iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** V **Month of publication:** May 2023

DOI: https://doi.org/10.22214/ijraset.2023.52062

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

Design and Development of Cost-Effective 3D-Printer

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Abstract: ***The objective of this project is to design and develop a cost-effective 3D printer that can produce high-quality prints while minimizing the overall cost of the system. The project will involve researching and selecting components that provide a balance between cost and performance, including a suitable frame, motors, electronics, and hotend. The printer will be designed with a large build volume to enable printing of larger objects. The control system will be based on an open-source microcontroller, and software will be developed to optimize print quality and minimize material usage. Testing and calibration will be performed to ensure the printer can produce accurate and high-quality prints. The outcome of this project will be a low-cost 3D printer that can be used by hobbyists, students, and small businesses for a variety of applications, such as prototyping and product development.***

Keywords: 3d printer, additive manufacting, 3d models, filament, affordable, cost effective.

I. INTRODUCTION

The advent of 3D printing technology has brought about a revolution in the manufacturing industry, allowing for the creation of complex shapes and structures that would have been difficult or impossible to produce using traditional methods. However, the high cost of commercial 3D printers has limited their accessibility, particularly for small businesses and hobbyists. This project aims to design and develop a cost-effective 3D printer that can provide the benefits of this technology without the high price tag. By carefully selecting components and optimizing the system design, the goal is to create a 3D printer that can produce high-quality prints while minimizing the overall cost. The resulting printer can be used for a wide range of applications, including product development, prototyping, and educational purposes. This project will contribute to the advancement of 3D printing technology and make it more accessible to a wider range of people.

II. CONSTRUCTION

Building a low-cost 3D printer requires careful selection of components and a basic understanding of electronics and mechanics. The printer frame can be constructed from simple materials such as plywood or acrylic sheets, and the printing bed can be made from teflon. The printer's motors, belts, and bearings can be purchased online at a low cost, and a microcontroller such as an Arduino can be used to control the printer's movement. The printer's hotend, which melts and extrudes the plastic filament, can also be purchased online at a low cost. Assembly of the printer requires careful attention to detail and following a guide or tutorial to ensure proper calibration and alignment of the printer's components. With some time and effort, a low-cost 3D printer can be constructed that can produce high-quality prints.

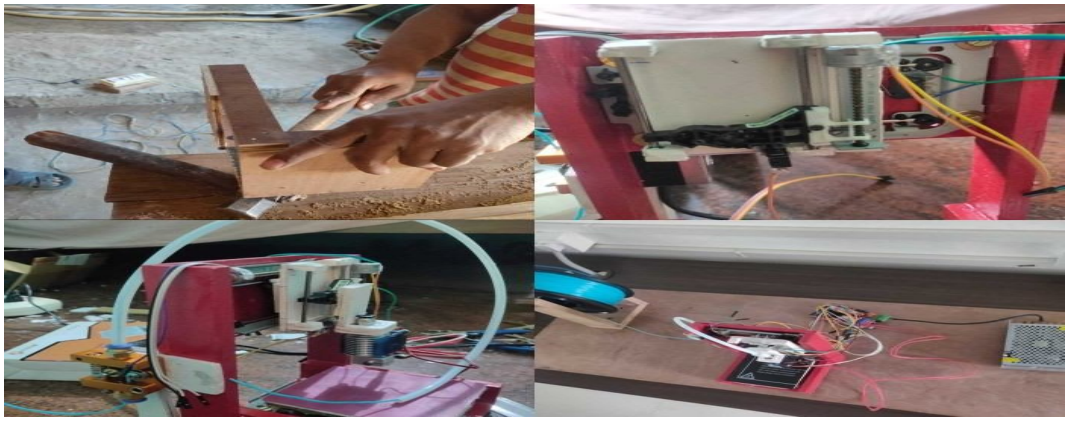


Fig. 1 Construction of the 3D printer

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III. WORKING

A low-cost 3D printer typically works by heating up a spool of plastic filament and extruding it through a nozzle onto a printing bed. The printer's microcontroller moves the extruder and the bed along the x, y, and z-axes to create the desired shape of the object being printed. The extruder moves back and forth across the printing bed, building up the object layer by layer. Once a layer is completed, the bed is lowered by a small amount to make room for the next layer. This process is repeated until the object is complete. The quality of the print is determined by several factors, including the accuracy of the printer's movements, the temperature of the extruder, and the type of filament being used. With proper calibration and settings, a low-cost 3D printer can produce high-quality prints that are suitable for a wide range of applications.

