IMPROVING OPERATION AND MAKING PRACTICAL APPLICATIONS ON THE 3D PRINTER CREALITY ENDER 3

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ABSTRACT: After purchasing and using the FDM (Fused Deposition Modeling) 3D Printer Hobby Creality Ender 3, I have noticed some manufacturing malfunctions, which may be an impediment to making a part design under normal conditions and at the best print quality. The main factor that negatively influences printing is the construction of the filament roller holder. There have been identified problems which involve 3D printer operation using standard filament holder and a new one has been designed to optimize the printing process. The paper describes how to use the Creality Ender 3 3D printer using computer aided design applications such as SolidWorks and Cura Ultimaker.

KEYWORDS: 3D printer, computer aided design, optimization, process.

1. Introduction

In recent years, 3D printing technologies have became more and more known and used, this has led to the development of this field and the launch on the free market of many models of 3D printers, but also of components and accessories so that such a printer can also be made in-house by amateurs. In the open market, the cost of such a printer varies greatly from a few hundred dollars for a hobby printer to several tens of thousands of dollars for an industrial printer.

The printer used in this work is produced by Creality and it is a hobby printer. Following its use, some manufacturing deficiencies were found, which may be an impediment to making a part under normal conditions and at the best quality. The paper aims to expose these shortcomings and identify practical solutions to optimize the printing process.

2. Current stage

3D Printing or layer-by-layer deposition is a process of making a three-dimensional object of any shape designed digitally. The 3D object is made by an additive process in which successive layers of material are deposited in various shapes. The difference between the 3D printing technique and the traditional method of making objects is that instead of cutting of excess material, the material is deposited in the desired shape from the beginning, without the need for further processing.

Three-dimensional printing is a technology introduced in 1980, when a Japanese doctor called Hide Kodama developed the first patent for rapid prototyping. Initially, the 3D printing process was called rapid prototyping, especially the fact that it allows the rapid creation of different prototypes of some products. The first 3D printer was created by Charles Hull in 1984, which allowed the creation of real objects based on digitally projected data. Hull's contribution was the STL (stereolithography) file format and the digital "slicing" and "infil" strategies common to many processes today. In 1986, Charles "Chuck" Hull was granted a patent for this system, and his company, 3D Systems Corporation, was founded and launched the first commercial 3D printer, the SLA-1 [1].

3D Printing Technology:

1. Fused deposition modeling (FDM);
2. Stereolithography (SLA);
3. Selective laser sintering (SLS);
4. Poly-Jet 3D Printing [2].

Fused deposition modeling (FDM)

In this project we chose as a 3D printing method, FDM (Fused Deposition Modeling).

In this 3D printing process, the starting material is usually in the form of a plastic wire, which is known as a filament. In fused deposition modeling, the filament is wound on a roller and it is pushed into the melting system by an extruder (motor). This continues until the material is extruded through the nozzle, the fused filament being applied to a heated printing bed. Each new layer will be deposited on top of another layer and attached to it thus forming the desired part [3,4].

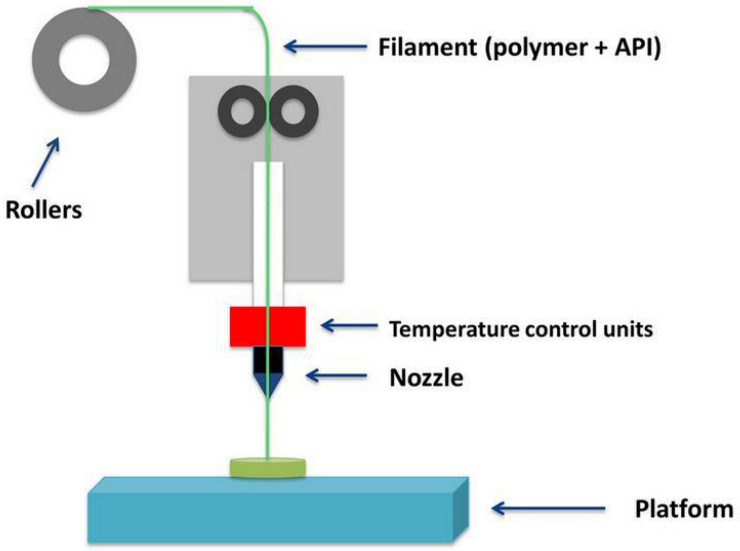

Fig. 1. FDM Technology [5]

