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A REVIEW- COMPARISON OF EFFICIENCY AND METHODOLOGY OF 3D SCANNER

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***Abstract*—** As we glance throughout history, the rich and privileged have had access to useful technologies before the masses. We have attempted to engineer a 3D scanner that is affordable and easy to use while maintaining the same level of accuracy and applicative traits as the current leading scanning technologies. After studying various research papers and learning from other researchers,we, with our collective knowledge, have put together a 3D scanner that uses the best of both worlds.We cover the essential components and their functioning in our design and expand on the workingsof this model.

Keywords – *Scanning, 3D Scanner, 3D Printing, Laser, Distance Scanning, IoT, Industrial design*

I. INTRODUCTION

The first records of 3D printing technology dates back to the early 1980s when a man named Hideo Kodama was developing a rapid prototyping machine. This technology was not patented as it had quite a few drawbacks, but it was followed by a window of strong advancements in this field, in 1986 this technology was patented as SLA printer and the first commercial printer was released in 1988 [1]. As theyears went on, 3D technological advancements were developed and heavily used. It combines the 3D scanning and 3D printing processes.

A 3D scanner is used to evaluate real-world objects and environments, gathering raw data on their appearance and shape. It is a device that uses sensors and or lasers to capture the outline and design of anobject and convert it into CAD (Computer Aided Design) data. This string of data is compiled in softwareand a 3D mask of the entire object is mapped.

This review was done to track the numerous technological breakthroughs in 3D scanning, and it covers the various scanning technologies, methodologies, advantages, disadvantages, and results. This study assesses the use of 3D scanning and looks at the process, overall effectiveness as well as its potential utilityfor use in design and engineering education.

II. SURVEY STUDY

Despite the fact that 3D scanning is not a new technology, it's becoming increasingly popular and growing every day. 3D scanning can be used for inspecting products, which can help reverse engineering them andlower the cost.

Mahesh Parde, Karan Khankal, Thotya S. and R. S . Meshram [2] provide information on 3D scanning technologies, their various types, and their limitations. The model developed had some drawbacks mentioned by the author and was considered less accurate. As it had difficulty in collecting data points ofcomplex shapes.

Mohamed Abdelmomen, F. Ozan Dengiz, and Mart Tamre [3] refer to the surveys of current 3D technologies. The main two focus points were 3D scanning, 3D printing, and software tools as they link these two technologies. It also enlightened about the various parameters to be taken into consideration while 3D scanning

Mr. Aditya Gaykar, Ms. Advyta Jujaray, Ms. Shalmali Mutalik, Ms. Prachi Waghmode, Prof. Sanjay B Matekar [4] introduce a mechanism to construct a 3D scanner that would be easier to use and handle. The3D scanner is mounted on a dolly mechanism to get accurate points from the scanner. The object was heldby a two-point support so that all surfaces are scanned by an Intel SR laser scanner

N Alberto Borghese, Giancarlo Ferrigno, Guido Baroni, Riccardo Savarè, Stefano Ferrari and Antonio Pedotti [5] focus on providing flexibility, reliability, and accuracy for scanning 3D surfaces. Their prototype included a two video cameras, laser pointer, a computer host and a real-time image processor. Their system can distinguish circular objects even in low-light circumstances, such as outdoors, and has great accuracy even employing a very small circular shape. The model's downside is its long scanning time and use of a single laser pointer.

Sampsa Kohtala, Jorgen F. Erichsen, Ole Petter Wullum, and Martin Steinert [6] provide insight into the photogrammetric 3D scanning technology, which utilizes images of the object. Their model demonstratedthe potential for low-cost, straightforward, accurate digitalization and overcoming obstacles such as the limitations of photogrammetry and the frequent need for manual mesh editing.

Siti Asmah Daud and Nasrul Humaimi Mahmood [7] proposed an infrared sensor rig to detect shapes that measure the distance between the sensors and the object placed at the center of the plate. An Arduino microcontroller will completely control the data received. The sensors then communicate this data to the MATLAB software, which reconstructs the picture of the item based on the values acquired. The suggested system makes use of five sensors arranged in the shape of a pentagon. The Arduino microcontroller will control the sensor movement, and the data collected will be saved. It is then used to plot the model within the MATLAB software.

A. Kus, E. Unver, and A. Taylor [8] focuses on a variety of different data from scanned organic 3D shapes to 3D CAD packages for learning and teaching in undergraduate education. They also created and applied repeatable methods for analyzing the laser scanner setup for capturing diverse 3D surfaces.