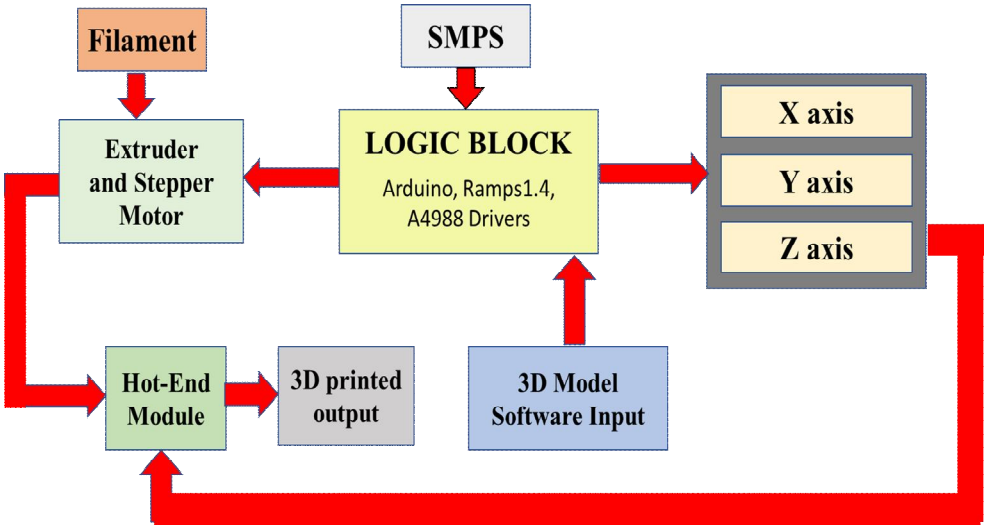


Fig. 2: Block Diagram

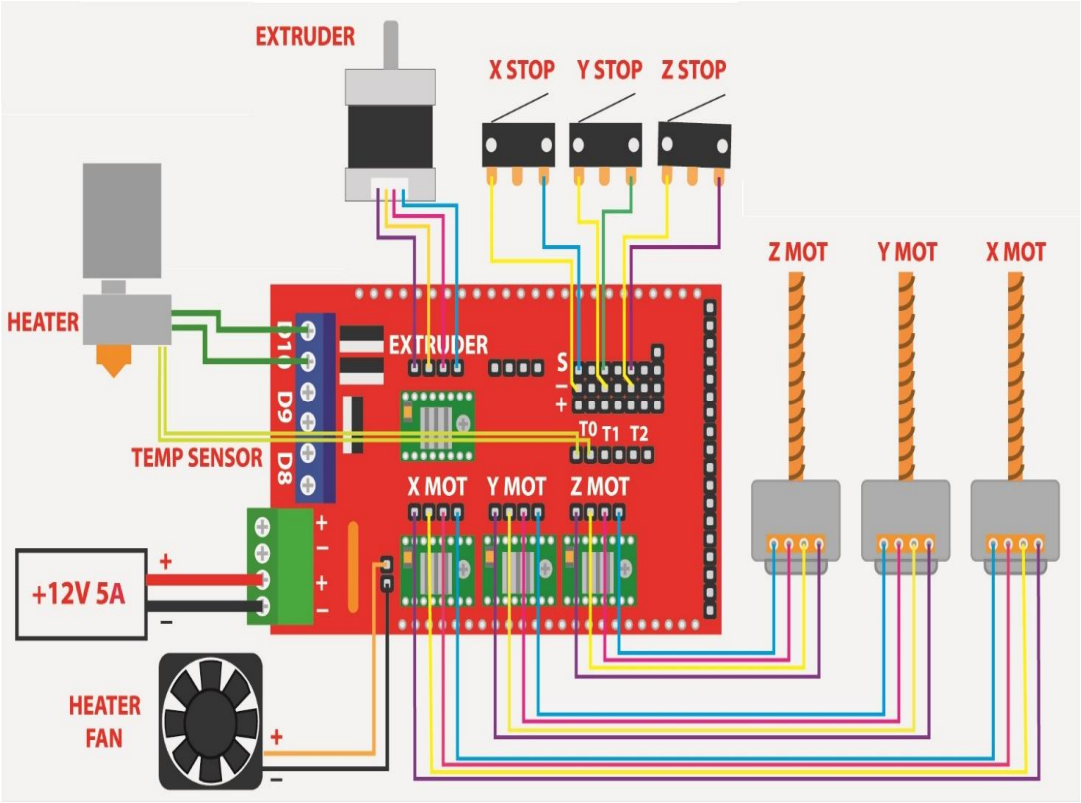


Fig. 3: Circuit Diagram

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Type	Technologies	Materials
Extrusion	Fused deposition modeling (FDM)	Thermoplastics (e.g. PLA, ABS), eutectic metals, edible materials
Granular	Direct metal laser sintering (DMLS)	Almost any metal alloy
	Electron beam melting (EBM)	Titanium alloys
	Selective heat sintering (SHS)	Thermoplastic powder
	Selective laser sintering (SLS)	Thermoplastics, metal powders, ceramic powders
	Powder bed and inkjet head 3d printing, Plaster-based 3D printing (PP)	Plaster
Laminated	Laminated object manufacturing (LOM)	Paper, metal foil, plastic film
Light polymerized	Stereolithography (SLA)	Photopolymer
	Digital Light Processing (DLP)	Liquid resin

