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3D PRINTING ▪ 3D SCANNING ▪ PRODUCT DESIGN

Types of 3D Scanners and 3D Scanning Technologies.

There are many types of 3D scanners and 3D scanning technologies. Some are ideal for short range scanning while others are better suited for mid or long range scanning. The 3D scanner and technology needed to 3D scan a very small object is very different from the best 3D scanner to 3D scan a large aircraft.

EMS uses a wide range of 3D scanners and 3D scanning technologies, which enables us to select the best 3D scanning technology or combination of technologies for every project.

Here is a brief outline of the 3D scanning technologies and types of 3D Scanners.

Short Range 3D Scanners

Short Range 3D scanners typically utilize a Laser triangulation or Structured Light technology.

Laser based 3D Scanners

Laser based 3D scanners use a process called trigonometric triangulation to accurately capture a 3D shape as millions of points. Laser scanners work by projecting a laser line or multiple lines onto an object and then capturing its reflection with a single sensor or multiple sensors. The sensors are located at a known distance from the laser's source. Accurate point measurements can then be made by calculating the reflection angle of the laser light.

Laser scanners are very popular and come in many designs. They include handheld portable units, arm based, CMM based, long range, and single point long range trackers.

Benefits of 3D Laser Scanners

- Able to scan tough surfaces, such as shiny or dark finishes
- Less sensitive to changing light conditions and ambient light
- Often more portable
- Simpler design – easier to use and lower cost

Konica-Minolta Range 7 3D laser scanner

Creaform HandySCAN handheld 3D laser scanner

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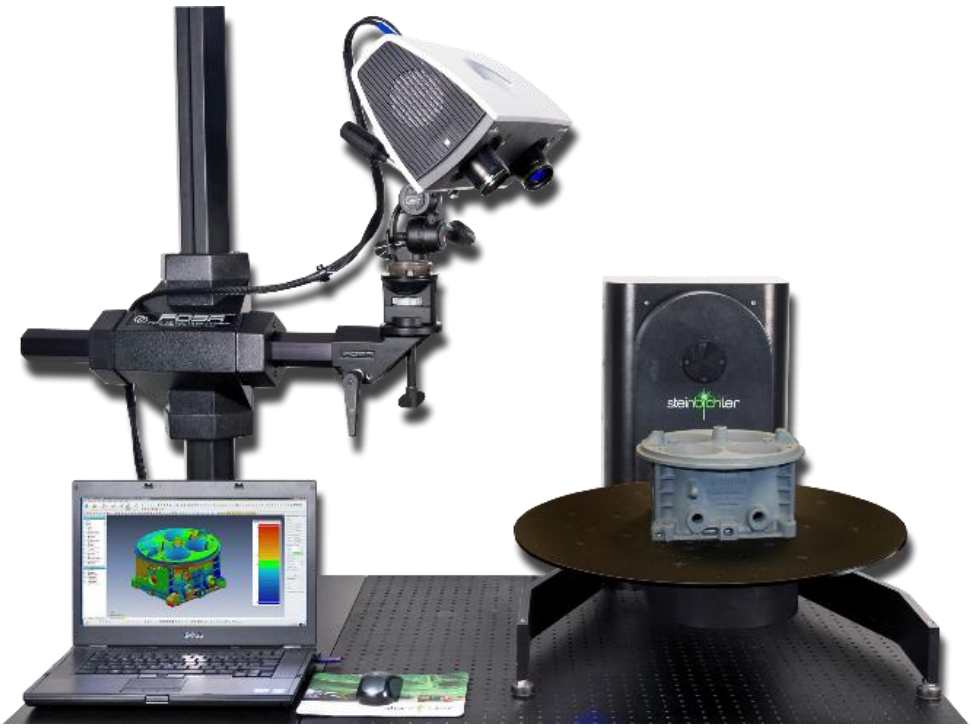
Projected or Structured Light 3D Scanners

Historically known as “white light” 3D scanners, most structured light 3D scanners today use a blue or white LED projected light. These 3D scanners project a light pattern consisting of bars, blocks or other shapes onto an object. The 3D scanner has one or more sensors that look at the edge of those patterns or structure shapes to determine the objects 3D shape. Using the same trigonometric triangulation method as laser scanners the distance from the sensors to the light source is known. Structured light scanners can be tripod mounted or hand held.

