D point cloud data from our SLAM based scanners can achieve survey grade accuracy.

Find out more in our detailed point clouds for beginners article. If you'd like to have a play around with a LiDAR point cloud, take a look at this sample data.

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LiDAR For Surveying – How Does It Work?

There are two main types of LiDAR:

- Topographic LiDAR typically uses a near-infrared laser to map the land
- Bathymetric LiDAR uses water-penetrating green light to also measure seafloor and riverbed elevations.

Laser-based scanners use a process called trigonometric triangulation to accurately capture a 3D shape as millions of points. A LiDAR instrument works by projecting a laser line or multiple lines onto an object. It then captures its reflection with single or multiple sensors. The sensors are located at a known distance from the laser's source. As a result, accurate point measurements can then be made by calculating the reflection angle of the laser light.

LiDAR System For Surveying – What Are The Best Use Cases?

There are many great use cases for LiDAR. These include civil engineering and surveying, from highways and roadworks, to bridge construction and mapping large retail developments. In fact, LiDAR is extensive, allowing surveying firms to be more cost effective while maintaining the highest level of professionalism. Some great examples include:

Design

LiDAR surveying equipment and 3D scanners help civil engineers get highly accurate results in a very short space of time. Essential when working with tight timeframes.

Evaluation

LiDAR technology is perfect for creating a digital model so you can spot and correct irregularities before building work starts, as well as monitor changes between scans to show progress.

Surveying

Surveyors prefer LiDAR systems to help them create detailed 3D images, accurate digital terrain models (DTM) and digital elevation models (DEMs) of specific landscapes.

LiDAR Surveying Benefits – What Sets It Apart From Traditional Methods?

Speed: LiDAR can collect hundreds of thousands of points per second making it an exceptionally fast method of surveying. Scans of building interiors can take only minutes, and even large-scale surveys can be completed in under an hour. Without the need for GPS.

Accuracy: LiDAR systems collect extremely dense data with very little room between points. This means that the results are highly accurate. This accurate data allows professionals to plot and model natural and man-made geographies with the level of precision they need to plan detailed projects.

Flexibility: When it comes to surveying land with LiDAR, there are plenty of options to choose from. Hand-held devices are ideal for laser scanning and can be mounted on to cars, poles or drones. LiDAR data can even be collected at any time of day or night since it uses light as the measurement tool.

Safety: LiDAR systems work relatively quickly and can be operated remotely, making them a good choice for locations that may be unsafe for humans to operate or stay for extended periods.

LiDAR Drones For Surveying – How Surveyors Are Reaching New Highs

Amidst All The New Consumer Tech Developments Of The Last 10 Years, There's Nothing That Quite Excites Forward-Thinking Surveyors As Airborne Laser Scanning For (Drone) ***Remote Surveying.***

And you can see why:

- Capturing topographic data with a drone can be up to five times faster than with land-based methods and requires less manpower.
- The beauty of airborne lasers and drones, unlike manned aircraft, is that they can fly at a much lower altitude, and are not restricted by cloud cover in making the generation of high-resolution, high-accuracy data much faster and less expensive.
- Airborne LiDAR takes the surveying out of your hands and delivers data from places that humans cannot go such as dense jungles or underground caverns.
- They don't interfere or disrupt site operations below.

There are 4 main parts of an airborne LiDAR which produce a vertical accuracy of 15 cm vertically and 40 cm horizontally. It sends over 160,000 pulses per second. This is why LiDAR point clouds create millions of points.

1. LiDAR Sensors: As the drone travels, sensors scan the ground from side to side. The pulses are commonly in green or near-infrared bands.
2. GPS Receivers: They measure the altitude and location of the drone. These tracks are important for accurate terrain and elevation values.
3. Inertial Measurement Units (IMU): As the drone travels, IMUs track its tilt. LiDAR systems use tilt to accurately measure the incident angle of the pulse.
4. Data Recorders: As LiDAR scans the surface, a computer records all of the pulse returns. As a result, these recordings get translated into elevation.

SLAM – What Exactly Is It, And How Is It Used In Surveying?

Alongside LiDAR, you'll likely have heard the acronym 'SLAM' and wonder what it's all about. SLAM stands for Simultaneous Localisation and Mapping and SLAM devices take data from sensors to build a picture of the environment around them and where they are positioned within that environment.

