International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-08, Special Issue, MAY 2022

Analysis of G-Code on FDM Build Parts to Achieve the Exact Height of CAD Model

Mr. R. Venkata Siva Subrahmanyam*, Ms. V. Veera Durga Chishma*, Mr. CH. Dorababu*, Mr. B. Jagadishvara*, Mr. P. Veera Venkata Sai Kishore*, Mr. M Sunil Raj, Mr. S Srikanth****

***UG students, Department of Mechanical Engineering, Pragati Engineering College (A)**

****Faculty, Department of Mechanical Engineering College, Pragati Engineering College (A)**

ABSTRACT: Additive manufacturing is the process of creating an object by building it one layer at a time. It is the opposite of subtractive manufacturing, in which an object is created by cutting away at a solid block of material until the final product is complete. Not every manufacturing process is the 100% efficient. In additive manufacturing also we have problems take care off before printing the model. Out of all the machine problems we have one more issue which we have taken care of slicing the model. When we slice the model, we have to consider the total height of the model and layer thickness. If, the layer height is not perfectly dividing the total height, we will get extra layers in the final printed model. These extra layers will consume extra energy and extra time. To avoid this extra material consumption and extra layer height we have rectified by editing the G-codes. Here we have modified the G code programme by using notepad. Here we have sliced the model with 0.1, 0.2, 0.3 0.4, 0.5 and 0.6mm layers of height. The final height of the component is calculated by reverse engineering the code and deleted the extra layer program and corrected it by replacing with the correct height programme layer.

Key words: FDM, G-Codes, CAD, AM, Slicing,

I. INTRODUCTION

The potentials of additive manufacturing (AM) to produce the parts for various applications including prosthetics, automotive, intelligent structure and defence show its increasing recommendations. It is able to fabricate the parts using a variety of materials ranging from plastics to metals. Many AM systems are commercially available such as stereo lithography apparatus (SLA), selective laser sintering (SLS), fused deposition modelling (FDM) and three-dimensional printing (3DP) for advanced applications. Among all available AM systems, FDM technology is the most widely used process for polymeric material. The major advantages of FDM technology are material availability, material diversity, cheaper, compact size and low working temperature. Based on the literature survey many studies also revealed some disadvantages of FDM technology such as surface properties, slow process and limits of dimensions. Researchers also performed the optimization of process parameters for avoiding limitations of FDM process.

In every manufacturing process, the cost of process depends upon the material and energy consumption per part. Since 3d printing is advancing rapidly in manufacturing process, the material consumption per part varying depend on the process parameter like infill density, wall count, infill pattern, support material, support infill and brim count etc..

The cost of 3D printed part is varying depends upon the complexity of the geometry. If the complexity of the geometry of the increases cost also increases & vice versa. Since 3d printing is layered manufacturing process the, material consumption per each layer varies because material each layer contains cross sectional details of the geometry. The area of each cross section varies continuously and material and energy also consumption also varies. Compared with conventional manufacturing (CM), this unique fabricating approach largely simplifies and accelerates the production process without the requirements of moulds, dies and tools. Its feature of rapid prototyping provides users with an efficient manufacturing environment with higher material utilisation and lower time consumption. As opposed to subtractive manufacture (SM) such as CNC machining, AM is conducive to both thin-skin and light-weighted production with an alternative infill density and a higher material usage efficiency, rather than solid fabrication. The design freedom with limitless geometric constraints offers AM a broad application into customised productions, which allows users to personalise the processing parameters. To produce complex designs, AM avoids the tooling-related constraints with the assist of support structure, especially for the consolidation of assemble parts. Since AM implements fabrication in terms of pre-defined path-planning code, it drives the production

 DOI : 10.35291/2454-9150.2022.0225

International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-08, Special Issue, MAY 2022

mode into mass customisation of high-differentiated products.