Benefits of Structured light 3D Scanners

- Very fast scan times – as fast as 2 seconds per scan
- Large scanning area – as large as 48 inches in a single scan
- High resolution – as high as 16 million points per scan and 16 micron (.00062”) point spacing
- Very high accuracy – as high as 10 microns (.00039”)
- Versatile – multiple lenses to scan small to large parts in a single system
- Portable – hand held systems are very portable
- Eye safe for 3D scanning of humans and animals
- Various price points from low cost to expensive depending on resolution and accuracy



Steinbichler Comet Structured light Blue LED 3D Scanner

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Medium and Long Range 3D Scanners

Long range 3D scanners come in two major formats - Pulse based and phase shift – both of which are well suited for large objects such as buildings, structures, aircraft, and military vehicles. Phase shift 3D scanners also work well for medium range scan needs such as automobiles, large pumps and industrial equipment. These scanners capture millions of points by rotating 360 degrees while spinning a mirror the redirects the laser outward towards the object or areas to be 3D scanned.

Laser pulse-based 3D scanners

Laser pulse-based scanners, also known as time-of-flight scanners, are based on a very simple concept: the speed of light is known very precisely. Thus, if the length of time a laser takes to reach an object and reflect back to a sensor is known, the distance from sensor to object is known. These systems use circuitry that is accurate to picoseconds to measure the time it takes for millions of pulses of the laser to return to the sensor, and calculates a distance. By rotating the laser and sensor (usually via a mirror), the scanner can scan up to a full 360 degrees around itself.

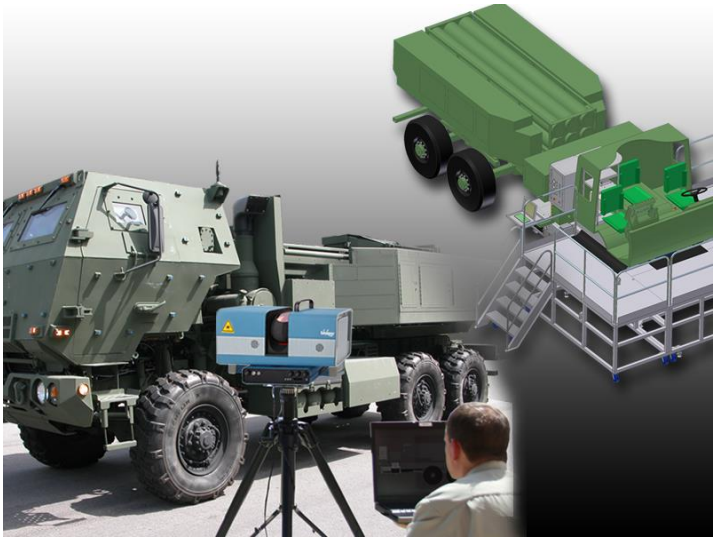
Laser Phase-shift 3D Scanners

Laser phase-shift systems are another type of time-of-flight 3D scanner technology, and conceptually work similarly to pulse-based systems. In addition to pulsing the laser, these systems also modulate the power of the laser beam, and the scanner compares the phase of the laser sent out and returned to the sensor.

Phase shift measurement are typically more accurate and quieter but are not as flexible for long range scanning as pulse-based 3D scanners. Laser pulse based 3D scanners can scan objects up to 1000m away while phase shift scanners are better suited for scanning objects up to 300m or less.

Benefits Long Range 3D Scanners

- 3D Scan millions of points in a single scan – up to 1 million points per second
- Large scanning area up to 1000 meters
- Good accuracy and resolution based on object size
- Non-contact to safely scan all types of objects
- Portable



Surphaser Long Range 3D Scanner

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Coordinate Measuring Machine (CMM)

