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Review of Different 3D Scanners and Scanning Techniques

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Abstract: *3D scanning is one of most widely used process for duplication of complicated articles. The data collected by 3D scanners can be used to build a digital 3D representation of the article under consideration. Other common applications include production of movies and video games in entertainment industries, studying of formation of plant phenotypes [1]. This type of scanning can be done through various techniques. Numerous techniques have been developed over time for different purposes in the industry. This review paper gives a detailed overview of such techniques which are prominently used. Each technique has its own limitations and advantages. Hence, a comparison between different methods for 3D scanning is done in this paper. Based on this comparison the implementation of right method in the industries will yield the most accurate replica of the target object while salvaging the expenditures.*

Keywords : *3D Scanning, Laser Scanning, Point Cloud, Reverse Engineering, Triangulation.*

I. Introduction

3D scanning methodology came into existence in late 20th century. The initial 3D scanners in the 1980s used contact probes. These physically touched the target articles a number of times until the device had enough digital data points to create a 3D model. As this method was time consuming, newer methods which were more efficient and fast were developed. Out of the methods used for reverse engineering, 3D scanning is the most effective. Reverse engineering involves recreating an existing product. It is mainly used to redesign and produce a reasonably accurate replica of the product. Computer vision has been widely used for reverse engineering. To enhance the quality of an image, a computer uses image processing. Using this computer vision, three dimensional data can be obtained from two dimensional images. The main purpose of 3D scanning is to create a digital three dimensional model out of the data collected by the scanner from its surroundings. Creation of the 3D digital model is made by using the idea of point cloud. Information regarding the object's shape is collected at such points.

The whole shape, geometry, color or pattern of the object is extrapolated using the data collected at these points. This process is called as reconstruction. Post reconstruction, STL (Stereo Lithography) file is generated which can be printed. After 3D printing of this file, the three dimensional replica of the original object is generated. The field of 3D scanning is growing rapidly in modern industries. Many techniques have been implemented to get the most accurate replica of the product. In such circumstances, it is essential that these techniques should be studied and compared with each other [2]. The methods used for 3D scanning are primarily classified as:-

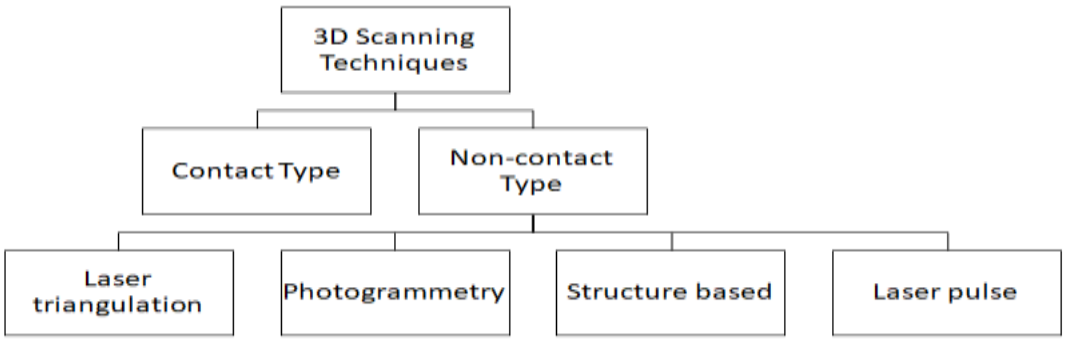

Fig. 1 Classification of 3D Scanning Techniques

These methods are described as follows:

1.1 Laser triangulation 3D scanner:-

This uses the principal of triangulation used for measuring distances. Laser beam is imparted on a point, for finding its distance from the laser source. Diffused reflections are detected by detectors placed such that source, object and detector forms a triangle [3].The main advantage of such type is its high speed of detection, accuracy and precision.

Surface properties of the object being the main disadvantage of this method, constraining its application. The line laser projects a linear vertical line on the object which is to be scanned, the image of this is taken by the camera and the position of the object or laser is changed depending on the setup so as to get the contour of other part of the object, slowly and steadily the whole object is covered .This information is then given to the processor which combines all the images to generate a 3D model.

Applications: Entertainment industry, reverse engineering

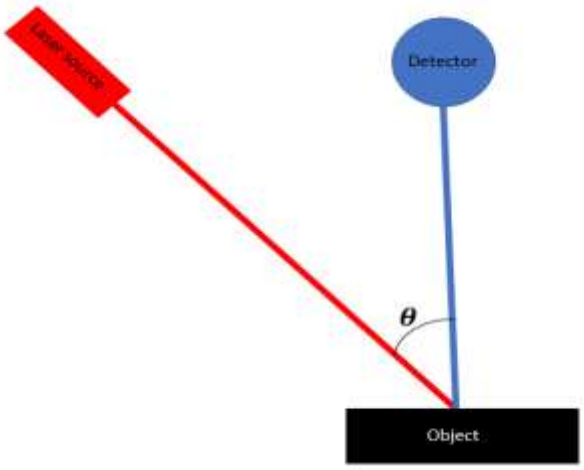

Fig. 2 Laser Triangulation Technique

1.2 Structured light 3D scanner:-

This method uses light grid pattern projections and synchronising it with a camera for obtaining surface properties of the object using triangulation principle. Pattern of light is produced by using light modulators based on different technologies, in this method displacement of individual stripe is converted to 3D coordinate of the object [4].