Due to the outstanding competitiveness, AM has profound impacts on numerous domains such as medicine, architecture, mechanics, aeronautics, chemical industry, education, food and social culture. It has been expanded into a wide variety of branches based on material feed and material process systems, ranging from powder bed fusion to material extrusion, from material deposition to sheet lamination, from thermal melting to light polymerisation. Many manufacturers have dedicated to developing AM mechanism and its supporting software to provide consumers an easy-to-use, high-dominated, and customised operation environment. However, this emerging production mode still has weaknesses in manufacturing speed, energy and material consumptions.

II. LITERATURE REVIEW

Whether AM is veritable as called "rapid prototype" is still doubtable. For mass customised production, AM mechanism is a limited factor itself as it consumes certain times on nozzle travelling, component heating and cooling down as well as its "job by job" mode. Against this issue, a relaxation scheme proposed by (Fok K et al., 2016) developed a path optimiser to shorten the extruder traversing time of each layer. Simulation results proved that the optimiser could significantly reduce the average time consumption in prefabricating and printing processes by nearly 10%. Another study in (Li et al., 2017) proposed a production planning model to estimate production time and cost of specific AM machines by considering multiple factors, including design geometry, task and machine allocation, machine characteristics.

Energy sustainability has become an important topic in recent decades. A related study outlined available research on the environmental performance of AM, including the analyses of energy and resource consumptions. Detailed statistics on various AM processes compared with CM were performed. The results confirmed that AM system had a higher electrical energy demand and less material consumption and wastage of material, in which the energy required for direct metal deposition, direct laser deposition, FDM and selective laser melting (SLM) was higher than the average level (Kellens et al., 2017)

From the perspective of material consumption, a research by (Watson J and Taminger K M, 2015) proposed a decision-support model for comparing energy and material consumptions between AM and SM. A volume faction was obtained as a critical value to judge AM's feasibility. The result confirmed the weakness of AM, for instance, the poorly recycled material from the products with higher usage ratio of support.

The move from subtractive manufacturing processes can minimize material waste (Huang et al., 2013), but are currently prone to various human errors. Under ideal conditions, the only material waste for FDM is support material. In practice, however, 3D printers may be used similarly to conventional printers in offices and result in high usage error. Since many users of commercial FDM printers are inexperienced in 3D printing operation, the actual material waste could be larger than that under ideal operating conditions without human or printer error. The quantity of support material changes with part orientation and other settings of the printer or design.

Failure could increase both the material and energy consumption, which undermined the environmental benefits of FDM. Failed prints might be produced due to various reasons such as insufficient preheating time, inappropriate geometry of parts or printer malfunctions (Grieser, 2015). When evaluating the material waste from FDM, most studies only consider the support material generation, in other words, the production under ideal conditions without failures.

Existing slicer software provides users with customised process parameters, such as layer thickness, support structure, product infill pattern, infill density, etc. Users may optimise both design and parameters to reduce consumed indicators. However, how to accurately model consumptions based on 3D design, machine characteristics and processing parameters; how to determine the most appropriate parameters to achieve the optimal consumptions require to be solved. Therefore, this study proposed a flexible and modular method to reduce the material consumption of AM task at prefabrication stage. It aims to benefit the improvement of design part and assist users in customised selection of process parameters. To achieve a high-precision prediction, the initial model can be upgraded in terms of machine characteristics. The prediction method is expected to be applied in practical AM environment which is suitable for other related manufacturing techniques using numerical control (NC) programming.

III. SLICING THE MODEL

Cura is an open source slicing application for 3D printers. It was created by David Braam who was later employed by Ultimaker, a 3D printer manufacturing company, to maintain the software. Cura is available under LGPLv3 license. Cura was initially released under the open source Affero General Public License version 3, but on 28 September 2017 the license was changed to LGPLv3. This change allowed for more integration with third-party CAD applications. Development is hosted on GitHub. Ultimaker Cura is used by over one million users worldwide and handles 1.4 million print jobs per week. It is the preferred 3D printing software for Ultimaker 3D printers, but it can be used with other printers as well.