This technology has the great advantage of the low price, both of the materials used for the actual printing, of the components of the 3D printer, as well as of the consumables. Such a printer is easy to buy and easy to use [6].

The main disadvantage of the FDM technique is that in the case of models with a high complexity from a geometric point of view, the speed of realization of the real object increases significantly but can also lead to the creation of small surface imperfections due to imperfect gluing of layers. Also, in the case of small parts, the resolution is not as good as in the case of really large parts.

The main applications of FDM modeling are: prototyping in various fields for testing purposes, making durable assemblies and subassemblies, conceptual design, production of household objects and much more [7].

3D Printer Creality Ender 3

Creality is a manufacturer of 3D printers from China, the company was established in 2014 and became known in 2018 with the launch of the Ender 3 printer, which is a budget hobby printer, very accessible to the general public [8].

This printer is a FDM technology (Fused Deposition Modeling). It is a simple printer, easy to assemble with high reliability and very good value for money. It is provided with a solid frame that provides rigidity and magnetic foil that facilitates the detachment of parts from the printing bed.

Machine Parameters:

Printing Size: 220*220*250 mm;

Filament: 1,75 mm:

Max Traveling Speed: 180 mm/s;

Machine Size: 440*440*465 mm;

Package Weight: 8 kg;

Max Nozzle Temperature: 255ºC;

Max Hot Bed Temperature: 110ºC;

Precision: ±0.1 mm;

Nozzle Diameter: 0.4 mm;

Layer Thickness: 0.1-0.4 mm;

Working Mode: Online/ Offline SD card;

File Format: STL, OBJ, G-code.

Fig. 2. Creality Ender 3 Printer [9]

3. Using the Creality Ender 3 printer

After using this 3D printer I noticed some deficiencies of the filament supply system:

1. The position of the filament holder on which the roller is mounted is wrong, the axis of the extrusion mechanism bushing and the axis of the filament forming a sharp angle so that there is a very high friction between the guide bush and the filament which is amplified by the type of filament (flexible filament is much tighter and the friction force is higher).
2. The filament holder on which the roller is placed is rigid and the sliding of the roller for feeding with filament is made similar to a bearing housing, thus making the load of the extrusion motor more difficult.

Using of this filament supply system may have the following consequences:

- Premature wear of the guide bush;
- Interrupt the printing process;
- Irregularities of the printed part;
- Extrusion motor failure.

To remedy these shortcomings and optimize the printing process, I rewrote the filament roller holder and mounted it in a position favorable to the extrusion motor. The new filament holder was designed in Solidworks 2016 and for the generation of the printing code, in order to make the parts physically we used the 3D slicer Ultimaker Cura 4.8.0.

The filament holder was made of PLA. I chose this material because it is not toxic, it does not emit toxic smoke when melting, which is an advantage when working in your own home. It is also easy to buy and its price is lower than other materials [10].

