

Analysis of dimensional accuracy and surface finish parameters for different 3D printers and cad softwares

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ABSTRACT – The dimensional accuracy and surface roughness of 3D printers are important parameters in additive manufacturing (AM). Among the factors that affect dimensional accuracy and surface roughness is tessellation produced by the software used. This paper present the study of comparing the dimensional accuracy and surface finish of three 3D printers, which are Mojo, Up Plus 2 and Creator Pro. Each 3D printer built workpieces from Solidworks 2013 and Catia V5R19 software. Surface roughness tester and coordinate measuring machine (CMM) were used to measure the surface roughness and dimensional accuracy of the work piece respectively. The results shows different output from different 3D printers.

was drawn using Solidworks 2013 and Catia V5R19 to be compared based on the tessellation, dimensional accuracy and performance of surface roughness. Work piece drawn is chosen as a design specimen based on the benchmarking evaluation [3].

After the drawing of work piece produced both Solidworks 2013 and Catia V5R19 drawing file must be converted to STL file format. This is because AM machine can only read the file in STL which the file is sliced into thin cross sectional layer. Three types of FDM machines; Mojo, UP Plus 2 and Creator Pro were used to print parts. The standard 3D printer machines parameter settings are using ABS material, with 0.15mm layer thickness, 450 Raster Angle, 00 Orientation, and low density Part Interior (Figure 1).

1. INTRODUCTION

Fused Deposition Modeling (FDM) is an Additive Manufacturing (AM) technology, which can construct physical models from Computer Aided Design (CAD) software automatically by using layers deposition of extrusion materials. Using additive manufacturing for prototyping, and latest trend into finished products is relatively a fast process [1]. This cause a reduction in cycle time of product development, which is a major consideration in industries, to remain competitive in the market place.

In spite of the favourable aspects of this innovation, obtaining a precise accuracy is hard to achieve. This includes poor surface quality. 3D printed work piece commonly have dimensional accuracy and surface finish problem [2]. Besides, parts produced by different 3D printers have varied accuracy and surface finish. The parts that not meet the design specifications according to the standard will affect the performance and the assembly fit with other components. All 3D printer machines have their own specifications and some of them do not provide consistent and precise measurement of the products.

2. METHODOLOGY

A simple work piece that contains basic prismatic; variation in circular surface and variation in flat surface

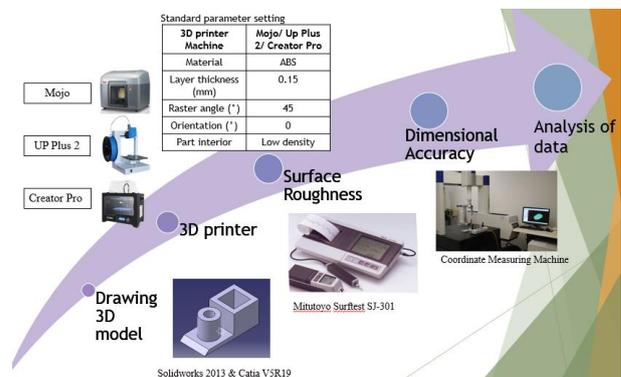


Figure 1 Methodology of this research

The dimensional accuracy of the work piece was measured using CMM, while the surface roughness of the part was measured using surface roughness tester.

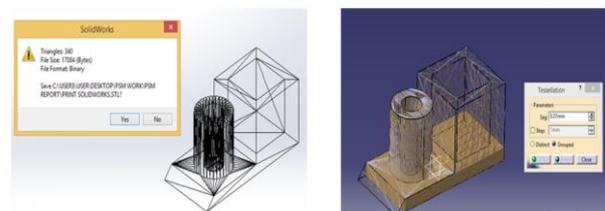


Figure 2 Different tessellation for different CAD software

Solidworks (left) creates 340 triangular mesh (facets) and Catia (right) file sliced up to 0.01mm for the same measurement of CAD drawing (Figure 2).

There are 4 work pieces produce by each machine which are Mojo, Up Plus 2 and Creator Pro printers. Two work pieces produces by Solidworks software and other two produces by Catia software. In total, there are twelve work pieces produced by three types of FDM machine [4]. Slicing takes a longer time with increased triangle count and consume more memory. These results in different printing time for different printers and different software.

3. RESULT AND DISCUSSION

The results include surface roughness and dimensional accuracies of specimens. Discussion on the results includes the microscopic inspection done to understand the results, and analysis of the relationship between dimensional accuracy and surface roughness.

In surface roughness, the tessellation produced by the software is not a major factor that affect the surface roughness because STL format creates by the software does not carry information on tolerance, surface finish and the build material. The best 3D printers for different surface area is shown at Figure 3. However, in dimensional accuracy, tessellation produced affect the accuracy result (Figure 4).

From Figure 5, error of surface roughness is the highest at Up Plus 3D printer, which is 15.664%. On the other hand, the smoothest surface roughness is by using Creator Pro, which creates error only 12.258%. The most accurate 3D printers in producing best results in dimensional accuracy between these three 3D printers is Mojo 3D printer. It only produced 0.162% error when using Catia software while 0.204% error when using Solidworks software. From this result, we can relate that Mojo print the best accuracy when using Catia software because Catia have higher number of triangular mesh (facets) in the STL file that improve accuracy.

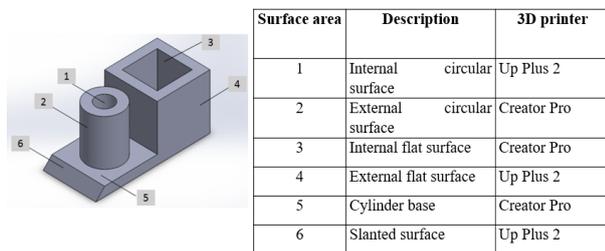


Figure 3 Summary of Surface Roughness

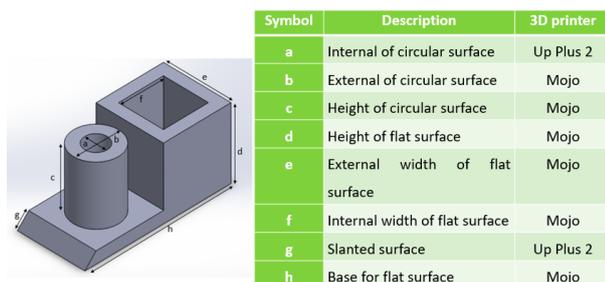


Figure 4 Summary of Dimensional accuracy.

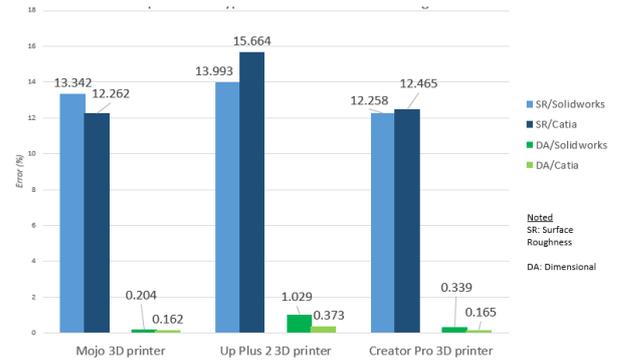


Figure 5 Relationship between Types of 3D Printer and Percentage Error

4. CONCLUSIONS

Work piece produce by Mojo produce the best dimensional accuracy because work piece produces are almost the same to the actual drawing compared to other two 3D printer while work piece built by Creator Pro gives lowest average surface roughness, Ra value, which indicates best surface quality.

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