IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 10, Issue 5, May 2020, ||Series -I|| PP 48-53

3-Dimensional Scanning Using Photogrammetry

Manasa Iyer[1], Babli Gupta[2], Sejal Sawant[3], Shrikant Velankar[4]
Department of Electronics Engineering,Vidyalankar Institute Of Technology affiliated to University Of Mumbai, Maharashtra State, India.
Received 9 May 2020; Accepted 22 May 2020

Abstract: Classification of objects is a basic task carried out for nearly every product. A common classification method is by classifying an object based on its shape and/or size. By scanning any object, one can look for intricacies in its design. This poses a need for a simple and efficient solution for scanning an object for its 3 dimensional structure. 3 dimensional modeling has become quite popular in recent times and various research is happening in the field of 3 dimensional scanning.
Our project aims at bringing the same features and convenience when it comes to detecting and manipulating 3 dimensional objects. It allows the user to understand various structures and replicate them on a computer to understand the mechanics behind the structure.
We have employed photogrammetry principle for 3 dimensional recognitions which relies on using a data set consisting of photographs of the same physical object. And those set of photographs will be matched together resulting in Reconstruction of same physical object 3-dimentionally.
Hence making scanning process simpler.
Keywords: 3 Dimensional modelling and scanning, Photogrammetry principle, Reconstruction.

I. INTRODUCTION

As we know a common classification method is by classifying an object based on its shape and/or size. By scanning any object, one can look for intricacies in its design, and a 3-D scanner is best to scan an object.

The Main aim of this project is to build a low cost, low scale and efficient 3-dimentional scanner which will make the scanning process of objects easier so as we will be able to look and analyze an object in detail easily. We are going to do this by using principle of close range photogrammetry for 3 dimensional recognitions which relies on using a data set consisting of photographs of the same physical object. And after acquisition of photographs we created a python code which uses image processing and reconstruct those images into a 3-d model.

Now, Photogrammetry is the art, science and technology of obtaining reliable information about physical objects and the environment through the process of recording, measuring and interpreting photographic images and patterns of electromagnetic radiant imagery and other phenomena,where we are implementing close range photogrammetry.

Close-range photogrammetry refers to the collection of photography from a lesser distance than traditional aerial (or orbital) photogrammetry. Photogrammetric analysis may be applied to one photograph, or may use high-speed photography and remote sensing to detect, measure and record complex 2D and 3D motion fields by feeding measurements and imagery analysis into computational models in an attempt to successively estimate, with increasing accuracy, the actual, 3D relative motions.
This is the main concept of our project.

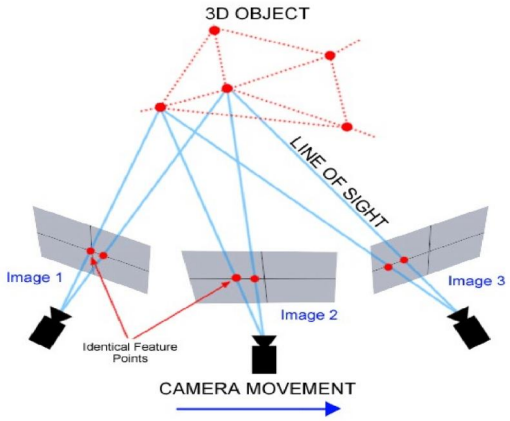

Figure 1: ***Photogrammetry principle***

3D scanning has been widely researched. It has innumerous applications; hence it is a common topic for research purposes.

Prince Khatarkar, Rahul Gupta and Ayush Shakya have used a Laser Scanner on Arduino platform. They use linear laser to scan objects and make a point cloud. A linear laser has projection as a line. With the help of this laser, they generate a 3D point cloud of the object with Meshlab [6].

CADScan has developed their own 3D scanning system.They developed a system software using their prototype scanner hardware on their own simulation software. A complete system simulation is created which allows them to test and validate system performance and to optimize the configuration of the scanner for several different applications [7].

Edge has used Structured light 3D scanning technologyfor its purposes.This technology makes use of the pattern of light deformation on an object for understanding its 3-dimensional geometry. The scanners use trigonometric triangulation method instead of LASER. It works by projecting a series of light in linear patterns onto an object. The system then examines edges of each line in the pattern and indirectly calculates the distance from the scanner to the object's surface. The structured light used generally are of colors white or blue. The light is generated with the use of various types of projectors such as the DLP technology (Digital Light Processing) [8].

