LMI TECHNOLOGIES

A Simple Guide To Understanding 3D Scanning Technologies

First Edition

Introduction

At LMI Technologies, solving complex problems in a simple way is the philosophy that guides our passion for developing leading edge 3D technologies. It is because of that guiding philosophy, we have created this eBook.

This guide is a high-level approach to the very technical world of 3D scanning. The concepts, principles, and devices presented here within have been generalized to give those new to 3D scanning a starting point. However, this guide is not just for newbies. It is also for those in-the-know who need to educate or present 3D to those outside of the engineering world.

As a first edition, this is only the beginning for this guide. In coming editions, we will cover more ground in the very fast paced world of 3D scanning technologies. Because this guide is for everyone, we invite you share with us any topics of interest for future editions. You can reach us at contact@lmi3d.com.

We hope that you enjoy this simple guide.

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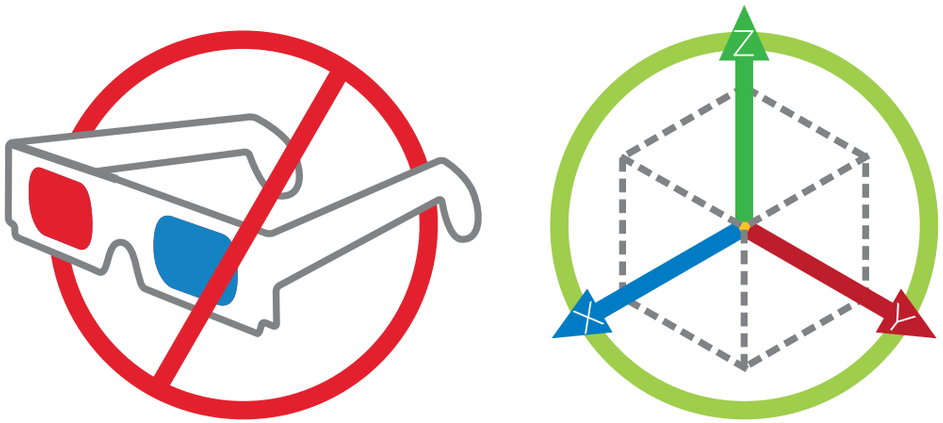
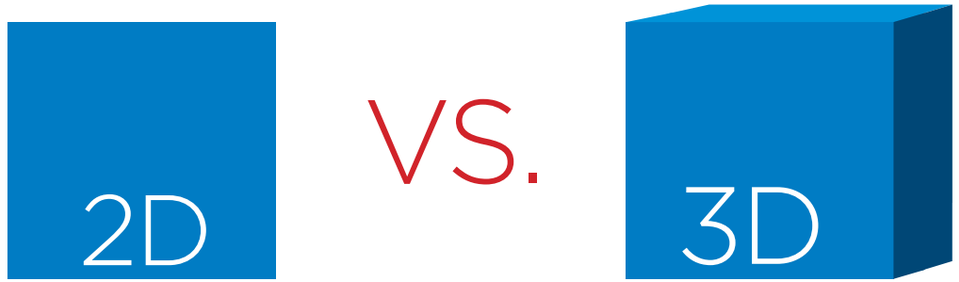
What do you mean by 3D?



Most people think of 3D in the same frame of mind as “3D” movies or TV. In that process, projection tricks are performed to create the illusion of depth (the third dimension) from flat 2D images. When we talk about 3D, we mean real-world coordinates in actual three-dimensional space.

In mathematics these coordinates are graphically represented as points on the X, Y, and Z-axis (also known as Cartesian coordinates). So, when we say or talk about 3D we really are talking about three dimensions as we experience them... and no special glasses required!

How do 2D and 3D systems differ?