Table 1: All available types of 3D Printing technologies and the materials

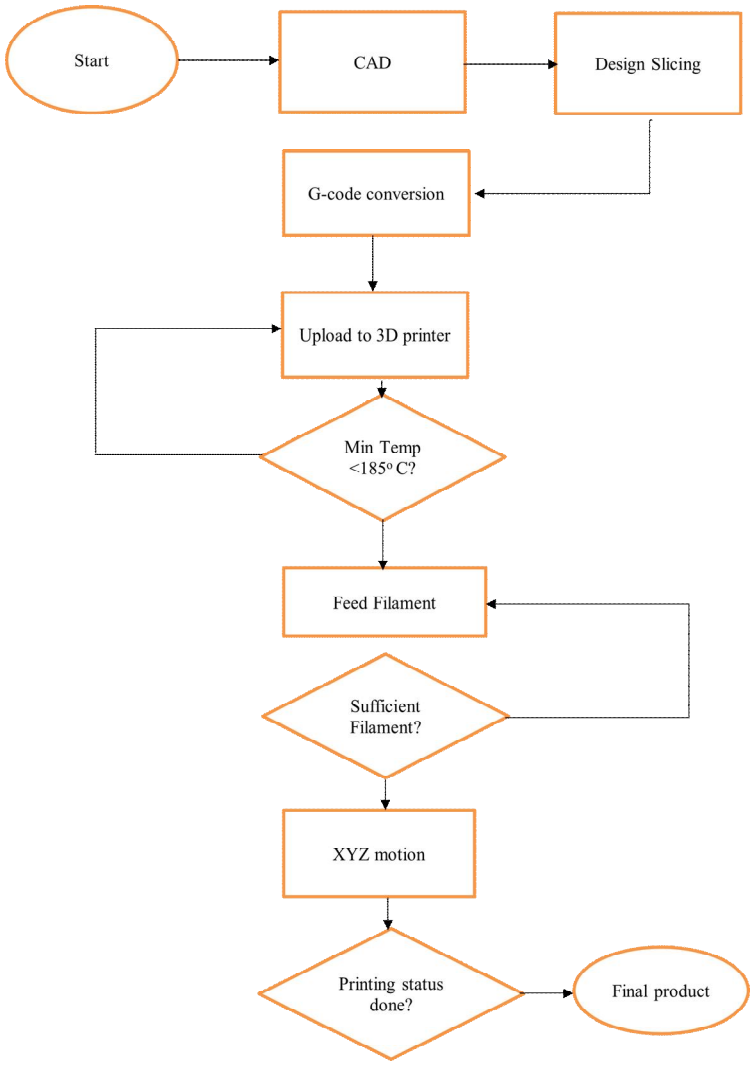


Fig. 3: Flowchart of the Arduino code

Stepper motors are used for X, Y & Z axis movement, and the pillars are constructed using wood to support the base of the 3D printer. When the sufficient amount of temperature and filament is fed, then printer will take control over the motion of X, Y & Z motors and hotend will print the model as per the G-Code instruction. In 3D printer, 4 stepper motors are needed to do the specific function, three of them are used for moving the X, Y & Z direction of the printer. Fourth one is needed for working of extruder. In the pronterface window, we can continuously monitor the status of the printer such as estimated time, elapsed time, and remaining time.