Application: Face Id, Forensic sciences

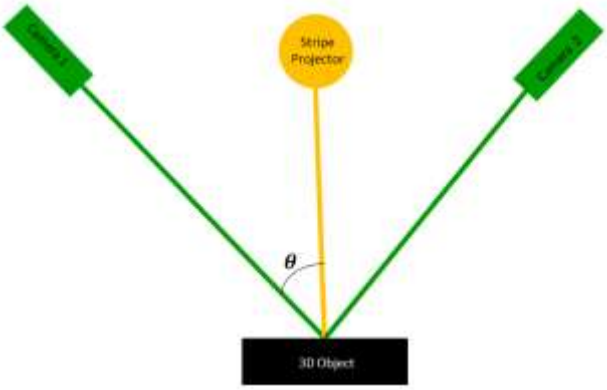

Fig. 3 Structured Light 3D Scanning

1.3 Photogrammetry

This technology reveals the geometric properties of the objects by means of photographic images. The principal of photogrammetry is to take several images of the object from various views with common reference point in each photograph. It eliminates laborious modelling of object and also captures the color aspect of the object used as a subject. The object which is to be 3D scanned is placed on a clear, bright and well-lit place.

Photographs are taken such that all points are covered. All these photographs are put in photogrammetry software to process and develop a 3D model of the object [5].

Application: Topographic mapping, Archeological department.

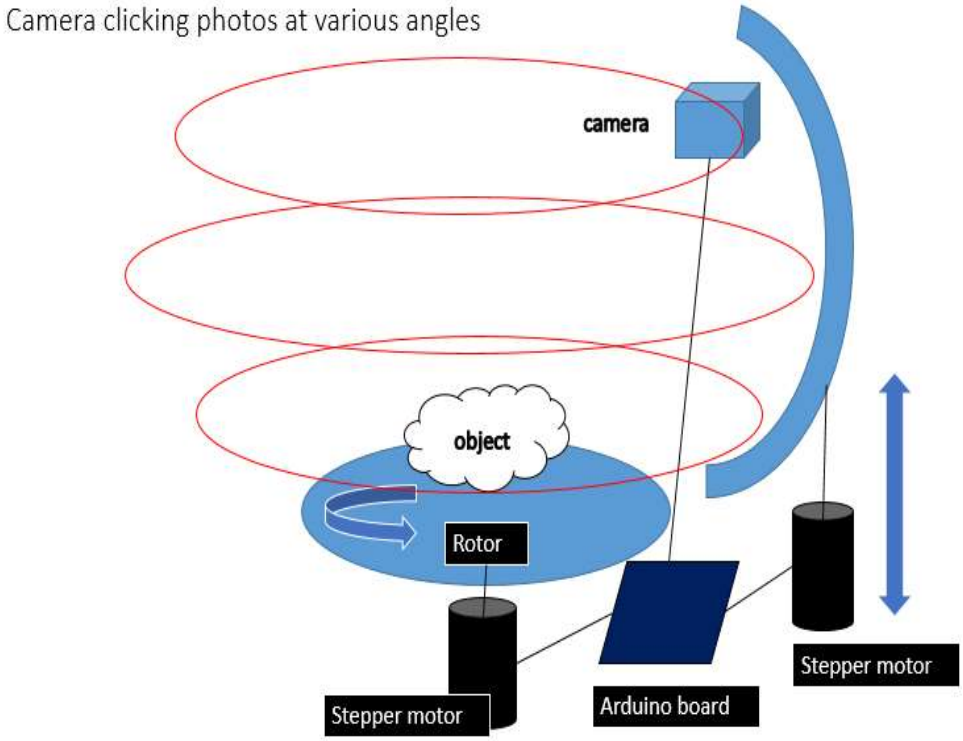

Fig.4 Photogrammetry Technique.

1.4 Laser Pulse Based 3D Scanning

These scanners are known as lidar or time of flight scanners based on the time taken by laser to hit target and return. The speed of light is defined and using the time taken by laser, the distance can be easily found. Laser range detects only the distance of a point in its path therefore to change the view of laser, system of rotating mirrors are implemented. These are particularly used in areas where huge objects is to be scanned but operates at slower processing speed.

Application: Area scan, large scale scanning

1.5 Contact Based 3D Scanning

Contact based 3D scanning uses contact between probe and the object to reveal the surface information measured by deformation of the probe. The probe is moved firmly over the surface to acquire the information. Coordinate measuring machines are well known contact based scanners, used for quality control. These class of lasers are largely used due to their potential to scan transparent and reflective surface [6].

Application: Transparent or Reflective objects, High precision and accuracy applications

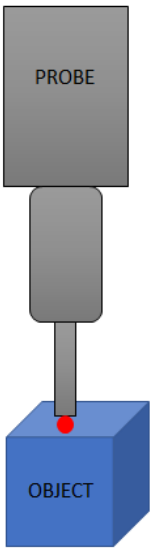

Fig.5 Contact Based 3D Scanning.

II. Comparision Table

Table no 1. Comparison of different 3D Scanning Techniques.

Sr.no.	Types	Major Hardware	Time required	Cost	Accuracy/ resolution	Applications
1	Laser triangulation	Line laser , camera , processor	High	Low	Medium	Entertainment industry , Archeological department
2	Structured light	Projector, 2 cameras	Low	High	High	Forensics , Face Id
3	Photogrammetry	Camera , processor	Low	Low	Low	Topological mapping , Archeological Department
4	Laser pulse	Laser source , Laser Detector	High	Low	High	Large objects , area scan
5	Contact based	Measuring probe	High	High	High	Transparent & reflective objects

III. Conclusion

In this paper, different methods for 3D scanning have been studied in detail. These methods are compared with each other on the basis of various parameters. From the comparison between these methods, it can be inferred that different applications require different types of scanners. The implementation of right method in the industries will yield the most accurate replica of the target object while saving the costs

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