Joao Braun, Ana I. Pereira, Paulo Costa, Jose Lima, and Claudia Rocha [9] propose a prototype of low- cost 3D scanning system for small objects using a point cloud to stereolithography approach where it was already validated in simulation. The model had drawback that it must have a uniform shape, i.e., without discontinuities

A. Various 3D Scanning Technologies

After surveying different 3D scanners on the market and those used in research & development, the following 5 techniques or methodologies are used for 3D scanners:

1) Laser Triangulation - Rectilinear laser beams are directed toward objects and reflected. A receiving sensor captures the reflected laser and calculates the angle. In most cases, a camera is used to measure thedeformities in reflected laser beams. Simple trigonometric theorems can be used to determine further distance measurements. It is a low-cost method, but its range is relatively limited (a few meters).

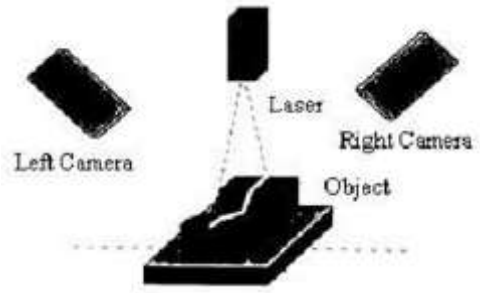

Figure 1. Laser Triangulation 3D Scanner [10]

2) Structured Light 3D Scanning - This technology requires a projector and camera system. A projector projects a specific light pattern onto an object. Patterns are stripes, dots, etc. Deformation is observed by the camera from different viewpoints along with pattern irregularities and calculated accordingly. Differentpatterns can be created by varying the angle between the beams. The observed information is used to reconstruct the object using software geometric calculations. Using this technology, it is possible to produce very fine patterns with infinite depth of field in a precise and

simple manner. The disadvantages are the high implementation costs and the difficulty in supplying the optimal beam geometry.

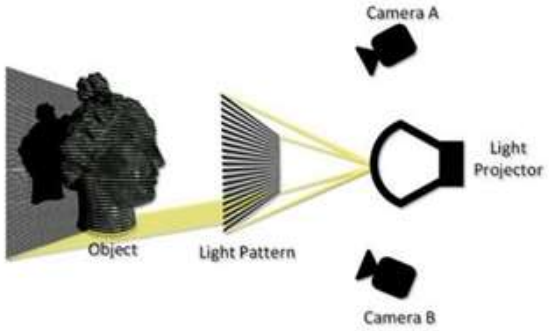

Figure 2. Structured Light 3D Scanner [11]

3) Photogrammetry - It converts two-dimensional data into three-dimensional measures (images). The distance between two points on a plane is then calculated. The co-ordinates are obtained by the cameras from various points of view. We can utilize many cameras to accomplish this. They collect data from various orientations and build a camera model. With all of the variables captured and the data obtained, the software creates a 3D reconstruction.

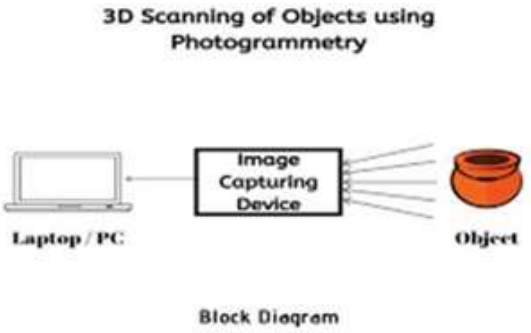

Figure 3. Photogrammetry 3D Scanner [12]

4) Contact Based 3D Scanning - This method uses a probe to collect 3D data. A probe acquires data by physically touching an object. The probe can be physically moved and aimed, but to get data points moreclearly, a mechanical arm is used to facilitate movement and precision. To do this, hold the object firmly,move the probe and place it next to it. The precision and capacity to 3D scan clear or reflecting surfaces are the primary benefits of contact technology for 3D scanning. There are a number of drawbacks associated with contact 3D scanning systems, including slow speeds and the inability to control organic structures in their natural state.

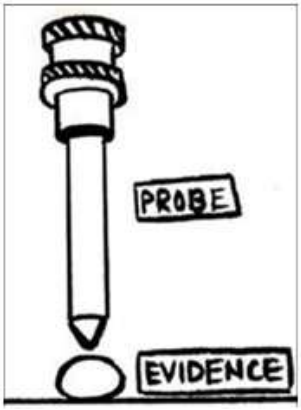

Figure 4. Contact Based 3D Scanner [13]

5) Laser Pulse Based 3D Scanning - It is also called time-of-flight technology because it measures the time it takes for a laser pulsed 3D scanning laser to hit an object and return, accuracy is up to 1 picosecond.Only one point is captured for each measurement. A large number of pulses are projected

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onto the object and reflected by the laser. It uses mirrors to rotate the laser and sensor hardware.

