

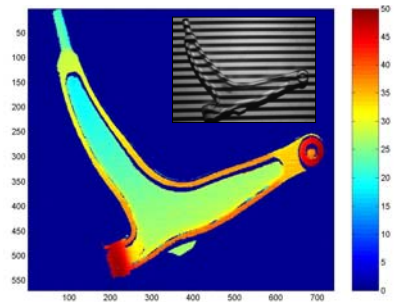
Optical shape measurement with structured light



Structured light is a fast and flexible optical method for measuring the three-dimensional shape of objects and surfaces. The measurement is performed within a few seconds. The result is a point cloud with approximately 1 million (X,Y,Z) triplets that accurately describes the shape of the surface. The information can be used e.g. to generate CAD models from a model designed by hand, or it can be used for product inspection. The desired information, such as distances, angles, profiles etc. can be easily extracted from the measurement result. It is also possible to calculate and visualise the deviation between a measurement and a CAD model.

Example application

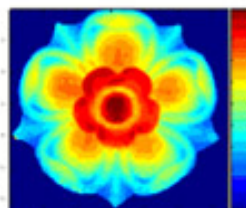
The image to the right shows a prototype of a system developed for performing flaw detection on car wheel suspension arms. The prototype was developed for Raufoss Chassis Components. By a combination of in-line 3D measurement by structured light and advanced image processing, the system is able to determine if the part meets certain tolerance requirements. The total time available for measurement, image processing and robot handling was 10 seconds.



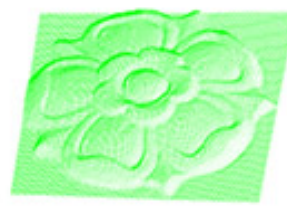
Data representation



Object with pattern



Height Map

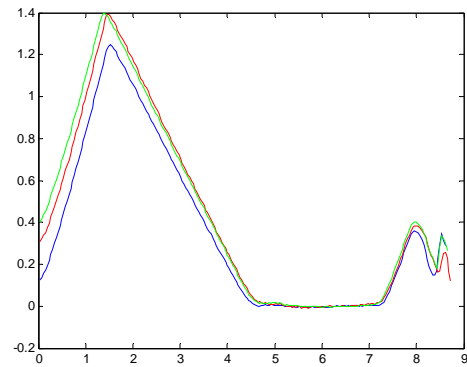
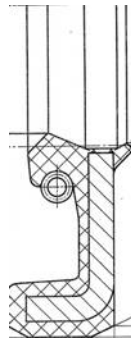
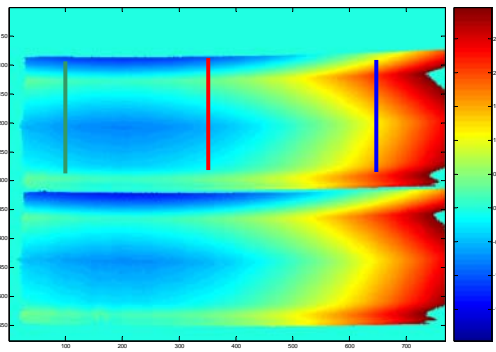


Point Cloud

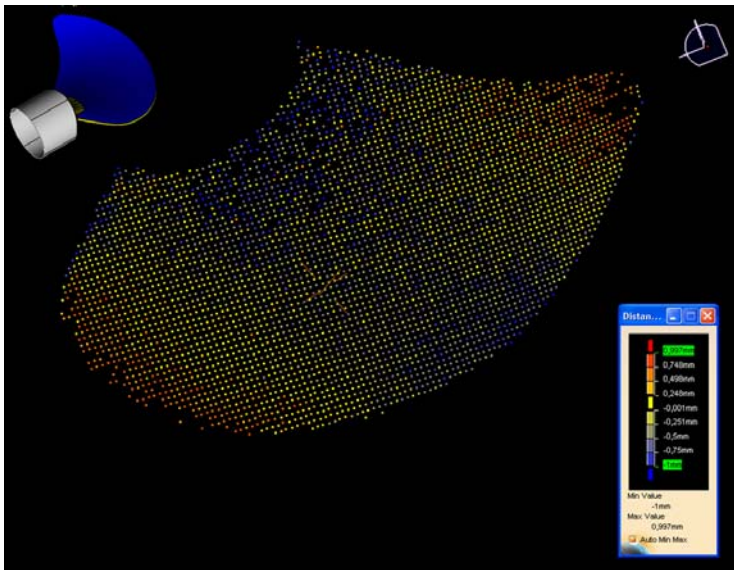


Generated Surface

Above: The image shows a cast aluminium rose illuminated by a fringe pattern (image 1 from the left), a height map with colours corresponding to different object heights (image 2), a point cloud (image 3) and a surface generated on the point cloud (image 4)



Above: The image to the left shows a measurement performed on two sealing rings stacked on top of each other. The middle image shows a CAD profile for the rings. The image to the right shows three different cross sections (indicated in three different colours on the left image).



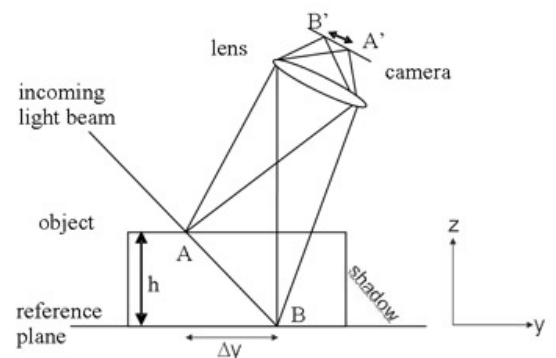
Above: CAD model of propeller blade (top left corner) and a measured point cloud of a propeller blade after machining and manual polishing. Each point is displayed in a colour that corresponds to the distance between the measured point and the CAD surface. Yellow is zero deviation, while red corresponds to +1mm and blue corresponds to -1mm deviation.

Specifications

Object size	From less than 1cm ² to more than 1m ²
Resolution (Z)	1/10.000 of image size (e.g. 10µm for an image size of 10cm)
Distance between points (X, Y)	1/1.000 of image size (depends on camera resolution)
Measurement time	2 seconds (real-time with simpler method)
Output	Point cloud with approx. 1 million (X, Y, Z) triplets

Principle and mode of operation

The method works by projecting a two-dimensional pattern of light stripes onto the object. The pattern is imaged by means of a camera which is placed at an angle relative to the projector. The shape of the light stripes will deviate due to the object's height above the surface in each point in the camera image (see figure). Based on this deviation, the object's three-dimensional shape can be determined very accurately.



For more information about structured light, please contact

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or see: <http://www.sintef.com/shape>