These sensors may use visual data (such as camera imagery), or non-visible data sources (such as Sonar, Radar, or LiDAR) and basic positional data, using an inertial measurement unit (IMU for short). The device utilizes this information to compute a 'best estimate' of where it is within the environment.

By moving its position within the environment, all environmental features (i.e., walls, floors, pillars) will move in relation to the device and the SLAM algorithm can improve its estimate with the new positional information. SLAM is an iterative process – the more iterations the device takes, the more accurately it can position itself within that space.

With a SLAM handheld scanner, it's possible to simply walk through an environment and build a digital map as you go. By removing laborious set-ups from the equation, the time and cost savings are enormous. SLAM-based mobile mapping systems slash survey times and can be over 10 times faster at acquiring data. By cutting out GPS, SLAM systems let you scan by hand or by attaching a scanner to a trolley, drone, pole or cradle.

How To Conduct A LiDAR Survey

Conducting a LiDAR survey is both easy and fast:

1
Choose the mobile scanner you'd like to use for your project. The LiDAR works by pointing a laser at a target surface.

2
The surface reflects the light back to the LiDAR equipment, and the sensor records the reflected light to measure the distance travelled.

3
This data is then combined with the position and orientation of the LiDAR equipment, which is measured using the GPS receiver and internal measurement systems.

4
This creates a set of three-dimensional spatial coordinates that include latitude, longitude and height, creating a combination of data that is called a point.

5
When land surveying, the LiDAR equipment collects innumerable points using the measurement methods described above.

You now have your point cloud.

LiDAR Data

LiDAR data attributes can vary, depending upon how the data was collected and processed. You can determine what attributes are available for each LiDAR point by looking at the metadata. All LiDAR data points will have an associated X,Y location and Z (elevation) values.

Most LiDAR data points will have an intensity value, representing the amount of light energy recorded by the sensor.

The real value comes from turning raw data and LiDAR survey data into actionable information. Including being able to georeference your point cloud. With modern software, data that's been collected can be extracted from most scanner units by either connecting the device to a PC or downloading the data to a USB memory stick. This LiDAR scan data can then be calibrated allowing analysis and modelling. Moreover, LiDAR data processing is very fast. Raw data requires just a few minutes of calibration (5-30min) to generate the final product.

LiDAR Accuracy

Depending on the environment in which the scan is conducted and the specifics of the 3D laser scanner, an accuracy of 0.002-0.197" may be achieved. This high level of accuracy helps ensure that measurements are correct the first time so that less work is needed to complete subsequent steps in design and production. Additionally, LiDAR takes the human element out of the process making the data even more accurate.

LiDAR Cost

When we look at the overall cost of LiDAR surveys, there are multiple cost items to be considered. First of all, the hardware: UAV LiDAR sensor sets (scanner, IMU, and GNSS) cost anywhere between tens to hundreds of thousands. How much does a drone LiDAR survey cost? It generally turns out to be about £3,000 per km2 for each of the survey grids. On the other hand, for example, GeoSLAM's ZEB Go mobile laser scanner costs around £22,000. Furthermore, GeoSLAM ZEB products come with a software package and local storage, with no hefty storage or subscriptions costs, making it the most cost effective SLAM system available today.

LiDAR Vs Traditional Surveying

We know how time-consuming it can be to set up traditional survey equipment, especially in very inaccessible environments. Fortunately, mobile laser scanners take away all this headache. You can literally create a point cloud as you 'walk and scan', or use remote scanning while simultaneously transmitting high-level fidelity images.

Airborne LiDAR helps to create highly accurate digital elevation and terrain models. This makes LiDAR particularly useful for example, in measuring surveying land, tree size, flood elevations, and site distances. Also, for modelling narrow objects such as power lines or road networks and poorly visible objects. All this information is captured in mere minutes – versus weeks when compared to a traditional survey crew using GPS. That means there's no need to visit the site more than once. In short, with LiDAR you can expect three improvements over a typical survey – faster delivery, value-added service, and a better return on investment.

LiDAR laser technology in surveying has been a game-changer for many companies around the world wanting to take advantage of its many benefits, as you can see from these success stories. And it will continue to do so as the rapid development in LiDAR hardware coupled with advanced, user-friendly software offer professionals greater opportunity to conduct highly accurate surveys faster, safer and more cost-effective.