II. PROPOSED SYSTEM AND METHODOLOGY

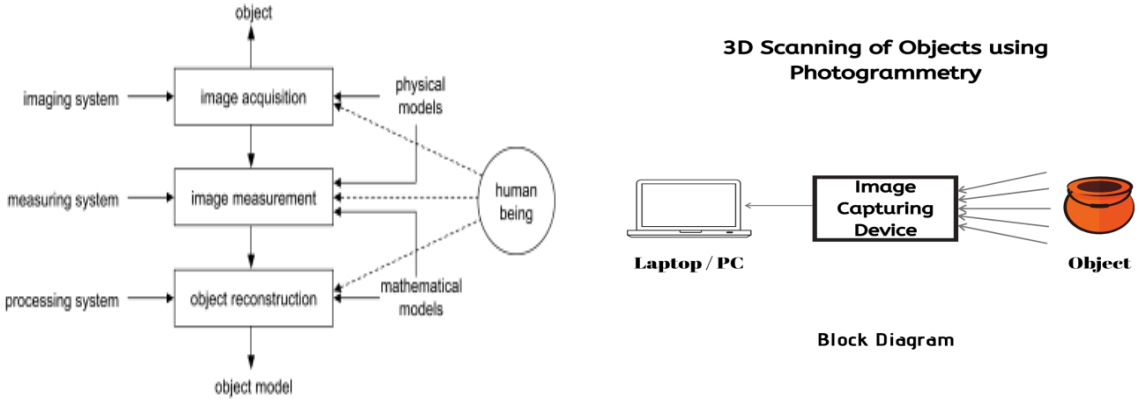

Figure 2: ***Block diagram***

The above is the basic block diagram of our proposed 3-d scanner model. As it can be clearly understood by the block diagram that the main aim of our proposed model is that there will be an object whose images will be captured (image acquisition) from different angles (image measurement) by using an image capturing device which can be any camera for example: mobile camera, webcam, or any other camera with good resolution which will be sent to a storing device such as laptop and then we will reconstruct the images into a 3-d model (image reconstruction).

This is the basic proposed model of our project.

Figure 3: ***Hardware representation***

This is our basic hardware representation that we have built. Here we have used one basic 5V geared DC motor on which the object will rotate 360 degrees on direct current using an 1A adapter and we have used our mobile phone to capture images which is held on 45 degrees in mobile stand and as the object will rotate we will start to capture images every 2-5 seconds.
This is a very efficient, low cost and low scale portable hardware that we have worked on using photogrammetry.

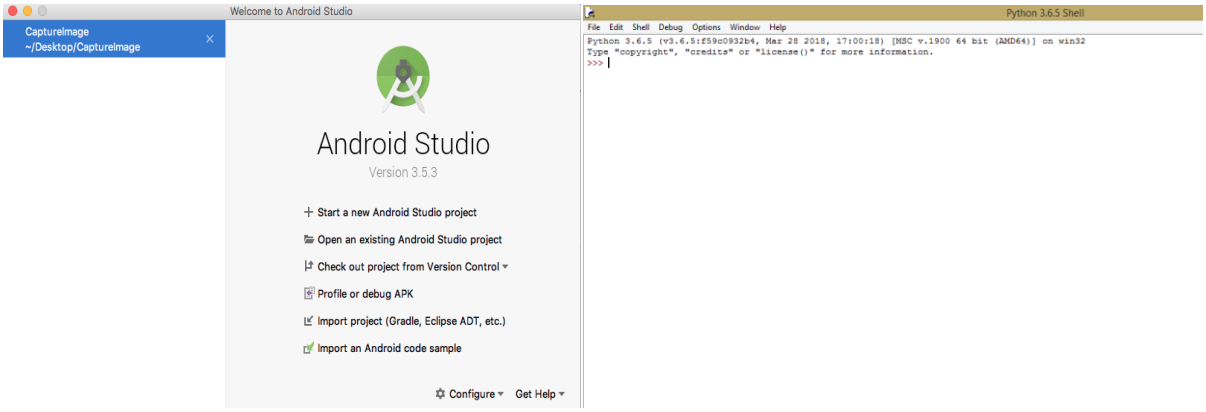

Figure 4: ***Software representation***

For the first step of our project that is image acquisition that is to capture image we had worked on 2 methods,
Click multiple pictures simultaneously after every 2-5s and then reconstruct it using already available online stitching tools.
Further we worked on android studio which is a software specially developed to build android applications. There we built a capture application to capture images. capture.apk.
Further for reconstruction of images we are using IDLE 3.6.5 and also trying already available software's to stitch.
Some of software's we have and are using are VisualSFM, 3DF Zephyr and Agisoft Metashape, which is completely based on photogrammetry principle.