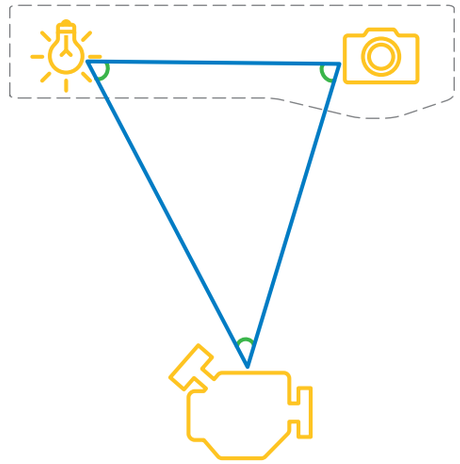


For a simple comparison, it could be said that 2D systems create digital images, while 3D systems create digital sculptures. Similar to comparing a common paper/photo printer to a 3D printer, the main difference between 2D and 3D systems is how they interpret and reproduce data in real-world space.

For a 2D system, depth is missing and flattened within two-dimensional space and Z-axis information doesn't exist. Like a photo, depth is perceived from the shadows and lighting, but doesn't truly exist. A 3D system reproduces a complete 3D shape, including depth, just like a sculpture.

Depth gives 3D systems an advantage in dimensional analysis where a 2D system's strength is only the collection of color (or grey scale) data. The difference between 2D and 3D systems does not make them incompatible. Many of today's 3D scanning devices combine both technologies. For instance, there are 3D scanners that can produce color digital 3D models by overlaying a 2D color maps onto a 3D model.

What is triangulation?



By understanding a limited set of angles and lengths of a triangle, mathematically you can figure out unknown values. Surveyors have been using this method to plot maps and build roads for hundreds of years. The process is called triangulation and it is the principle that enables 3D scanning technologies to determine the dimensions and geometry of real-world objects. Triangulation is used by both single camera and multiple camera (stereo-vision) devices.

For 3D scanning technologies, the distance and angles between imagers and the projected light source (laser or LED) creates a base of the triangle. The angle of the projected light returning to the imager from the surface completes a triangle where a 3D coordinate can be calculated. By applying this principle of solving triangles repetitively, a 3D representation of an object is created.

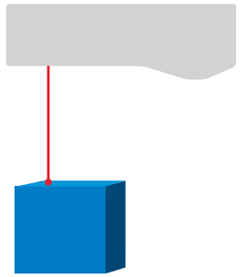
What is 3D scanning?

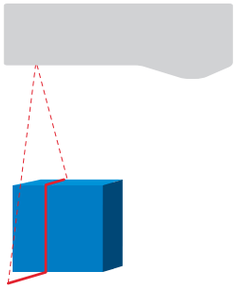
Using the method of triangulation, 3D scanning is a process of determining the shape of an object's surface or its volume in three-dimensional space. By collecting information about the real-world object using a 3D scanning device, this makes 3D measurement and 3D visualization possible. Accurate 3D measurements derived from a scanned object are useful for material inspection and quality control. If a 3D scanning technology is capable of collecting a lot of 3D data from the scanned object, it has the ability to recreate a high resolution, accurate 3D digital model of the real-world object. This is known as 3D visualization.

What are some common types of 3D scanning technologies?

There are many types of 3D scanning technologies on the market today, from commercially used game controllers to industrially designed smart scanning devices. The most commonly used technologies fall into three categories: Displacement, Profile, and Snapshot (aka, Scanner).

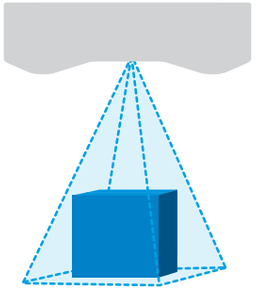
Displacement devices use a single point laser beam projection to measure the height, thickness, or position of an object.



