Slicer Method Comparison Using Open-source 3D Printer

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Abstract. Open-source 3D printer has been one of the popular choices in fabricating 3D models. This technology is easily accessible and low in cost. However, several studies have been made to improve the performance of this low-cost technology in term of the accuracy of the parts finish. This study is focusing on the selection of slicer mode between CuraEngine and Slic3r. The effect on this slicer has been observe in terms of accuracy and surface visualization. The result shows that if the accuracy is the top priority, CuraEngine is the better option to use as contribute more accuracy as well as less filament is needed compared to the Slic3r. Slic3r may be very useful for complicated parts such as hanging structure due to excessive material which act as support material. The study provides basic platform for the user to have an idea which option to be used in fabricating 3D model.

1. Introduction

The first paragraph after a heading is not indented (Bodytext style). 3D Printing technology has been widely used since the expiration of FDM technology a few years ago [1]. The first open-source 3D printer has been developed by Jones et al and the first model was named as Version I “Darwin”[2]. Nowadays, the popular open-source technology is including MakerBot and Ultimaker which commonly used use polymer materials such as acrylonitrile butadiene styrene (ABS) and polylactic acid (PLA) [3]. The cost of this technology is around $1500 to $5000 which is quite affordable [3].

Low-cost is one of the factor that this open-source 3D printing has been chose to fabricate the 3D models. However, the performance of open-source 3D printer still in doubt where study was done on the dimensional accuracy using low-cost 3D printer shows differential in dimension to the actual value [4]. Also other study showing 20% different between the finish parts and the CAD data [5]. Despite of this drawback, some study was done to improve the performance by investigating the process parameters to increase the accuracy of the finish parts [6]. Other study was done on improving the nozzle with specific die angle to improve the accuracy as well [7]. Cost also has been study by comparing several 3D printing technologies to give an idea in choosing the right parameters and technology depending on desired specification [5].

This present study focus on comparing the slicer mode to observe the different on the performance. The slicing option is to convert the design model from CAD data into readable code to start the printing process. So far, there is no study has been done regarding the selection of slicer mode option and their effect on the finish parts. This study will observe the two slicers which are CuraEngine and Slic3r to see the effect on the finish parts which can be used to improve the product.
2. Methodology

A new open-source was developed in the lab consist of micro-controller (Arduino), having five stepper motor for x, y, z axes and for the feeding filament. The 3D printer using lead screw for all the three axes and also single power supply. The build dimension is 21mm x 21mm x 30mm.

2.1 Slicing Method

In this research, two types of slicer have been used for the comparison which are CuraEngine and also Slic3r. The function of this slice is to convert the design model from CAD data into readable code such G-code for the printing process. This process need to be done after setting up the parameters such layer thickness, percentage infill, printing speed and so on. The slicing software will automatically convert all the data into readable code for the extrusion process.

2.2 Sample Fabrication

In order to compare the slicing method, two samples were designed using Autodesk Inventor Software (Autodesk, USA) and converted into standard triangular language (STL) format. The first sample is quite simple with straight and curve design as shown in Figure 1(a) while the second sample more complicated with a combination of roundness shape, chamfer, fillet, and tiny hole as depicted in Figure 1(b).

![Figure 1. (a) Sample 1 (b) Sample 2](image)

The process parameters were fixed for both slicer including layer thickness of 0.3 mm, shell thickness of 1.2 mm, printing speed of 60 mm/s, and rectilinear fill pattern.

2.3 Dimensional Accuracy Measurements

The dimension was measured only for sample 1 using vernier calliper. Several dimension on the sample parts was taken to compare the differences for both slicer CuraEngine and Slic3r.

3. Results and Discussion

The study focus on two aspects which are the dimensional accuracy and the surface visual of the finish parts. There were two parts from sample 1 were fabricated by using both slicer. This condition was applied to the sample 2.

3.1 Accuracy Measurements

Two parts from sample 1 were printed using CuraEngine and Slic3r slicer as shown in Figure 2. Both slicer was compared and the data were recorded in Table 1.

![Figure 2. Printed sample 1 (a) Slice with CuraEngine; (b) Slice with Slic3r](image)
Table 1. Dimension measurements for both slicer

| Nominal Dimension (mm) | CuraEngine (mm) | Slic3r (mm) |
|------------------------|----------------|------------|
| 25.0                   | 25.0           | 24.9       |
| 6.2                    | 6.2            | 6.0        |
| 2.0                    | 2.0            | 1.9        |
| 113.5                  | 113.4          | 113.3      |

Based on the measurement of the dimension, there is slightly different between slice with CuraEngine and Slic3r. Overall, the CuraEngine give much better accuracy around 0.1 mm. Some of the feature shows quite significant different around 0.2 mm.

3.2 Surface Visual
The sample 2 design was exported to Repetier-host software. The first model was sliced using option of CuraEngine. The second model from the same sample 2 was sliced using Slic3r. To compare both slicer, two models from sample 2 were fabricated. By visualizing the surface of the finished parts, there is a difference in terms of the smoothness of the certain parts. If we observe carefully, especially in roundness shape and the two-tiny hole showing some of the excessive materials by using Slic3r while the CuraEngine just slightly excessive material. This clearly can be seen in Figure 3 below.

![Figure 3](image1.png)

Figure 3. (a) Excessive material in tiny hole (b) Excessive material in roundness shape

For the finished parts that slice using CuraEngine, the model smoother compare to the Slic3r and just a slight excessive material as shown in Figure 4.

![Figure 4](image2.png)

Figure 4. (a) Smooth parts slice using CuraEngine (b) Excessive material appear using Slic3r
Table 2. Comparison between CuraEngine and Slic3r

| Printing Spec   | CuraEngine (mm) | Slic3r (mm) |
|-----------------|-----------------|-------------|
| Printing time   | 38m 19s         | 35m 23s     |
| Layer Count     | 29              | 33          |
| Filament needed | 6230 mm         | 6968 mm     |

The finding from this study is that if the models need more accuracy, the better slicer option was to use the CuraEngine. In addition less time required and save more filament which is less cost as shown in Table 2. Besides, the finished parts are also good enough which is within the range of 0.1 mm. Meanwhile, if using Slic3r, more filament was needed compared to the CuraEngine which shows a lot of excessive materials appeared on the finish parts. In terms of accuracy, the Slic3r less accurate due to excessive material. However, Slice3r maybe is the best option for the complicated parts which involve a lot hanging structure because the excessive material can be used as support material.

4. Conclusion

Both slicer between CuraEngine and Slic3r has been compared in terms of dimensional accuracy and the surface visualization. It shows that CuraEngine contribute more accuracy and less filament is needed for printing the parts. However, the Slice3r can be used for parts that possess a lot of hanging structure. Overall, the study is providing the platform for the user to have many options available so that they can manipulate to have any output that they wanted depending on the spec.

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