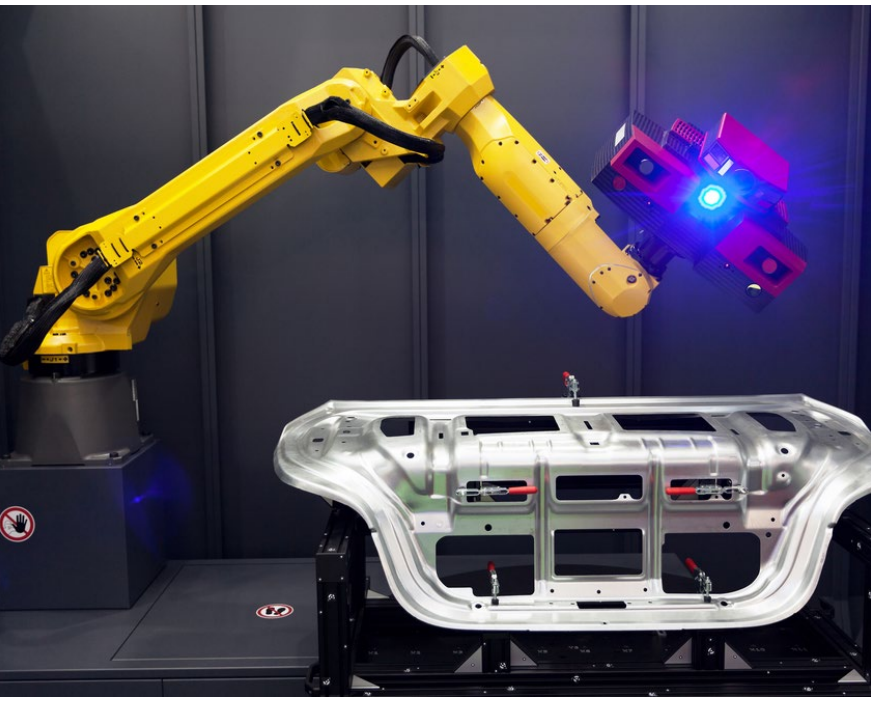
Photogrammetry in mechanical engineering

- Photogrammetry is a great way to visually analyse complex 2D and 3D systems.
- This article looks at the basics of what it is and how it is used in different applications.
- Reverse engineering and quality control are two of the main benefits, both of which are discussed in the article.
- Curious? Read on to learn more about how photogrammetry might help in your mechanical engineering project.



Photogrammetry in mechanical engineering is becoming more popular, so let's take a look at the concept and how it's used.

Photogrammetry derives from the Greek words photos, meaning light, gramma, meaning record, and metreo, which means measurement. It's a process that has been used since the mid-19th century, of taking measurements from photographs. Obviously, the technology has advanced significantly since the early days of taking crude hand measurements and scaling them.

Close-range photogrammetry is most commonly used in topography (for terrain mapping), in architecture for building archiving, and civil engineering for structural analysis.

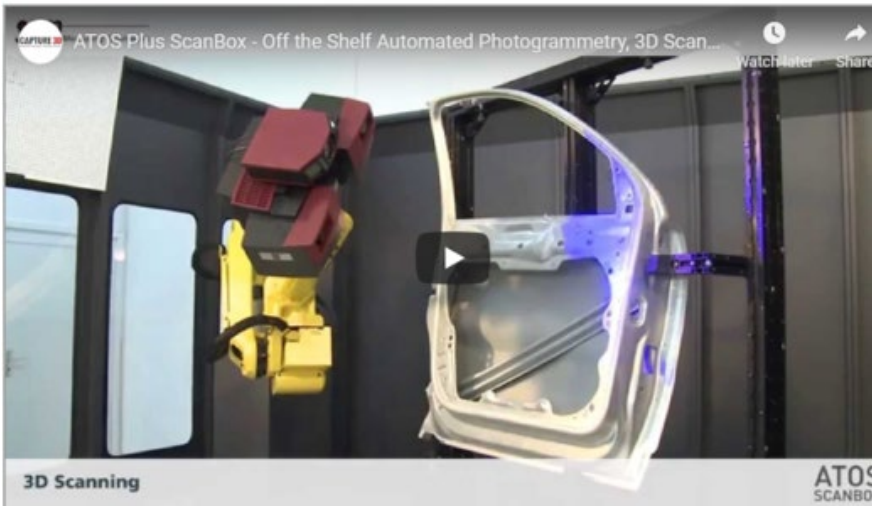
In recent years, close-range photogrammetry has been used to measure and analyse complex 2-D and 3-D systems, by applying optical scanning, triangulation and projective geometry. Due to these advancements, it can now be used as a useful tool in mechanical engineering to reverse engineer mechanical parts or systems.

