DEVELOPMENT OF LOW COST FDM 3D PRINTER

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Fused Deposition Modelling, Additive Manufacturing, Rapid Prototyping, Embedded Control System

Introduction:
Additive Manufacturing (AM), also known as 3D printing, is a new way to make three-dimensional objects by adding material one layer at a time. This method is different from traditional manufacturing methods because it adds material to a solid block instead of taking it away. It builds the object slowly based on a digital design made on a computer. First, the digital model is sliced into many thin horizontal layers. There are instructions on each layer that tell the printer how to make the final object. Additive manufacturing and 3D printing are two terms that mean the same thing: making things by adding material in steps to make a whole structure. This method lets designers and manufacturers make complicated shapes that are often hard or impossible to make with regular machining methods. There are two main types of 3D printing technologies: direct and indirect printing. The printer makes the final part directly from the digital model in direct 3D printing. Indirect printing, on the other hand, uses the printed part as a mold, pattern, or prototype to make the final product.

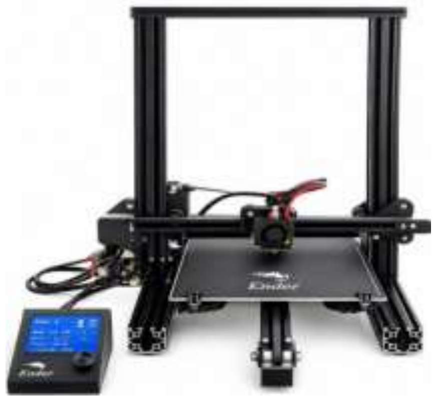
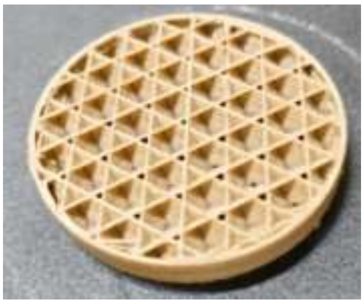


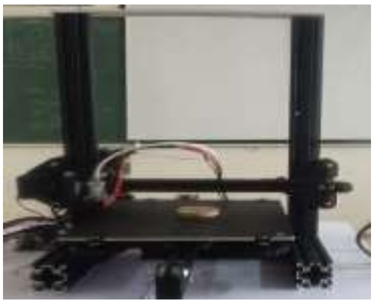
Figure 1: Fused Deposition Modeling (FDM) 3D Printer

Objectives:
1. To develop a low-cost FDM 3D printer using a compact and stable structure.
2. To implement a reliable filament extrusion system using PLA and wood-based materials.
3. To ensure accurate and consistent printing performance for basic prototyping applications.

Methodology:

The methodology adopted for this project involves the design and development of a low-cost FDM (Fused Deposition Modeling) 3D printer capable of printing with both PLA and wood filaments. Initially, a detailed literature review was conducted to understand the working principles, design requirements, and recent developments in FDM 3D printing technology. Based on the findings, suitable components such as the frame structure, stepper motors, GT2 timing belts and pulleys, M5 lead screw with anti-backlash nut, extruder assembly, and control electronics were selected considering both performance and cost.The printer frame was designed using CAD software and assembled along with the motion transmission system. Electrical components, including the control board, motor drivers, power supply, and sensors, were integrated and connected according to the system requirements. Firmware was then installed and configured to ensure proper communication between hardware and software.After assembly, the printer underwent calibration procedures such as bed leveling, axis alignment, and extrusion tuning to achieve accurate printing performance. Test prints were initially performed using PLA filament to verify dimensional accuracy and print quality. Subsequently, wood filament was used to evaluate the printer's capability to handle composite materials and to optimize printing parameters such as temperature, speed, and layer height.The printed samples were inspected for surface finish, dimensional accuracy, and overall quality. The performance of the developed printer was analyzed and compared with commercially available FDM printers in terms of cost, functionality, and print quality. Finally, the results were evaluated to determine the effectiveness of the proposed low-cost 3D printer design and its suitability for educational, prototyping, and small-scale manufacturing applications.


Wood Filament Printed model


3D printing of object


PLA Filament Printed model

Result and Conclusion:

Result:
The low-cost FDM 3D printer was successfully designed and fabricated. All mechanical and electronic components functioned properly after assembly. The printer achieved smooth movement along the X, Y, and Z axes. PLA filament produced prints with good dimensional accuracy and surface finish. Wood filament was also successfully printed after optimizing the printing parameters. The extrusion system provided consistent material flow during printing. Test models showed satisfactory layer adhesion and structural strength. The printer operated reliably with minimal vibration and printing errors. The developed printer achieved performance comparable to basic commercial FDM printers. The overall manufacturing cost was significantly lower than that of commercially available printers.

Conclusion:

The project successfully developed a low-cost FDM 3D printer using readily available components. The printer was capable of printing objects using both PLA and wood filaments. Experimental results confirmed good print quality and dimensional accuracy. The machine demonstrated reliable performance during testing. The use of affordable components reduced the overall system cost. The printer is suitable for educational, research, and prototyping applications. The project proved the feasibility of developing an economical 3D printing solution. The design can be easily modified and upgraded in the future. Additional features such as automatic bed leveling and wireless control can further improve performance. Overall, the project objectives were achieved successfully.

References:

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Future Scope:

The future scope of this project includes:

1. The 3D printer can be upgraded with automatic bed leveling, wireless monitoring, and improved printing accuracy for better performance.
2. Advanced materials such as PETG, carbon-fiber reinforced PLA, and recycled filaments can be used to expand its applications.
3. The printer can be further developed for educational institutions, small-scale industries, and rapid prototyping with reduced cost and energy consumption.