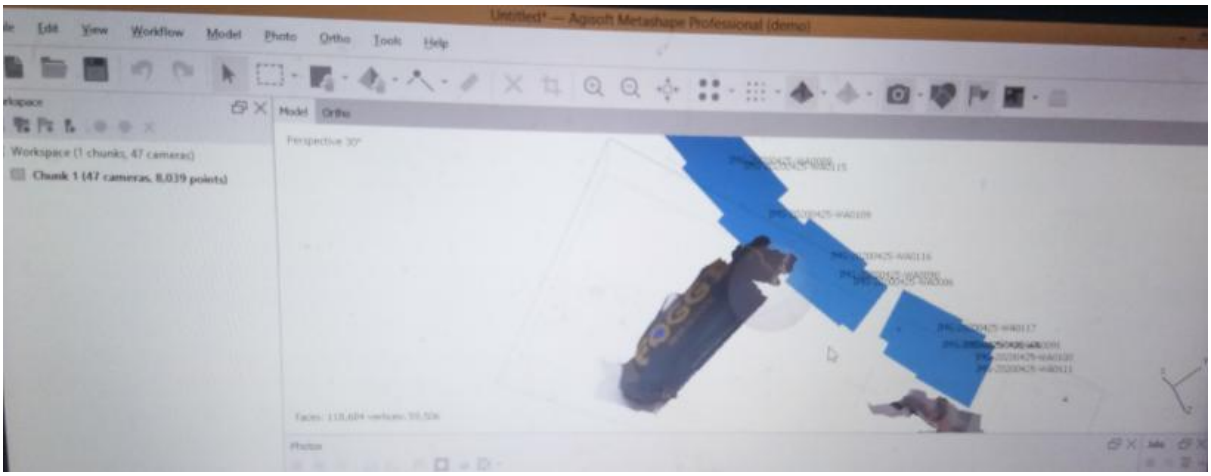

Figure 5: ***Reconstruction Of Model Using Agisoft Metashape***

III. FEASIBILITY ANALYSIS

Technical	Operational	Economical
Camera and free software	Better texture and quality	Low cost and affordable
Close range operation	More precise and accurate depending upon camera	Easy to build
Less complex	Fast and easy to operate	Compact and portable
Approximate scaling	Any home object can be used	Fast process
Good visual quality	Not much experience needed	Can be build in home

Table 1: ***Feasibility check***

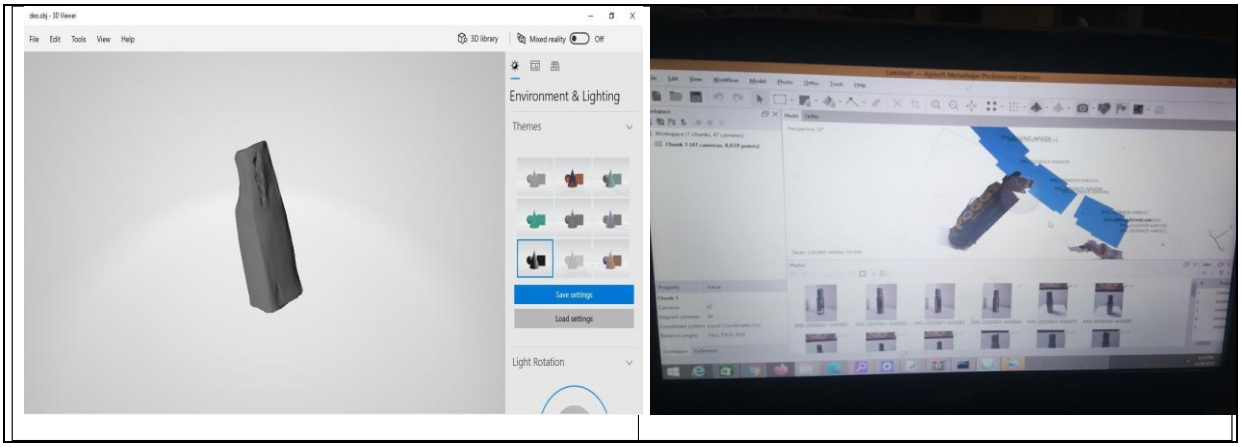

Table 2: ***Comparison between reconstructed model of our made software and already existing software respectively***

IV. RESULTS AND CONCLUSION

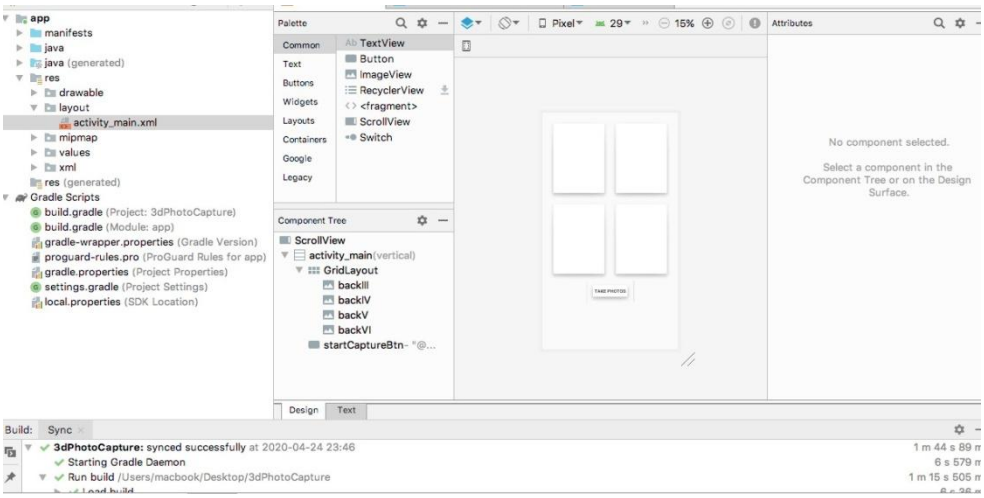

Figure 6: ***Output and capture.apk application creation***

This is how the capture.apk application interface looks. Further we install this application into our mobile phones, where we can find the same interface.

Now when we will attach our mobile to the stand and once we start the application it will direct us to camera where best 4 pictures will be clicked after every 2-3s considering all angles at 45 degree, as the object will rotate simultaneously.

Once clicked, the images will respectively be stored into the slots which could be seen on the interface and once the images are stored it is transferred to the laptop where the further reconstruction process is carried out.

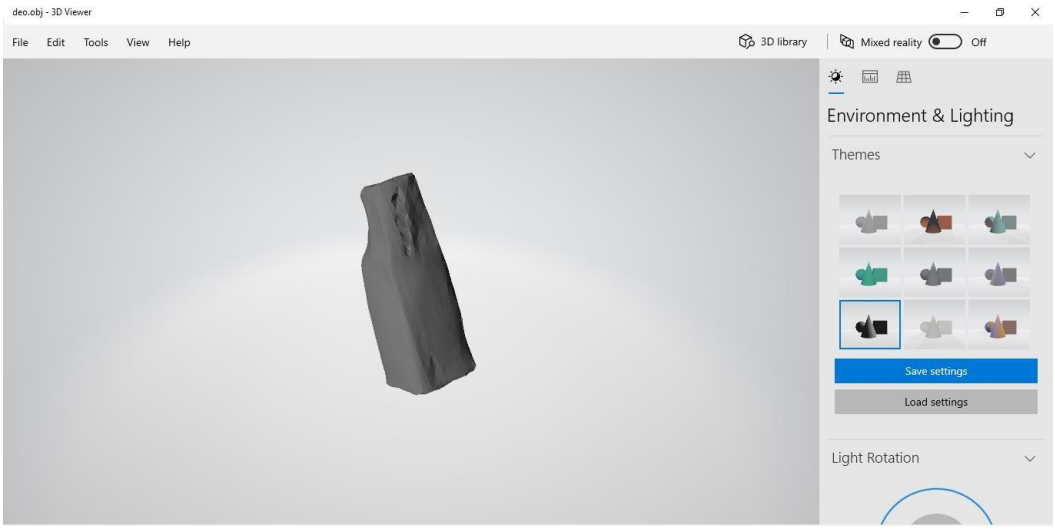

Figure 7: ***Reconstructed output***

This is the final reconstructed model that we have created.

