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3D Printer filament Extruder machine's filament collecting machine

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Abstract

3D printing relies heavily on the quality of the filament, which is formed by heating and shaping raw PLA material into the desired dimensions. The manufacturing process involves extruding raw PLA pellets, heating them, and using a nozzle to create a circular filament with a specific diameter. While numerous extruders on the market can produce 3D printer filament from raw PLA, there is a lack of machines specifically designed for collecting the extruded filament. This paper introduces a filament collecting machine designed to address this gap in the manufacturing process. Our collecting machine features a cooling mechanism, an automatic winding mechanism, and a collecting mechanism. Additionally, it is equipped with a sensing unit that accurately measures the length of filament collected on an empty spool.

Keywords: Automatic winding; Cooling mechanism; Filament collection; Sensing unit

1. Introduction

Additive manufacturing, commonly known as 3D printing, has revolutionized manufacturing processes across various industries. This transformative approach to production has significantly altered traditional methods. Unlike subtractive manufacturing processes that involve cutting away material from a solid block, 3D printing builds objects layer by layer from digital design files. This method has the advantages of reducing material waste and minimizing resource consumption. Additionally, 3D printing enables new possibilities for innovation, customization, and sustainability by enhancing the materials used in 3D printing filaments through custom and composite material selections. 3D printer filament is the primary material used in Fused Deposition Modeling (FDM). In this process, the filament is melted and extruded through a nozzle, layer by layer, to create three-dimensional objects. Typically, filaments come in the form of long spools and are available in various materials, colors, and diameters to meet different printing needs. A wide range of filaments is available in the market, including PLA, ABS, PETG, TPU, and nylon. Among these, PLA is the most widely used in 3D printing technology. PLA is a biodegradable thermoplastic polymer derived from renewable resources like corn starch, making it environmentally friendly. On the other hand, ABS offers high strength and temperature resistance but requires a higher bed temperature for printing, which is why PLA is often preferred over ABS.

Although 3D printing minimizes material waste, some waste is generated, particularly from support materials and defects in printed objects. To address this, an extruder can be introduced to recycle 3D printed waste into new filament, thereby eliminating waste in 3D printing technology. This paper discusses an additional setup for the 3D printer filament extruder machine, which collects the filament extruded from the 3D printer filament extruder.

2. Literature review

The evolution of 3D printing material extruders has seen significant advancements aimed at enhancing performance, reliability, and cost efficiency. Early designs focused on basic functionality, but modern extruders feature dual-extrusion, variable nozzles, and precise temperature control systems, enabling the use of diverse and specialized

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materials. Recent innovations have improved print quality, reduced waste, and increased efficiency, making additive manufacturing more accessible and cost-effective. Material reusability and recycling have become crucial, with strategies like closed-loop systems and recycled filament production reducing costs and environmental impact. Advanced temperature-controlled heating systems, utilizing PID controllers and thermocouples, ensure precise temperature regulation, improving print accuracy and reliability. Additionally, advanced cooling methods, such as water-cooling and fan-assisted cooling, enhance solidification and minimize warping, leading to better dimensional accuracy and surface finishes. These advancements make 3D printing more efficient, sustainable, and adaptable to various applications.

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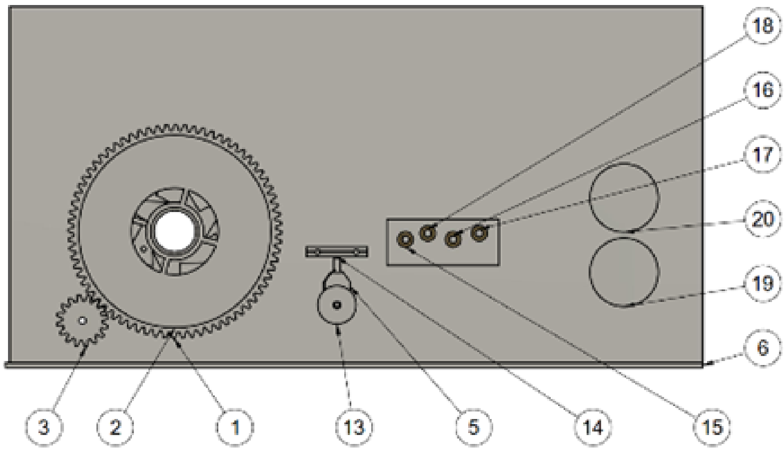
4. Construction