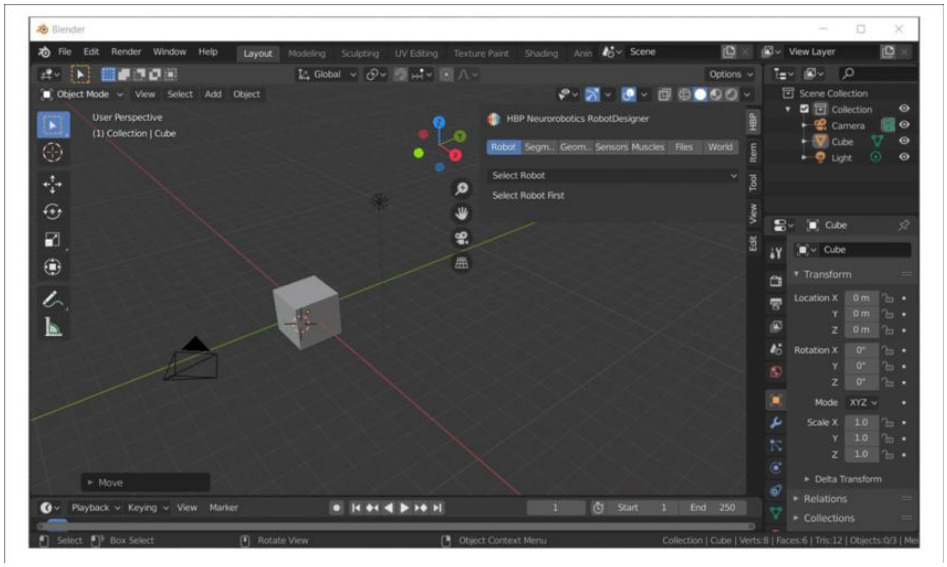


Fig. 4: Design of 3D models using Blender

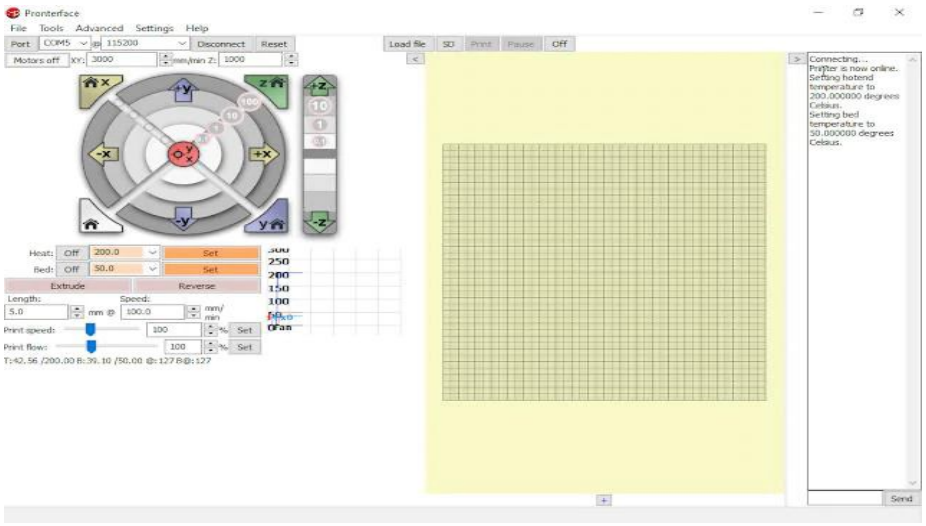


Fig. 5: 3D printer interface software (Pronterface)

IV. ADVANTAGES

Low-cost 3D printers offer several advantages over traditional industrial 3D printers. Firstly, low cost 3D printers are more affordable, making them accessible to individuals, hobbyists, and small businesses who cannot afford expensive industrial printers. They are also typically smaller in size and require less power, making them ideal for home or office use. Another advantage is the flexibility of low-cost 3D printers to use a variety of materials such as PLA, ABS, and PETG, making them suitable for a range of applications, including prototyping, product design, and small-scale production. Low-cost 3D printers are also customizable, allowing users to modify and upgrade their printers with new components and features. Finally, the ability to create and print objects on demand offers a significant advantage, saving time and money in prototyping and production processes..

V. DISADVANTAGES

While low-cost 3D printers have made the technology more accessible to hobbyists and small businesses, there are several disadvantages to these machines. One of the main drawbacks is the limited build volume, which can restrict the size of objects that can be printed. Low-cost printers also tend to have less accurate movement and less stable construction than their more expensive counterparts, leading to lower quality prints and the need for frequent calibration. Additionally, low-cost printers often have a slower print speed and may be less reliable over time, requiring more frequent maintenance and repairs. The quality of prints can also be affected by the type and quality of the filament used, and cheaper filaments may not produce the same level of detail and strength as higher-quality ones. Finally, low-cost printers may not have as many features as more expensive models, such as dual extruders or automatic bed leveling, which can limit their versatility and usefulness for certain applications.