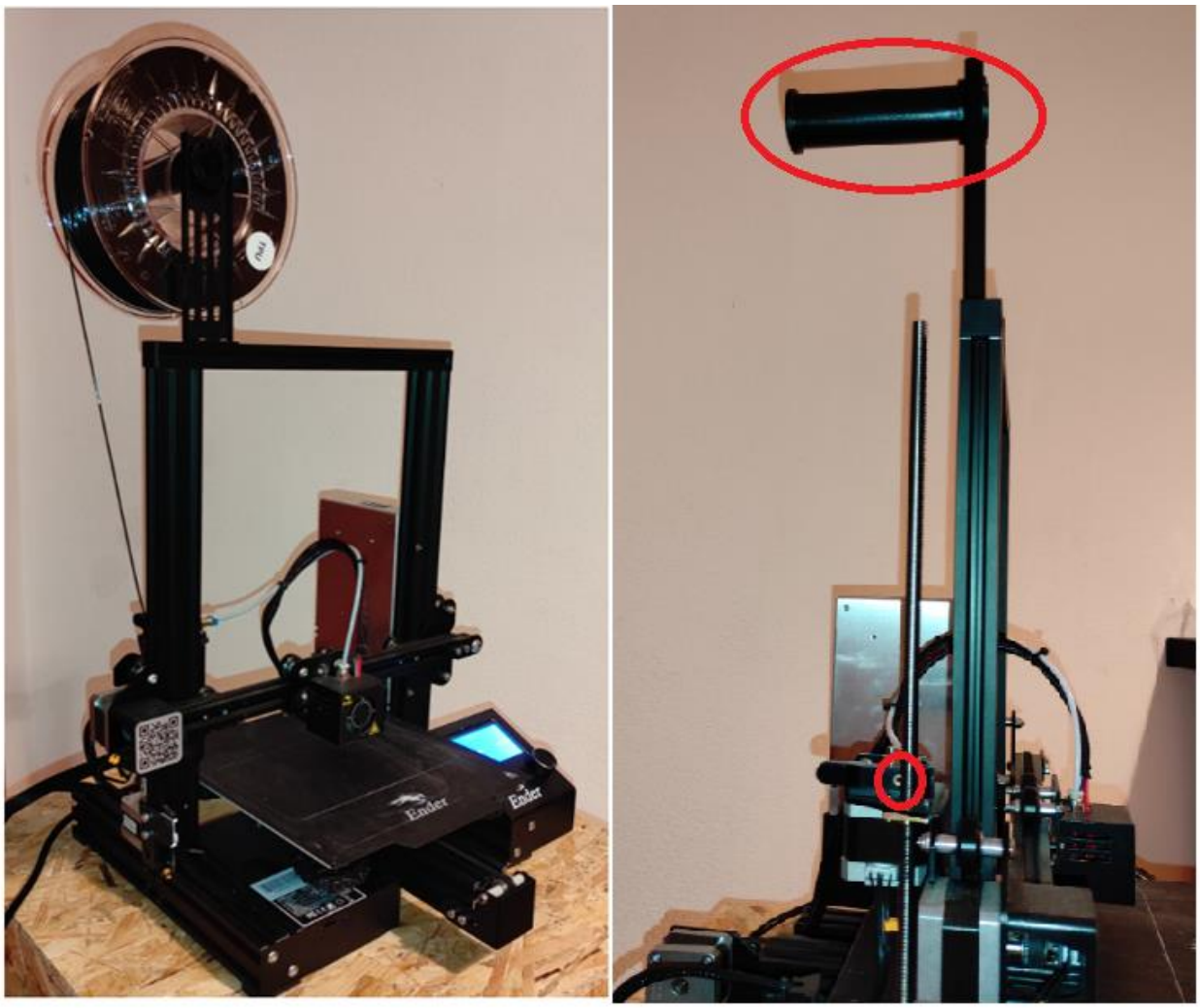

Fig. 3. Standard Filament Holder

Properties of PLA 3D filaments:

- The melting point for PLA is between 150 and 160 degrees Celsius and may depend on other materials added to give it texture or color;
- Vapors released during melting of PLA are non-toxic and do not have a strong smell;
- Hardness is high and flexibility is considered low;
- Easily adheres to many types of materials;
- It can also be used without a heated bed as a base, but if a bed is still used, it should be between 40 and 50 degrees Celsius [11].