The components used in this project include a 5mm rod radial ball bearing, bearing U90zz, 5mm shaft, 12V DC gear motor, 12V motor speed controller, 12V submersible mini pump, Arduino board, IR sensor, LCD display, 12V AC to DC converter, and 2-pin switches. Additionally, the project incorporates specialized parts such as an automatic wire winding mechanism and a 3D printer filament spool holder. CAD designs provide blueprints for precise machine fabrication. All components are mounted on plywood, with specific holes cut for the DC motor, speed controller, switches, LCD display, and IR sensor. These plywood modifications are performed using a CNC router, with the code generated through ArtCam software. The components for the automatic wire winding mechanism and the spool holder are fabricated using 3D printing technology.



Parts List			
Item	Qty	Part Number	Material
1	1	Spool roller (big gear)	Plastic
2	1	Component2	Plastic
3	1	Spool roller (small gear)	Plastic
4	1	Component4	
5	1	Guider	Plastic
6	1	Base	
13	1	Roller (AWM)	Plastic
14	1	Slider (AWM)	Plastic
15	1	U604ZZ bearing	Bronze
16	1	U604ZZ bearing (1)	Bronze
17	1	U604ZZ bearing (2)	Bronze
18	1	U604ZZ bearing (3)	Bronze
19	1	Filament roller	Plastic
20	1	Filament roller (1)	Plastic

Figure 1 Layout of the machine with component

5. Working

The filament extruded from the 3D printer filament extruder machine is at a temperature of 250°C. To cool this filament, a 12V DC submersible mini pump and a 30cm vertically cut PVC pipe with sealed sides are used. Excess water from the PVC pipe is collected in a rectangular box and recirculated by the pump. The cooled filament then enters a roller system consisting of two cylinders that pull the filament from the extruder. To prevent deformation, a 5mm U604zz ball bearing is used, ensuring the filament maintains a proper circular shape. After passing through the U604zz bearing, the filament enters the automatic wire winding mechanism, which includes a roller, guider, and slider. The roller, powered by a 12V DC gear motor, features a thread-like guideway that converts rotational motion to linear motion. The guider follows this path, enabling linear movement, and the slider, attached to the guider, slides between two 5mm aluminum rods. The filament is then wound onto an empty spool connected to a gear mechanism, powered by a small gear linked to the 12V DC gear motor. All motors are controlled using a 12V DC speed controller.
+5

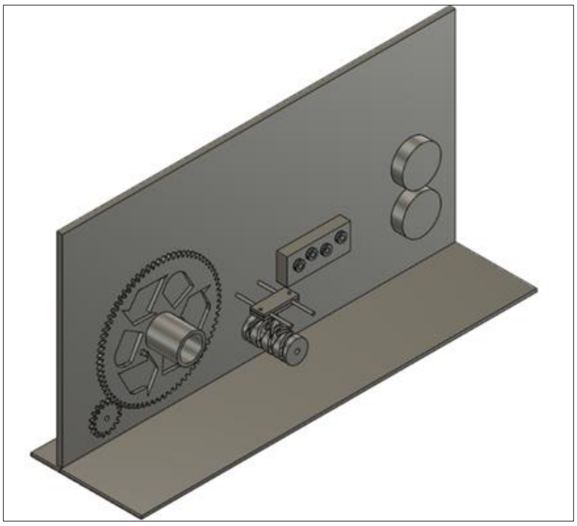


Figure 2 Final design of the machine

6. Design

The design of the machine is done with fusion 360 software some of the images are listed below.