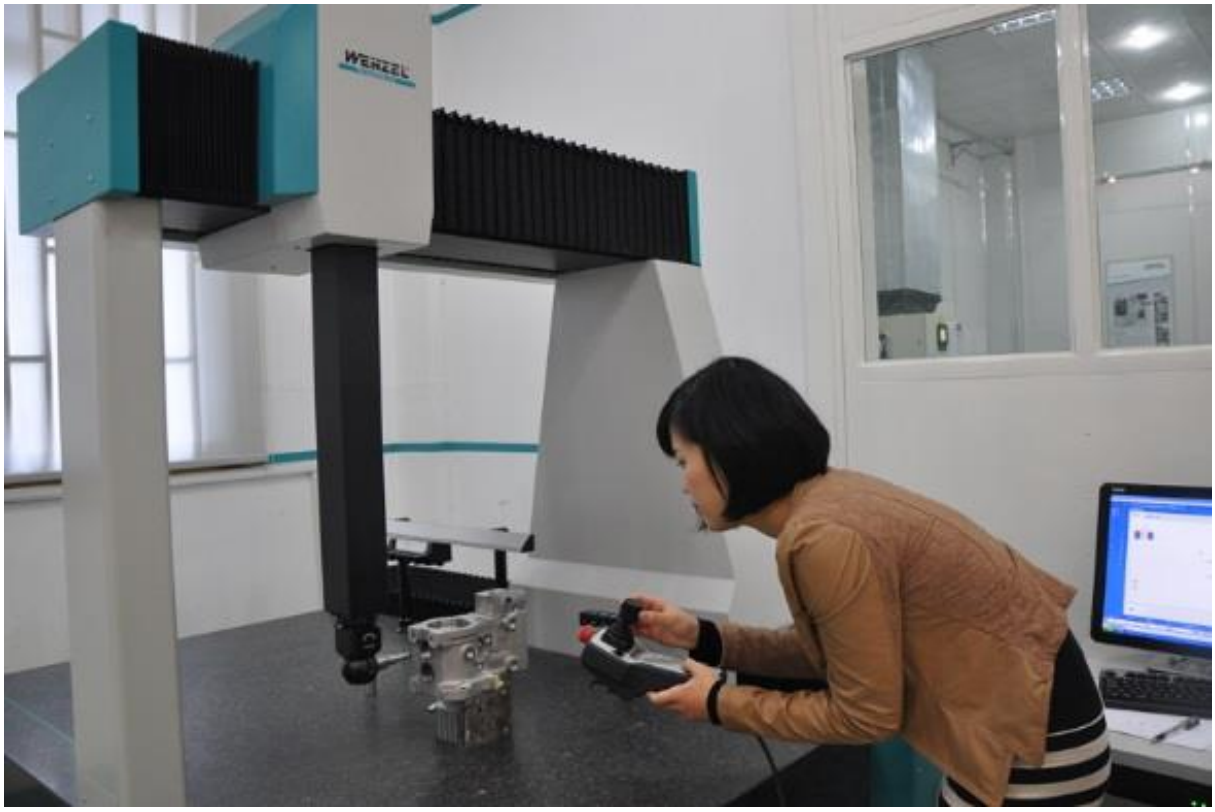
A coordinate measuring machine (CMM) is used primarily to inspect parts. The machine can be controlled manually or through controlled offline through software and computers. Measurements are defined by attaching a probe to the machine. The probe typically has a small ball at the end of a shaft of a known diameter. The CMM is then programed to contact the part. When the machine senses contact of the probe tip a measurement value in taken in XYZ space.

The most common type of CMM is a bridge type which has 3 axis X, Y & Z. The probing system that is attached many times can rotate providing an additional 3 axis for a total of 6 degrees of freedom (DOF).

To very accurately measure parts to a few microns, CMM's are typically deployed in a very controlled inspection room that includes a reinforced floor, controlled humidity and temperature, and isolation from vibration and other forces that could affect the accuracy. In addition, most CMM's have a large granite table surface that is perfectly level. Parts are fixtured onto the granite table so that there is no movement during the measuring process.

Benefits of CMM's

- One of the most accurate ways of measuring an object
- Small to large parts can be measured with the proper machine
- Industry standards and certifications for measurements and software exist
- Many styles and sizes of machines exist from many manufactures



Wenzel CMM

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Arm based 3D Scanners and Probe systems

An armed based 3D scanning or probing system is similar to a coordinate measuring machine (CMM) in the fact it can use a touch probe to measure a part. In addition to the probe, many arm based systems also have an attachable 3D laser scanner for collecting large amount of points. Software keeps track of the joint movements of the arm to know where it is in 3D space at all time.

Arm based systems work by attaching the articulated arm to either a table or sturdy base. Then the arm is held by a hand grip at the end and moved around to probe or scan. The main advantage of these systems is they are much more portable then a CMM and can be used in a shop floor environment.