 DOI : 10.35291/2454-9150.2022.0225

ISSN : 2454-9150 Vol-08, Special Issue, MAY 2022

IV. RESULTS AND DISCUSSION

Printing Time and Material Consumption of Different Layer Heights

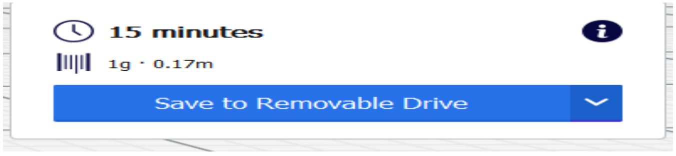


Fig 1 printing time and material consumption for 0.1 mm LH

Fig 2 printing time and material consumption for 0.2 mm LH

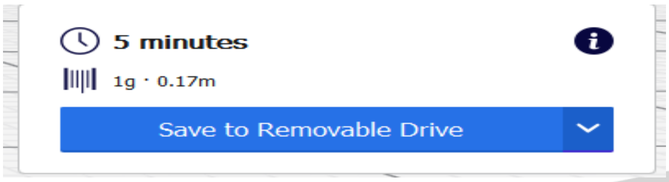


Fig 3 printing time and material consumption for 0.3 mm LH

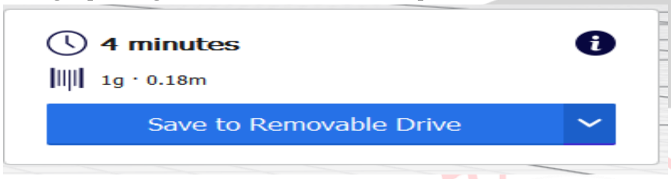


Fig 4 printing time and material consumption for 0.4 mm LH

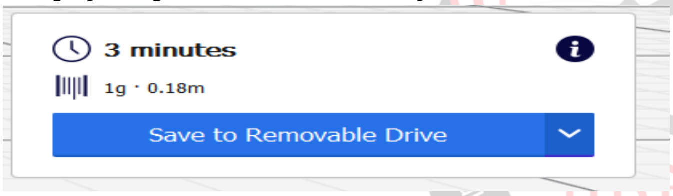


Fig 5 printing time and material consumption for 0.5 mm LH

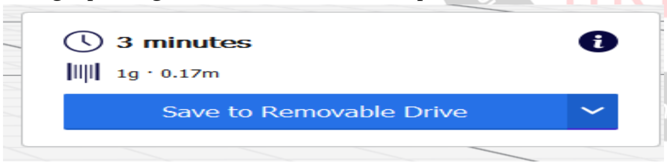
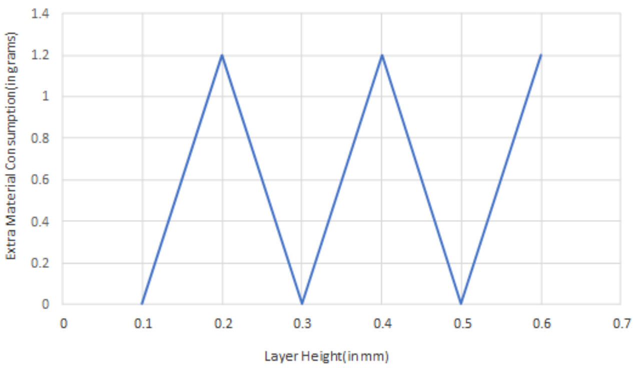


Fig 6 printing time and material consumption for 0.6 mm LH

Table 1: Extra Material Consumption

Layer height (mm)	Extra Material Consumption (grams)
0.1	0
0.2	1.2
0.3	0
0.4	1.2
0.5	0
0.6	1.2

Graph 1: Extra Material Consumption



The graph represents the extra material consumption for different layer heights. When the layer height is not exactly dividing the total height of the component extra layers will be created. These extra layers will consume extra material and consumes more energy. The energy consumption graph will be exactly similar to the material consumption graph. Here the height correction done by editing the g code by using note pad++ software.