4. Making the component parts and assembling the filament holder

The filament holder was designed in SolidWorks 2016 and the Cura Ultimaker 4.8.0 program was used to generate the printing code.

I decided that the position of the filament base holder would be on the side of the extrusion motor. For an easy assembly without other modifications to the printer, we measured and copied the aluminum profile from which the printer is made, and the new filament holder is mounted directly on it.

Fig.4. Holder Design

The 3D model was created in Solidworks and was imported into the Ultimaker Cure software to set the printing parameters and generate the G code program.

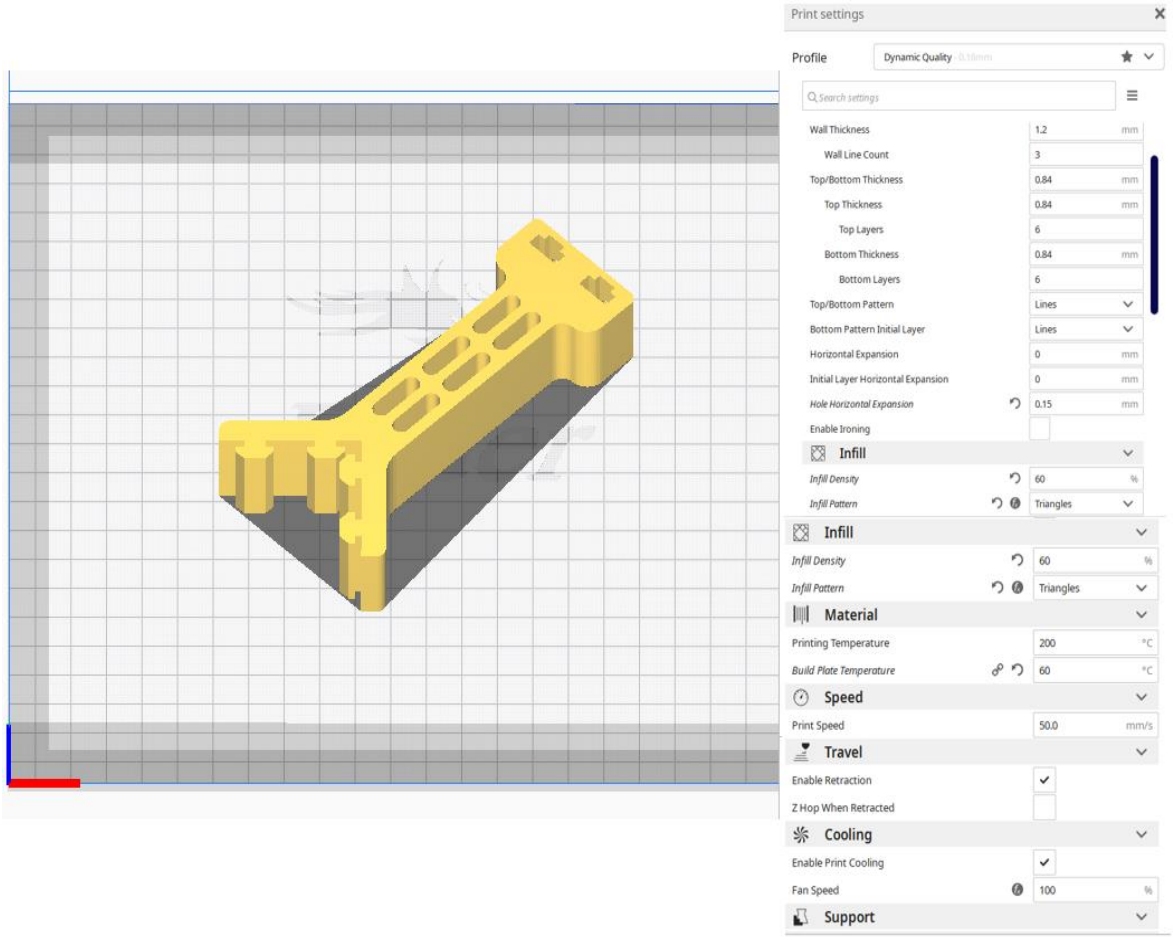

Fig. 5. Printing Settings

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;Generated with Cura_SteamEngine 4.8.0
M140 S60
M105
M190 S60
M104 S200
M105
M109 S200
M82 ;absolute extrusion mode
; Ender 3 Custom Start G-code
G92 E0 ; Reset Extruder
G28 ; Home all axes
G1 Z2.0 F3000 ; Move Z Axis up little to prevent scratching of Heat Bed
G1 X0.1 Y20 Z0.3 F5000.0 ; Move to start position
G1 X0.1 Y200.0 Z0.3 F1500.0 E15 ; Draw the first line
G1 X0.4 Y200.0 Z0.3 F5000.0 ; Move to side a little
G1 X0.4 Y20 Z0.3 F1500.0 E30 ; Draw the second line