Benefits of Arm based 3D Scanners and Probe systems

- Portable system
- Good accuracy on small to medium size parts
- Ability to probe and scan a single part

Arm based 3D Scanner and probing system

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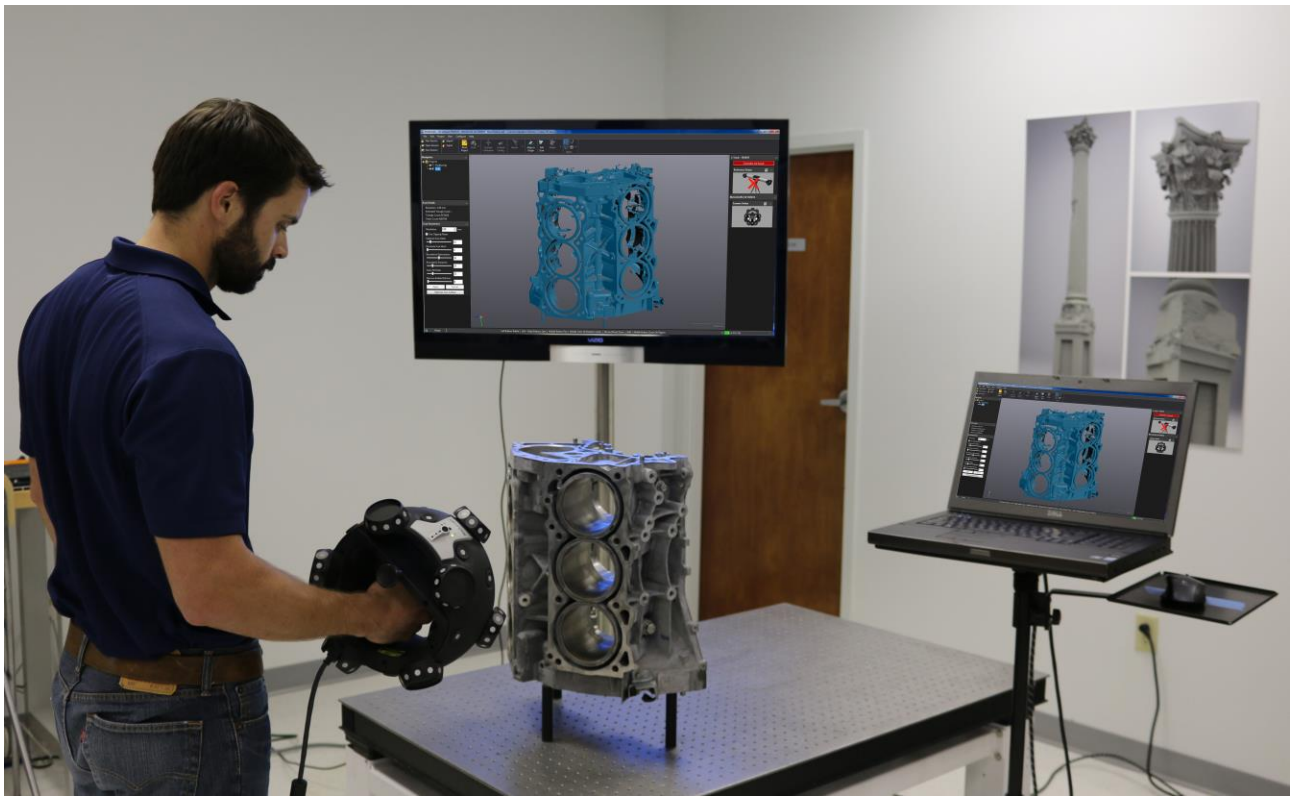
Optically tracked 3D Scanners and Probe Systems

Optically tracked 3D scanning and probing systems use a set of cameras to track the location of the 3D scan head or probe in 3D space. These systems offer advantages over arm based systems including freedom of movement, better accuracy over distance, and the ability to include “dynamic referencing”. Dynamic referencing systems work by attaching targets or led lights to the object you are scanning or probing. This allows the camera system to track the part and scan or probe head separately from each other. The net result is the part can be moving even while scanning and no loss of accuracy or data quality occurs. In addition, the camera system can also be moved around allowing you to scan large parts in one setup.

Benefits of optically tracked 3D scanning and probing systems

- 3D scanning and probing in the same system
- Freedom of movement
- Large 3D scanning volume
- Ability to probe and scan even while the part is moving with no loss of accuracy
- Very portable



Creaform MetraSCAN optically tracked 3D scanning and probing system

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About EMS

Founded in 2001, EMS®, Inc. is a leading full service provider of commercial 3D printing and 3D scanning solutions to customers across a wide range of industries, including aerospace, automotive, military, consumer goods and more.

As one of the only single source providers of both 3D Printing and 3D Scanning solutions, EMS specializes in helping clients streamline product development costs and time to market, inspect tough-to-measure parts and assemblies, and reverse engineer complex products to create accurate 3D models and CAD files where none exist.

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