Component Manufacturing

Photogrammetry techniques can be used in the manufacture of duplicate parts, providing a relatively inexpensive method of creating a prototype and mould for the final product, when compared to reverse engineering.

The reverse engineering process involves using a 3-D optical scanner or CMM (Coordinates Measuring

Machine) to create a point cloud. The generated data is then fed into software that constructs a 3-D CAD representation of the object. This is an expensive method due to the cost and complexity of the scanning hardware, and it can also be a time-consuming process.



Photogrammetry methods typically use three or more photos to get the dimensions and shape of the object, which are then modelled as point clouds to create the 3-D CAD image. The benefits of this approach are that it can be carried out with a relatively cheap digital camera and is much faster.

Photogrammetry is especially useful in the manufacturing process of small mechanical components. A system of rapid-prototyping can be employed, whereby photographs of the object are taken, a point cloud surface model created in CAD, then a prototype is printed using a 3-D printer and finally a mould made for the final product.

There are some limitations regarding the accuracy of the photogrammetry method. It is best used for rough prototypes, depending on the tolerances required. Photogrammetry techniques are typically accurate to within one-tenth of a millimeter (+-0.1mm).

Penn State University has been conducting pioneering research into the use of photogrammetry in the manufacturing of mechanical parts. Michael Immel of Penn State University's department of industrial and manufacturing engineering stated, "If we can take pictures of the parts and use commercial software to create the point cloud file from the images, we can come up with the dimensions within some reasonable amount of accuracy and apply it in industry."

Quality Control

Another application of photogrammetry that overlaps mechanical engineering and manufacturing is in quality control. A series of cameras could photograph parts from different angles as they come off the production line. The image data would be used to create a 3-D point cloud that a quality control engineer or technician can use to compare to the original file, highlighting any items that are out of tolerance. This has the potential to make the quality control process far more streamlined and less expensive for manufacturers, compared to hand measurements.

Mobile device photogrammetry

You can download smartphone apps as a very cheap (often free) photogrammetry option, but they obviously lack the accuracy of 3-D scanning or more conventional photogrammetry techniques. They

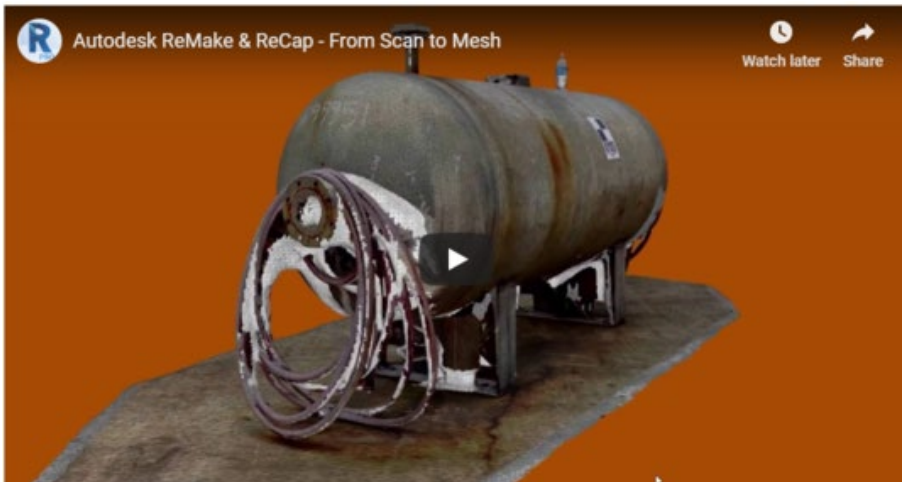
can be used to get a very rough point cloud that creates a 3-D model. Trnio and Scann3D are two of the main free ones.

This technology may have practical mechanical engineering applications in situations where obsolete machinery is being repaired. An on-site fitter can take a 3-D scan of a broken part with his smartphone, relaying it to a mechanical engineer who can then upload the data to CAD and create a replacement part using the method described earlier.

Photogrammetry Software

There are several companies that offer photogrammetry and 3-D scanning software. Arc3D is completely free but lacks some of the functionality of the other commercial software.

Autodesk Recap 360 is probably the most frequently used, with licences costing around £230 or $300 per year, but usually come with a short free trial period.



Summary

Photogrammetry offers a way to get most of the benefits of 3-D scanning, without the expense and technical know-how needed to use infrared or laser scanning. As it is low cost, it is ideal for the process of reverse-engineering and quality control within the manufacturing industry, especially for small-scale mechanical parts.