HENCE Photogrammetry is a field that has seen exponential advancement along with the use of software that can cater to the specific needs of the user. Its compact size and ease to use is an added incentive that makes it the best option to use for structural analysis and 3D representations of any object. The high precision measurements it offers with the computational benefits has allowed for the incorporation of photogrammetric techniques in various fields. This is a growing technology and will see numerous advancements and changes with the increasing digitization and use of complex software.

And using this principle and all the above software and tools we built an efficient, reliable, low cost and portable 3-D scanner.

REFERENCES

[1]. https://www.emerald.com/insight/content/doi/10.1108/LHT-10-2017-0206/full/html?af=R Henson, K., Constantino, P., O'Keefe, F. and Popovich, G. (2019), "Three-dimensional scanning and printing techniques to analyze and archive human skeletal remains", Library Hi Tech, Vol. 37 No. 3, pp. 389-400. https://doi.org/10.1108/LHT-10-2017-0206

[2]. https://en.wikipedia.org/wiki/Photogrammetry
Wikipedia contributors. (2020, April 14). Photogrammetry. In *Wikipedia, The Free Encyclopedia*. Retrieved 17:05, April 28, 2020.

[3]. http://students.iitk.ac.in/eclub/assets/documentations/summer14/3d_laser_scanner.pdf
This was a research paper published by iitKanpur students where they had explained about entire process of 3-d scanning , its various types, comparison between them and explained various aspects of laser scanning.

[4]. https://www.kickstarter.com/projects/621838643/desktop-3d-scanner
CADScan was formed in 2011, motivated by a desire to make 3D scanning easy to use and accessible to all. They developed a system software using their prototype scanner hardware on their own simulation software. A complete system simulation is created which allows them to test and validate system performance and to optimize the configuration of the scanner for several different applications [7].

[5]. https://www.edge3d.io/what-3d-scanning-types-applications-advantages-and-methods-laser- lidar-contact-based-photogrammetry-triangulation-structured-pulse-light/
This site explains 3-D scanning methods, applications and advantages concept of LIDAR technology based scanning by EDGE-3D

[6]. http://www.tiespl.com/sites/default/files/pdfebook/Full%20page%20Html%20interface/pdf/Photo grammetry.pdf
This was a research paper which had completely discussed about photogrammetric processes, types, purpose and implementation it also provided block diagram of photogrammetric process.

[7]. https://www.researchgate.net/figure/scheme-of-principle-of-3D-image-caputure-using- photogrammetry-7_fig1_313738306
Tokkari, Niki & Verdaasdonk, Rudolf & Liberton, Niels & Wolff, Jan & Den heijer, Martin & Veen, Albert & Klaessens, John H G M. (2017). Comparison and use of 3D scanners to improve the

quantification of medical images (surface structures and volumes) during follow up of clinical (surgical) procedures. 100540Z. 10.1117/12.2253241.
[8]. https://www.electronicscomp.com/3.5-rpm-centre-shaft-dc-geared-motor-india this link provides specifacations and fdeatures of DC motor.
[9]. https://i7star.com/product/mobile-stand-camera-holder-tripod-stand/
[10]. https://techmed3d.com/2019/04/photogrammetry-vs-3d-scanning/
Dixit I., Kennedy S., Piemontesi J., Kennedy B., Krebs C. (2019) Which Tool Is Best: 3D Scanning or Photogrammetry – It Depends on the Task. In: Rea P. (eds) Biomedical Visualisation. Advances in Experimental Medicine and Biology, vol 1120. Springer, Cham
[11]. https://3space.com/blog/photogrammetry-vs-3d-scanning/
This site provides Blog by cthorsberry which compares all exixting tools for photogrammetric scanning and let us know what is best.
[12]. https://www.techopedia.com/definition/19297/feasibility-study
This site technopedia explains about feasibility study and its various components such as economic, operation, technical etc.
[13]. https://en.wikipedia.org/wiki/Scale-invariant_feature_transform
[14]. https://www.3dbeginners.com/list-of-free-photogrammetry-software/
Wikipedia contributors. (2020, April 16). Scale-invariant feature transform. In *Wikipedia, The Free Encyclopedia*. Retrieved 18:05, April 28, 2020
[15]. https://youtu.be/28vrZIj-hYQ
This video by Eric strbel is about building a functional usable turntable 3D Scanner for Photogrammetry, which we have tried to implement.

Manasa Iyer, et. al. "3-Dimensional Scanning Using Photogrammetry." *IOSR Journal of Engineering (IOSRJEN)*, 10(5), 2020, pp. 48-53.