AUTOMATED 3D PRINTING FILAMENT MAKER USING SOLID WASTE

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Automated Filament Extruder, Filament Maker Solid Waste Up cycling, Filament Extrusion Process Open-Source Extruder, Plastic Shredder/Grinder, Filament Winder/Spooler Diameter Sensor/Quality Control.

Introduction:

1. The rapid advancement of Additive Manufacturing (AM), particularly Fused Deposition Modelling (FDM), has transformed prototyping and decentralized production. However, this growth has led to increased plastic waste from failed prints, support structures, and short-lived prototypes. At the same time, the global issue of mismanaged solid waste, especially post-consumer thermoplastics like PET bottles poses a serious environmental challenge. These combined issues highlight the need for a Circular Economy approach in the 3D printing ecosystem.
2. This report focuses on the design and implementation of an Automated 3D Printing Filament Maker, a localized recycling system that converts solid waste into high-quality printable filament. Unlike traditional recycling, which is energy-intensive and centralized, Distributed Recycling and Additive Manufacturing (DRAM) enables waste to be processed at the source, increasing its value.
3. The proposed system integrates key stages such as shredding, controlled thermal extrusion, and real-time quality monitoring. Using sensors and closed-loop feedback, it maintains consistent filament diameter and shape and critical parameters when processing variable waste materials.
4. In addition to technical feasibility, this system addresses economic challenges by reducing reliance on costly virgin filament. Converting waste into usable material lowers production costs and minimizes environmental impact. Filtration mechanisms are also incorporated to remove contaminants, helping maintain mechanical properties such as strength and thermal stability.
5. Overall, this work presents a sustainable and self-sufficient manufacturing approach, demonstrating that the future of 3D printing lies in the efficient recovery and reuse of plastic waste rather than continued dependence on new materials.

Objectives:

1. Effective waste material utilization: Experiment with different waste materials to create filaments for specific needs.
2. Cost reduction: Creating filament from plastic pellets is cheaper than buying new filament.
3. Recycling of plastic: Converting of plastic waste into reusable filament.
4. Conserve natural resources: By using recycled materials, the demand for virgin plastics reduces.

Methodology:

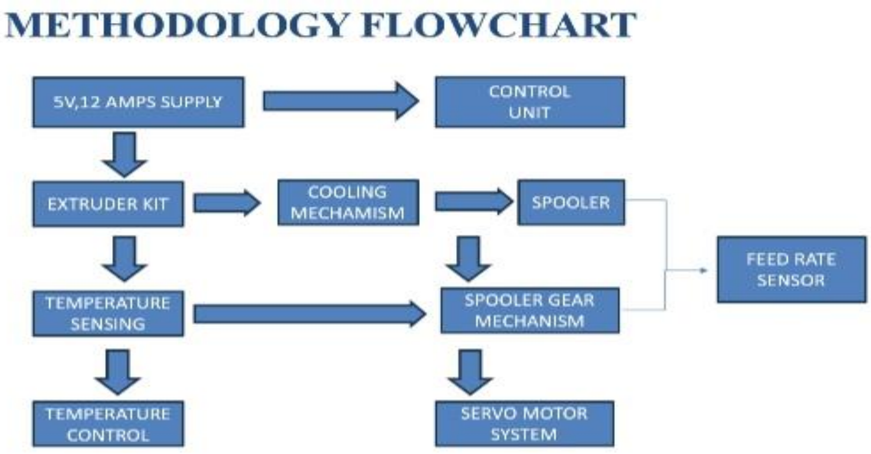

Fig 1: Methodology flow Chart

The process flow involves the steps as mentioned below:

- Clean up the bottles and remove all the moisture content from them.
- Apply air pressure and heat up the bottles so that it doesn't have any bumps or grooves.
- Extract evenly cut strips from bottle resembling ribbon.
- Setup the heating element and extruder nozzle that reshapes the ribbon into a cylindrical wire
- 5volts, 12 amperes of high electric supply has to be given.
- Find out the temperature required to melt and reshape the raw element.
- Use filament diameter sensor to control the consistent filament size.
- Use temperature controller to set the required temperature for different water bottles.
- Feedback control is used the rectifying mistakes.
- Cooling fans are used for the cooling of extruded filament.
- Now using servo motors and pulleys to collect the filament.
- Harden the filament as soon as it leaves the extruder system by attaching it to the rotating spool.
- Collect the filament and let it completely dry, then it is ready to print.

Result and Conclusion:

1. The automated filament maker successfully converted waste PET bottles into usable 3D printing filament, demonstrating effective waste material utilization.
2. The system operated smoothly with stable temperature control and consistent spooling, ensuring reliable performance.
3. Proper cleaning and drying of plastic waste enabled uniform feeding and continuous filament production.
4. The produced filament had an approximate diameter of 1.75 mm, with minor variations due to feeding and cooling inconsistencies.
5. Recycled filament showed good printability, with satisfactory layer adhesion, dimensional accuracy, and surface finish for general applications.
6. Optimal printing performance was achieved at lower speeds (~40 mm/s) with slightly higher flow rates.
7. The process reduces overall filament cost, making it an economical alternative to commercial filament.
8. The system promotes recycling of plastic waste, thereby reducing environmental pollution.
9. It contributes to conservation of natural resources by minimizing the use of virgin plastics.
10. Moisture in PET and slight diameter variations were identified as key challenges, which can be improved through better drying and process control.
11. Overall, the system proves to be a sustainable, cost-effective, and eco-friendly solution aligned with circular economy principles.

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Future Scope:

The future scope of this project includes:

1. Reaching output levels suited for heavy-duty operation**s**
2. Multi-feedstock flexibility
3. Material quality control inline sensing
4. Additive blending property tuning.
5. Energy lifecycle optimization: