

AUTOMATED 3D PRINTING FILAMENT MAKER USING SOLID WASTE

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Abstract - This paper describes the design and fabrication of an automated system that converts post-consumer PET plastic waste into usable 3D printing filament. The proposed setup integrates controlled heating, extrusion, cooling, and synchronized spooling using an Arduino-based controller to maintain dimensional stability of the filament. The process flow minimizes manual intervention while improving repeatability and safety. Experimental evaluation indicates that the produced filament achieves near-uniform diameter suitable for low-cost prototyping and academic use, thereby supporting sustainable manufacturing and effective solid waste utilization.

Keywords: 3D Printing Recycled PET, Filament Extrusion, Automation, Solid Waste Management.

1. INTRODUCTION

The increasing adoption of additive manufacturing has resulted in a growing dependence on thermoplastic filaments, which contributes to higher material costs and environmental burden. Among plastic wastes, PET bottles represent a significant fraction due to their widespread use. Transforming PET waste into 3D printing filament presents an economical and environmentally responsible solution. This work aims to develop an automated filament production system capable of delivering consistent output quality from discarded PET materials.

1.1 Evolution of 3D printing filament

3D printing changed how stuff gets made - everything from test models to working pieces. Even though plenty of machines use store-bought filament, more folks are now making their own using old materials like soda bottles.

1.2 Reusing of trashed plastic bottles

It cuts down on trash while opening up new options that save money and fit specific needs better. PET's a tough plastic that people use a lot - and it can be recycled pretty easily. Bottles made from this stuff, usually holding drinks or similar items, get turned into 3D printer feedstock using a method named pultrusion.

Because of this, more people are turning to greener ways - like reusing old stuff for prints. PET's a common plastic, tough and clear, plus it can be recycled. It's used loads for drink bottles and food wraps, so there's plenty around. On

top of that, it holds up well when turned into 3D printed stuff such as, food packaging boxes used to deliver food in online platform.

2. METHODOLOGY

The adopted methodology involves sequential stages, collection and washing of PET bottles. Right after gathering, the bottles then cut into tiny strips- after that, they're crushed into dust- like particles. That dust sits in a dryer because taking out water matters a lot if you want good results. Once dry, the material goes into an extrusion device; heat hits it between 90 and 110°C based on what kind of PET it is, shaping it through a mold to create a steady plastic string. The extruded plastic strand gets chilled using air, water, or even oil - so it won't snap easily. Once hardened, it's rolled up neatly on a spool. From there, checks happen now and then to verify how strong or bendable it is. These tests make sure every batch stays reliable. Safety comes first during production; folks wear gloves, masks, and keep the area well-ventilated. A device that crunches old bottles into flakes, plus something to grind those smaller. Then a heater dries them out before feeding into an extrusion unit.

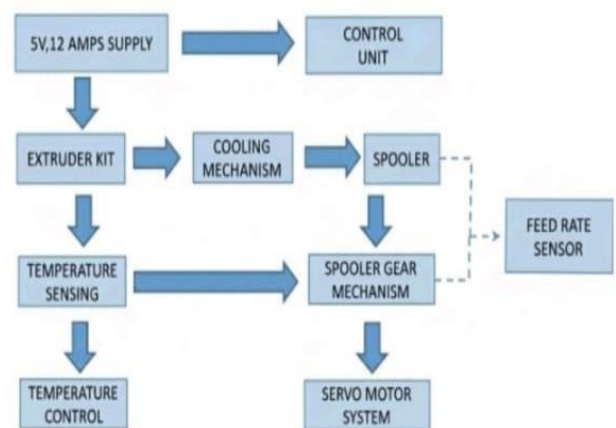


Chart -1: Flow Diagram

3.PROJECT DESCRIPTION

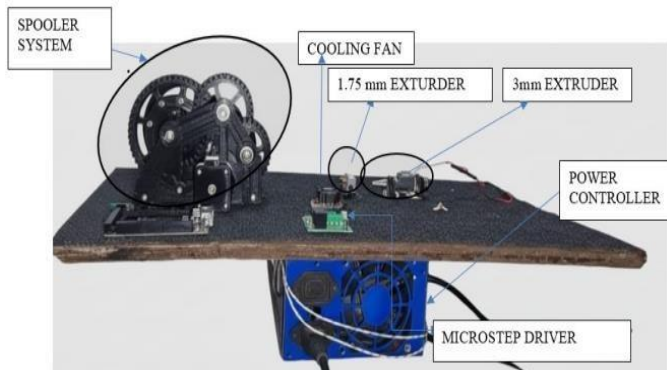


Figure -1: Assembly

Fig 1. Shows the exact model of the developed 3D printing filament maker. On the entry end, there's a setup for slicing PET bottles; it chops washed containers into even ribbons that move steadily to the extruder, helped along by rollers or guiding channels. After that, you put in the extruder setup. This includes a hot tube, a spinning rod, along with a motor hooked to gears. The rod fits just right inside the tube so it can move plastic pieces smoothly, heat them up, also blend them well.

Heating wraps get tightened onto the tube's outside, while small detectors like thermocouples are placed near where melting happens; these keep an eye on how hot things get, making sure everything stays under control. Right where the plastic comes out, a small tip usually 2 to 3 millimeters wide shapes the melted. PET into a string like form. To stop drips and keep thickness steady, everything must fit tight and line up just right. Just past that point, cold air from fans or a dip in water starts hardening the strand without warping it. After it cools down, rollers grab the thread, keeping the tug steady using powered wheels.

That pace lines up with how fast it's pushed out, so thickness stays even throughout. Next, the string moves into a winding setup spinning reel, guiding arm, plus electric drive team up to coil it neat and tight, avoiding knots or strain. Lastly, electric parts and controls get put together. That means setting up the power box, an Arduino Mega or another brain motor controllers, toggles, plus safeguards like fuses and kill switches. Cables are hooked up based on the blueprint, then things like heat levels, spin rates, align tightness.

4.SYSTEM ARCHITECTURE

The developed system comprises an extrusion unit with band heaters, a temperature sensing module, a DC motor driven screw mechanism, a cooling arrangement, and a motorized spooler.

Electronic control is achieved using a microcontroller and motor drivers, allowing synchronized extrusion and winding to maintain filament diameter. The components are individually listed with their means of use as follows.

4.1 Spooler



Figure -2: Spooler

The spooler is in charge of continuously and carefully winding the extruded filament onto a spool in a 3D-printing filament maker that uses PET bottles. It keeps the filament's diameter constant and guards against flaws like stretching, uneven thickness, or breakage by applying uniform tension. Smooth filament flow, appropriate cooling and straightening, and the avoidance of tangling or overlapping are all made possible by the spooler.

4.2 Extruder (3mm Nozzle)



Figure -3: 3mm Extruder

The 3mm extruder is a crucial component in a 3D-printing filament maker that uses shredded or strip-cut PET bottles from accessories to create uniform, printable filament. The extruder heats the PET plastic to its melting temperature and then uses a rotating screw to melt and pressurize the plastic, creating a homogeneous melt that is then pumped out through a 3 mm diameter die, which sets the diameter of the filament. By controlling the

temperature, pressure, and flow rate of the PET material during extrusion, the 3 mm extruder can ensure that the diameter and surface finish of the filament are uniform and that the material density is appropriate, minimizing defects such as bubbles, voids, or variations in diameter.

4.3 Extruder (1.75mm Nozzle)



Figure -4: 1.75mm Extruder

In a machine that turns PET bottles into plastic string, the 1.75 mm hole at the end - called the nozzle - is what shapes the melted material right before it comes out. Instead of just letting goopy plastic drip, these tiny opening forces the hot stuff through in a steady line exactly 1.75 mm wide. Once the goo squirts out under pressure, it changes from a thick blob into a smooth, unbroken thread ready for most common 3D printers. Because it acts like a filter for flow, the nozzle keeps things even, evening out hiccups caused by the turning screw inside. Proper temp handling at the nozzle stops PET from breaking down or getting blocked, whereas a well-shaped die gives smooth surfaces, tight size precision, also solid durability in reused filament. In general, the 1.75 mm nozzle plays a key role in making steady, print-safe material out of used PET bottles helping stable reprocessing plus use in 3D printing.

4.4 Cooling Fan

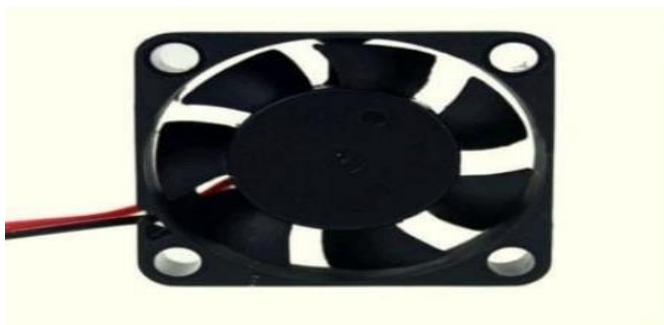


Figure -5: Cooling Fan

In a machine that turns old PET bottles into 3D printing plastic string, the cooling fan matters right when the hot material comes out. Right after it exits the tip, air from the fan hits it - this pulls away heat bit by bit so it hardens just enough.

4.5 Temperature Sensor



Figure -6: Temperature Sensor

In a machine that turns PET bottles into plastic thread, the heat detector plays a key role by keeping track of warmth during squeezing. Because it checks hot spots like the heating tube, melted zone, and exit tip, it gives live updates to the brain unit. So the setup holds PET at just the right softness, helping it flows evenly while avoiding damage. Accurate temp reading stops issues like not enough heat - this leads to bad melting, heavy extrusion force, plus inconsistent thickness - or too much heat, ruining PET by creating smoke, color changes, or weak strands.

4.6 Arduino Mega



Figure -7: Arduino Mega

In a machine that turns plastic bottles into 3D printing material, the Arduino Mega runs everything like a main hub. Instead of just linking parts, it keeps motors, sensors, and heaters working together at the right pace. This way, the output stays smooth without hiccups. The Arduino Mega picks up signals from devices like heat detectors say,

thermocouples or thermistors - alongside thickness gauges and end-stop triggers, keeping tabs on what's happening in real time. Because of these readings, it manages components such as heating elements, the extrusion drive, haul-off unit, winder motor, and airflow blower by way of relay modules, MOSFET circuits, or motion controllers.

4.7 Micro step driver



Figure8: Micro step driver

The tiny step controller helps the motor run without jerks nice and slow - so it places each bit just right, making sure the reworked plastic thread comes out even and clean for 3D jobs. Function of a Micro-Step Driver: A micro-step driver breaks down every complete step of a stepper motor into much tinier movements. Because of this, it's easier to manage how smoothly the motor turns key when making uniform filament. Less shaking, sudden moves, or speed changes means fewer flaws like thin spots, snapping, or stretching in the strand.

4.8 Micro step driver



Figure9: Power supply unit

A power supply unit takes electricity from an outlet typically household AC and changes it into steady DC power

electronics can actually use. Instead of just passing raw energy through, it adjusts both voltage and current so parts get exactly what they need. This helps prevent damage caused by surges or sudden spikes in flow. By managing these factors, it keeps gadgets running without unexpected shutdowns or harm. A power supply unit (PSU) in a self- running PET bottle-to-filament machine delivers steady electric energy to every part like heating elements, drive units, Arduino Mega, detectors, airflow blowers, plus circuitry that manages functions.

5.RESULTS AND DISCUSSION

The automatic 3D printer plastic maker turned old plastic bottles into working filament no issues during runs. It ran steady, thanks to consistent melting heat along with properly timed winding on the reel. Once washed and air-dried, the shredded PET bits fed evenly, then melted down before exiting the nozzle. Output came out smooth: a never-ending strand that rarely snapped or jammed up. Prints made from reclaimed feedstock hold shape similar to standard PLA, yet stick better when layered at slower rates, think 40mm per second, with flow cranked up toward 130 Test prints with recycled PET filament, it showed decent layer bonding, correct sizing, plus smooth surfaces good enough for everyday 3D printing tasks.

The findings show making filament from used PET bottles using machines works well plus helps the environment. Steady warmth at the right PET temps stopped breakdown while letting it melt fully. Slight differences in filament thickness showed up now and then mostly tied to inconsistent cooling. Fixing that could come from using real-time thickness feedback, better consistency in raw material width, also smarter layout of cooling paths. Trapped water inside the PET turned out to matter a lot; if it's not dried well enough, tiny air pockets pop up plus the surface gets rough. From managing trash - which ties into what you're learning - this method shows how plastic junk can turn into useful stuff. Unlike old-school ways of tossing things out.

6.CONCLUSION

In conclusion, the project shows what can happen when old plastic gets another chance bottles might turn into handy 3D printer material. However, we let our town fix this trash issue using a sustainable fix through building something affordable that can grow easy way to change old plastic bottles into top-grade stuff filaments. We adjust heat carefully with a smart system so every strand turns out just right. This idea cuts down plastic trash more than regular 3D stuff, making it a cleaner choice instead. People nearby can build printers themselves this, sparks new ideas while giving them power over how they create holds

promise for greener solutions across the board. This study highlights a practical, low-impact way to reuse plastic waste in 3D printing methods that could evolve over time, supporting custom production through responsible techniques in real world. Looking at everyday use, this setup turns plastic trash into something usable cutting down on waste while fitting right into small labs, schools, or neighborhood recycling spots. Even though slight differences popped in the filament's thickness, thanks to dirty inputs or uneven processing, those with sharper sorting, and fine-tuned adjustments. In real terms, it shows how junk isn't always junk; given the right twist, old scraps become fresh resources a budget-smart, earth-kind path toward smarter making and closer to home reuse.

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