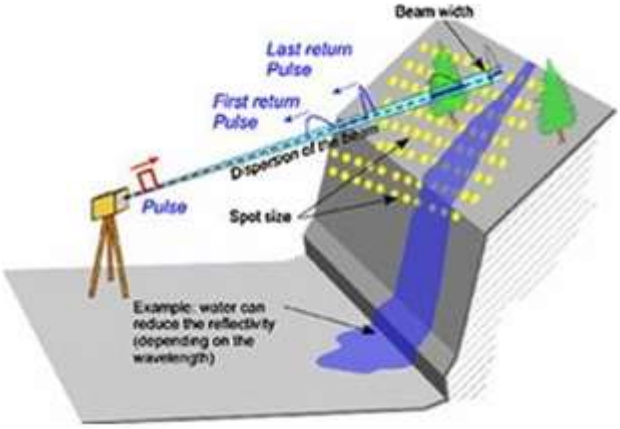

Figure 5. Laser Pulse Based 3D Scanner [14]

Table 1. Comparison between the 3D Scanning Techniques [15-17]

Parameter	1) Laser Triangulation 3D Scanning	2) Structured Light 3D Scanning	3) Photogrammetry	4) Contact Based 3D Scanning	5) Laser Pulse Based 3D Scanning
Advantages	• It's a highly versatile technology • It has high level accuracy • It is capable of scanning objects as well as measuring distances. • Scan objects at high speed at low resolution, measuring only a few points at a time	• It has a very fast scan time compared to other technologies • With the use of commercial scanners, you are usually very likely to get good results in terms of accuracy • This is a model that has a high level of precision	• There is no specialized equipment required, so it is relatively cheap • It is also possible to scan very large objects with this scanner • It properly captures the texture of the object. • It is very precise.	• It requires contact between theprobe and the object • It can collect precise 3D data points • Used to 3D scan transparent or reflective surfaces	• It has the ability to scan big object and anenvironment • Laser beams are measured in time between emission and reception to obtain geometrical information

Disadvantages	• During brightly lit environment, it does not perform well • There is also the possibility of more errors and minimal accuracy when compared to structured light scanning • It isn't ideal forscanning objects with transparent orshiny surface	• Cannot be used outdoor or inbrightly lit environment • We cannot scanvery large objects • Scanners can be expensive	• Due to the lack of specialized scanners, this is difficult. • Computers with high processing power, high resolution cameras, and specialized software are necessary for this method	• Slow speed and inabilityto work with free form shape • Equipment 'sare very expensive	• Does not workwell in brightlit environment and rain • It is a slow method in comparison toother 3D scanning techniques.
Cost	• Low Price	• Most Expensive	• Cost Effective	• Expensive	• Cost Effective

III. PROPOSED SYSTEM

After understanding and analyzing various models we have picked a suitable mechanism. The scanning mechanism (photogrammetry) used in our model entails an object kept on a turntable controlled using a potentiometer and gear mechanism to rotate the object to be scanned at a predefined speed. The ideal speedfor generating a detailed data set is 1 RPM. The data collected is put together to generate a composite 3Dimage.

Advantage: Scans colour of the object, cost effective, portable and easy rotation of the object.

Disadvantage: Since the object is mounted on the turntable, the lower data points of the object cannot be captured. In the bottom part of the object, there might be designs, holes, or cavities that cannot be captured.

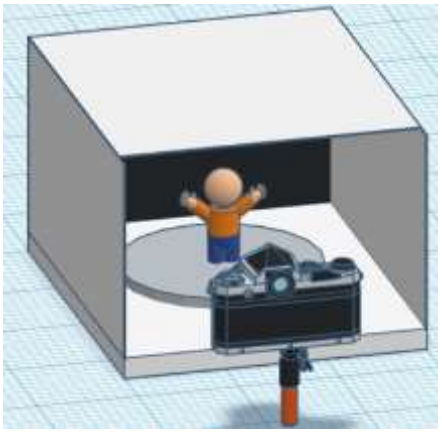

Figure 6. 3D Scanner Proposed System

IV. CONCLUSION

Using simpler cameras in place of a complex sensors while maintaining accuracy and reliability while compromising on some of the data captured and the time required helps us in manufacturing a 3D scanner that is more economical and user-friendly. This model can be used in various industries owing to all the avenues it opensin the design sector and its ease of use.

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