VI. CONCLUSION

In conclusion, building a low-cost 3D printer is a challenging but rewarding project that can provide access to this exciting technology to a wider range of people. By carefully selecting components and following detailed guides and tutorials, it is possible to construct a 3D printer that can produce high-quality prints for a variety of applications. However, it is important to be aware of the limitations of low-cost printers, including their smaller build volume, lower accuracy and reliability, and limited features compared to more expensive models. Nevertheless, a low-cost 3D printer can be an excellent tool for hobbyists, students, and small businesses looking to explore the possibilities of 3D printing without breaking the bank.

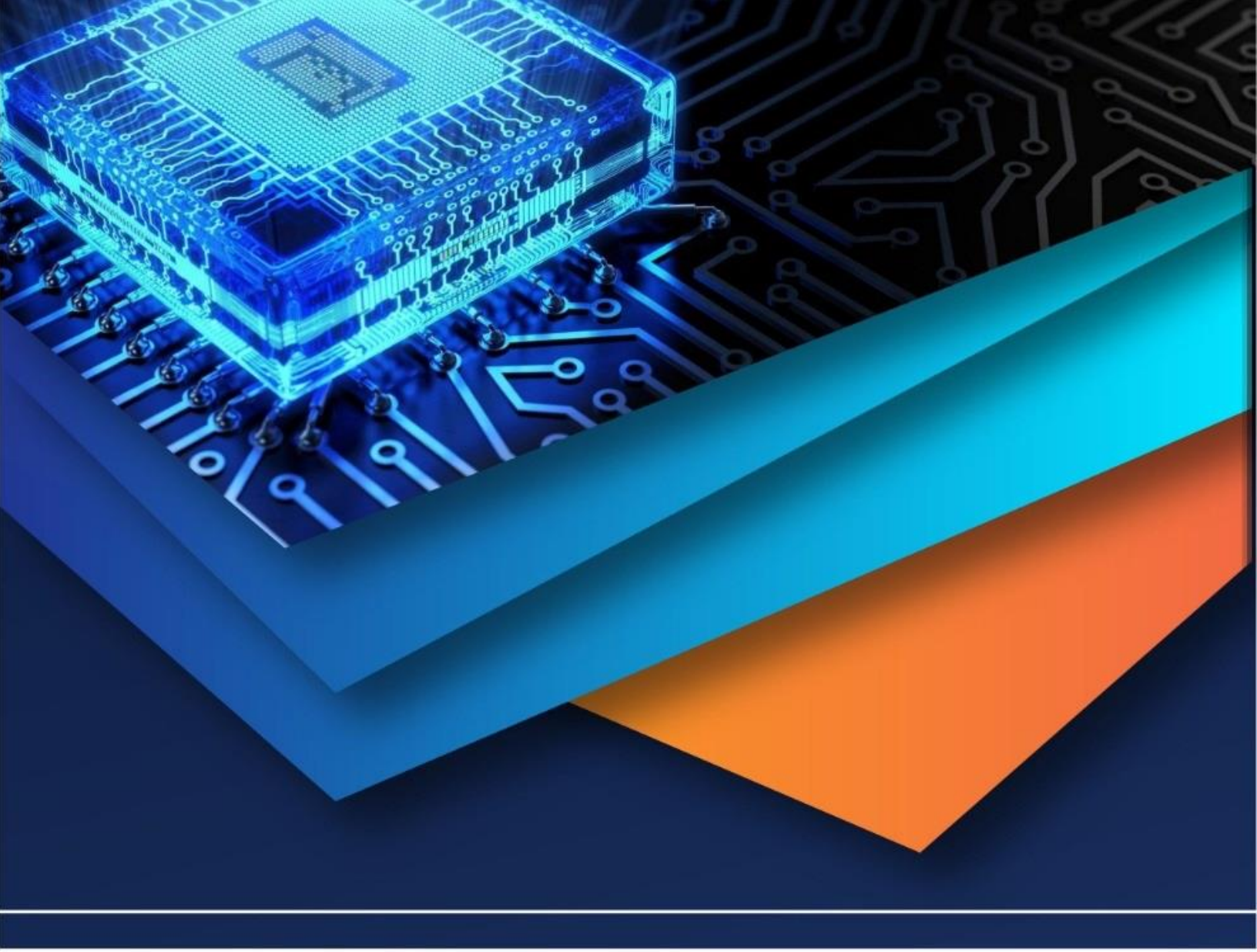
VII. ACKNOWLEDGMENT

This study was supported by the department of Electrical and Electronics engineering of SJB Institute of Technology, Bengaluru, Karnataka, India.

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