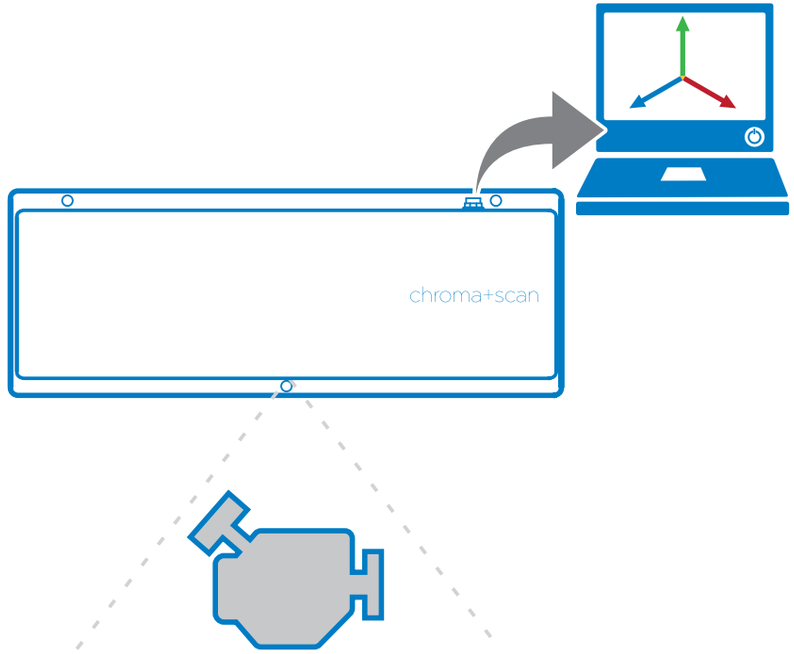


Line Profile devices typically use a projected laser line to create a cross section profile for measuring aspects of an object's contour. Moving an object under the laser line creates many profiles that can be combined into a complete 3D shape.

Snapshot devices use structured light (non-laser) and stereo-vision to generate full 3D volume data. Because Snapshot technology captures so much 3D data at one time, objects need to remain stationary during the scanning process.



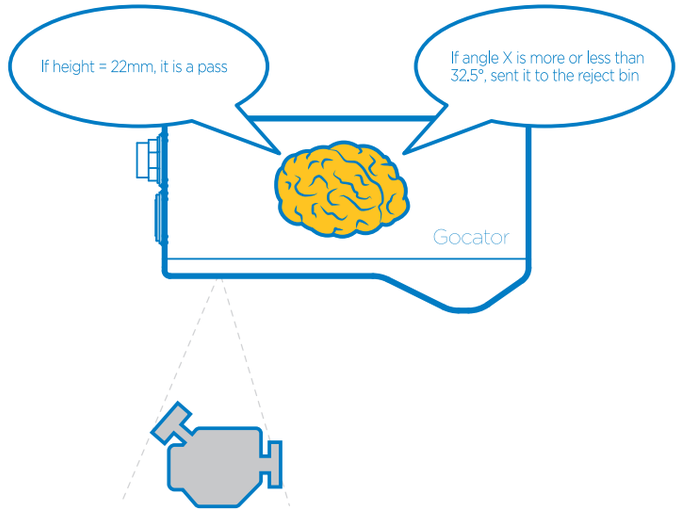
What is a 3D sensor?



A 3D sensor is a single device that uses fixed optics, a light source (typically laser) and at least one digital imager to acquire 3D data. Typically 3D sensors are pre-calibrated and operate in manufacturing facilities as part of an automated production line.

Much like the human eye, a 3D sensor merely collects and transmits the data for processing. An external computer or controller acts like our brain. This ‘brain’ takes in the data the 3D sensor generates and processes it to perform measurements, analysis, or visualization.