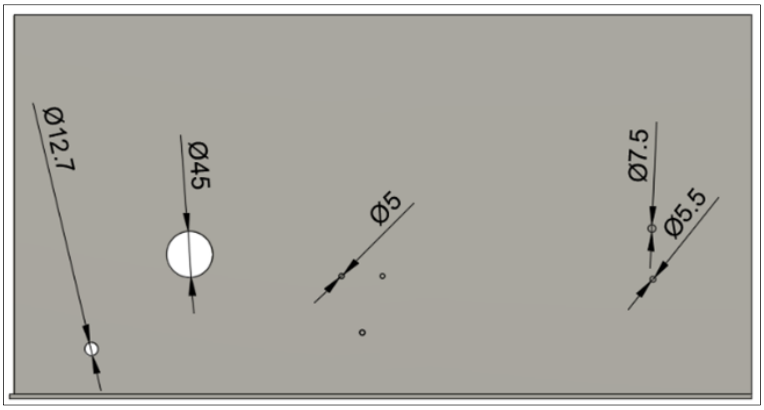


Figure 3 Design for CNC router

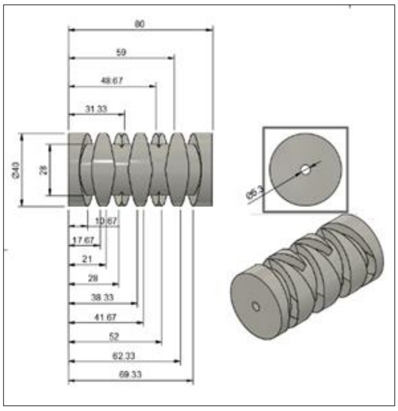


Figure 4 Roller design

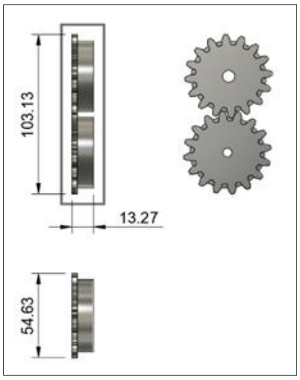


Figure 5 Roller design

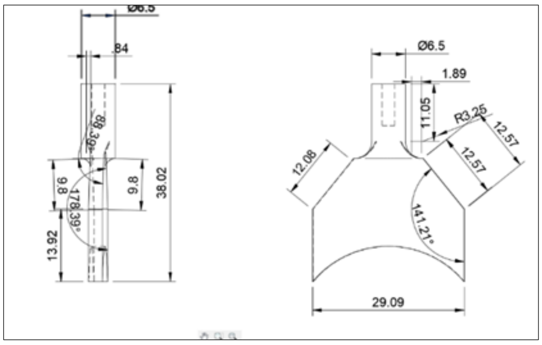


Figure 6 Guide design with dimension

7. Conclusion

This project exemplifies the fusion of innovation, precision engineering, and meticulous craftsmanship in 3D printing filament production. It ensures consistent, high-quality filament through a systematic approach involving extrusion, cooling, tensioning, winding, and collection stages. Advanced technology and engineering principles maintain filament integrity and dimensional stability. Tensioning and guiding mechanisms enhance uniformity, while an automatic winding system optimizes spool capacity. The integration of an infrared sensor for filament quantity monitoring ensures efficient inventory management. Committed to safety, maintenance, and scalability, this project meets modern additive manufacturing demands, driving innovation and efficiency in the industry.

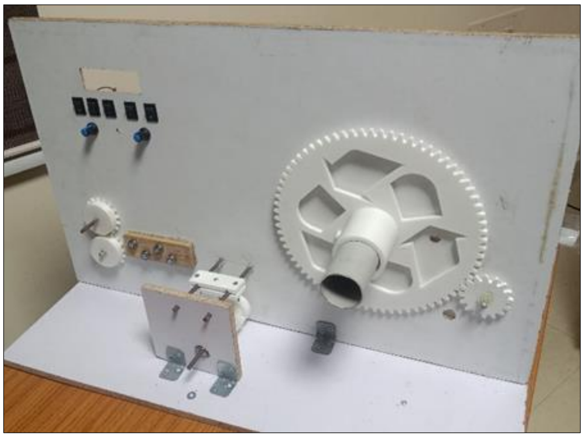


Figure 7 Final output of the machine

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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