Edited Layer View of Edited G Code Program

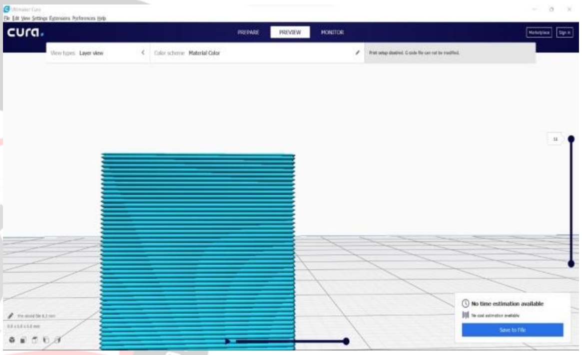


Fig 7 edited 0.2 mm layer height program

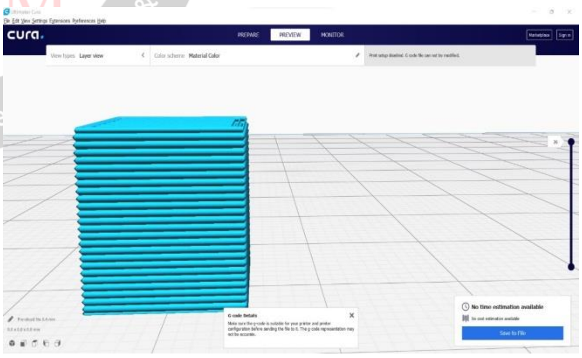


Fig 8 edited 0.4 mm layer height program

V. CONCLUSION

After slicing with different layer heights, printing time and material consumption varies. When the CAD model height is exactly divisible with layer height, we will get exact height of the CAD model.

Here we observed that at the layer height of 0.1mm ,0.3mm,0.5mm we are having the optimized material consumption with no extra material consumption and at

DOI : 10.35291/2454-9150.2022.0225

ISSN : 2454-9150 Vol-08, Special Issue, MAY 2022

layer heights of 0.2mm,0.4mm,0.6mm there is an extra material consumption.

When the layer height is not exactly divisible layer height (LH) material consumption and printing time will vary. To capture the exact layer height, we modified the G-code in such a way that it will print the last layer height exactly. By modifying the G-code, we can reduce the printing time, material consumption and energy consumption.

REFERENCES

[1] Whitley D 3rd, Eidson RS, Rudek I, Bencharit S. In-office fabrication of dental implant surgical guides using desktop stereolithographic printing and implant treatment planning software: A clinical report. J Prosthet Dent 2017;118:256-63.

[2] Hultin M, Svensson KG, Trulsson M. Clinical advantages of computerguided implant placement: a systematic review. Clin Oral Implants Res 2012;23:124-35.

[3] Marchack CB, Moy PK. Computed tomography-based, template-guided implant placement and immediate loading: an 8-year clinical report. J Prosthet Dent 2014;112:1319-23.

[4] Deeb GR, Allen RK, Hall VP, Whitley D 3rd, Laskin DM, Bencharit S. How accurate are implant surgical guides produced with desktop stereolithographic 3-dimentional printers? J Oral Maxillofac Surg 2017;75: 2559.e1-8.

[5] Bencharit S, Staffen A, Yeung M, Whitley D 3rd, Laskin DM, Deeb GR. In vivo tooth-supported implant surgical guides fabricated with desktop stereolithographic printers: Fully guided surgery is more accurate than partially guided surgery. J Oral Maxillofac Surg 2018;76: 1431-9.

[6] Deeb JG, Bencharit S, Loschiavo CA, Yeung M, Laskin D, Deeb GR. Do implant surgical guides allow an adequate zone of keratinized tissue for flapless surgery? J Oral Maxillofac Surg 2018;76:2540-50.

[7] Deeb G, Koerich L, Whitley D 3rd, Bencharit S. Computer-guided implant removal: A clinical report. J Prosthet Dent 2018;120:796-800.

[8] Seo C, Juodzbalys G. Accuracy of guided surgery via stereolithographic mucosa-supported surgical guide in implant surgery for edentulous patient: a systematic review. J Oral Maxillofac Res 2018;9:e1.

[9] Colombo M, Mangano C, Mijiritsky E, Krebs M, Hauschild U, Fortin T. Clinical applications and effectiveness of guided implant surgery: a critical review based on randomized controlled trials. BMC Oral Health 2017;17:150.

 DOI : 10.35291/2454-9150.2022.0225