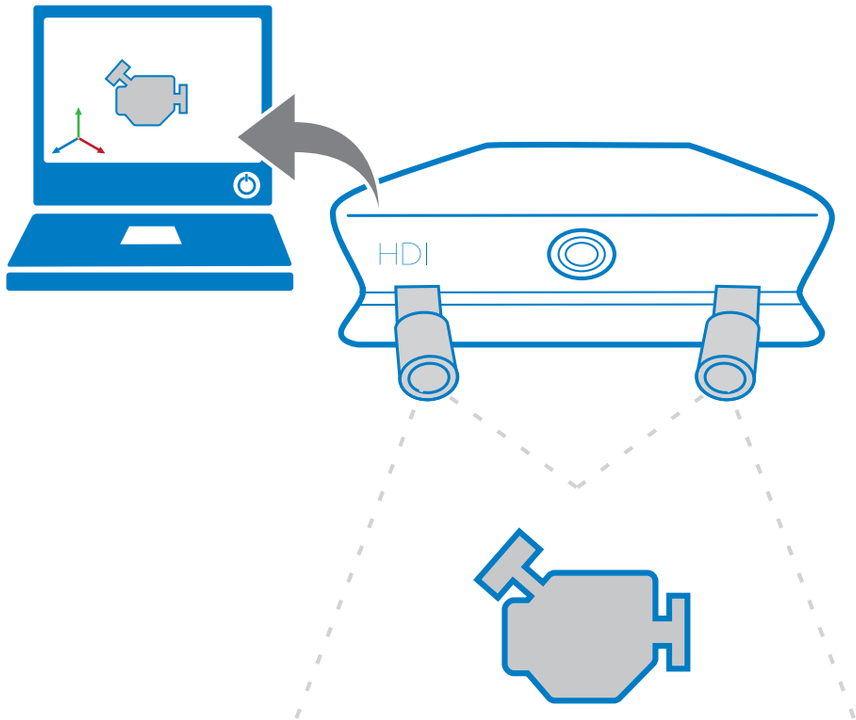
What is a 3D smart sensor?



A 3D smart sensor combines 3D scanning, measurement and control decisions (sorting, pass/fail, alerts) inside one pre-calibrated device. A 3D sensor, however, requires a PC with software in order to perform measurements and control.

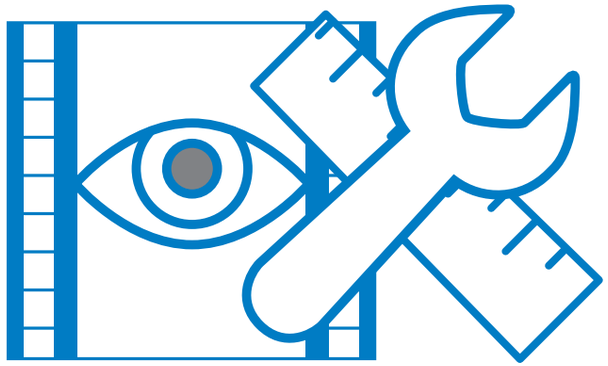
To get a better understanding of the difference between a 3D smart sensor and a 3D sensor, consider the difference between a smartphone and a regular mobile phone. You can talk or send a text message on either device, but on a smartphone you can set it to tell you when you have a new email, let others know you're busy, or whichever task you desire (providing you have the right app). Also like the smartphone, a 3D smart sensor is an all-in-one device with built-in tools and accessed through its onboard operating system. Unlike a smartphone, however, you can't play angry birds on a 3D smart sensor. ;-)

What is a 3D scanner?



A 3D scanner is a device for creating high resolution, accurate digital 3D models from real-world objects. The scanner is built around stereo-vision (normally two digital imagers) and structured light projection in order to generate 3D. The scanner is controlled by 3D scanning software that runs on a computer. A 3D scanner is also capable of capturing the color map of an object. By merging the color map onto the 3D model, a color 3D digital model is created.

What are some typical 3D scanning applications?



3D sensors and 3D smart sensors are typically used to inspect and measure parts and/or materials moving along a production line. 3D scanners are useful in applications that require 3D visualization and 3D measurement of stationary objects.

Some applications for 3D sensors and 3D smart sensors:

- Quality control decisions in a manufacturing facility's production line
- 3D scanning of logs and boards in saw mills for better cutting decisions
- Inspection of pavement for highways and airport runways to determine wear and tear

Applications for 3D scanners:

- Gaming, animation, and the entertainment industry for CGI (Computer-Generated Imagery)
- Reproduction and archival purposes for arts and archaeology
- Reverse engineering to analyzing the construction of a product in order to develop a similar or improved product/design

How do I learn more about 3D?

At LMI Technologies, we are passionate about developing innovative 3D scanning, measurement, and data visualization technologies that solve complex problems in a simple way.

We have a dedicated resource section on our website with more information on 3D scanning technologies. For more information, please visit www.lmi3D.com/resources

If you would like to speak to one of our technical specialists to learn more about how our 3D solutions can help you with your application, please contact contact@lmi3D.com.