G92 E0 ; Reset Extruder
G1 Z2.0 F3000 ; Move Z Axis up little to prevent scratching of Heat Bed
G1 X5 Y20 Z0.3 F5000.0 ; Move over to prevent blob squish
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Fig. 6. G-code

I have developed a new filament roller holder system. To facilitate the filament supply by reducing the stress exerted by the extrusion motor, I decided to use a bearing assembly.

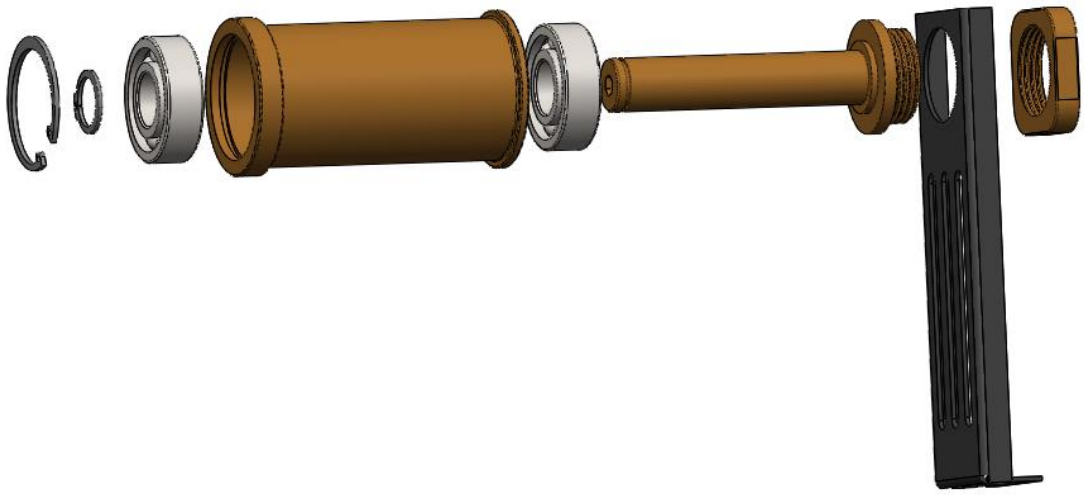

Fig. 7. Roller Holder

The steps described above were followed to make all the printed elements of the final assembly.

Following the printed filament holder, I mounted the original printer holder. It is made of sheet metal and was assembled using 2 M5 screws and 2 T-nuts.

I have developed a new filament roller holder system. To facilitate the filament supply by reducing the stress exerted by the extrusion motor, I decided to use a bearing assembly.

I chose to use two bearings code 6203Z and their securing was done with the help of two Seeger safety rings, respectively 40 mm inner safety and 17 mm outer safety.

In order to facilitate the tightening of the shaft on the sheet metal holder, it is provided with a keyhole with a wrench of 6 mm. The support of the shaft is made with the help of the M30x2 mm thread.