Digital Light Processing and Fused Deposition Modelling 3D Printer

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Atria Institute of Technology

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KEY WORDS

- Digital Light Processing (DLP)
- Fused Deposition Modelling (FDM)
- Additive Manufacturing
- 3D Printer
- Marlin
- Slicing Software
- Filament
- Resin
- Extruder
- Print Bed
- Support Structures
- Layer-by-Layer
- Printing Parameters
- Post-Processing
- Calibration
- Maintenance
- Prototyping
- Rapid Manufacturing
- Design Optimization
- Material Properties
- Printing Resolution
- Surface Finish

INTRODUCTION / BACKGROUND

1. Three-dimensional (3D) printing, also known as additive manufacturing, is a revolutionary technology that has transformed the way we create and produce objects.
2. 3D printing involves the layer-by-layer addition of material to create a three- dimensional object.
3. The concept of 3D printing was first introduced in the 1980s by Chuck Hull, the co-founder of 3D Systems.
4. Hull developed a process called stereo lithography, which used a laser to solidify a liquid polymer layer by layer to create a 3D object.
5. It wasn't until the early 2000s that the technology became more widely available and affordable to the general public The first commercially available 3D printer was the 3D Systems' SLA-1, which was introduced in 1988.
6. However, it wasn't until the early 2000s that affordable 3D printers were introduced. One of the first affordable 3D printers was the Rep-rap, which was developed in 2005 by Adrian Bowyer.

7. The Rep-rap was an open source project that allowed individuals to build their 3D printers from scratch using a set of instructions that were freely available online.
8. 3D printing has become increasingly popular and affordable.
9. Today, there are a variety of 3D printing technologies available, including Fused Deposition Modeling (FDM), Stereo lithography (SLA), Selective Laser Sintering (SLS), and Digital Light Processing (DLP).
10. 3D printing is the process of creating a physical object from a digital model. The process involves three basic steps: design, slicing, and printing.

OBJECTIVES

1. To develop feed stock customized for 3D-printing (AM) at reduced cost.
2. To design and build next generation of 3D printers and strategies specifically dedicated to ceramics production. (net-shape ceramics faster with desired properties & design at reduced cost).
3. To correlate input to output produced ceramics and demonstrate it for applications.
4. To define and establish standardization, regulatory issues, qualifications and risks analysis.
5. To increase knowledge on modelling & characterizations and develop specific tools for that.
6. To use 3D printers for small-scale manufacturing and production of customized or low-volume parts.
7. We can use 3D printers to solve a real-world problems or to develop innovative solutions.
8. By using 3D printer we can work on our group projects and we can share ideas and to divide tasks within each other.
9. We can use 3D printer for personal exploration and creative expression and to unleash our imagination.
10. To pursue career in field such as engineering, design, architecture, or manufacturing can use 3D printers to gain practical skills

METHODOLOGY

Materials

Hardware:

- 1Pcs Ramps 1.4 Controller
- 1 Pc Ramps 1.4 2004 LCD l
- Hot end
- Stepper motor (4 nos)
- PLA Filament 1.75 mm
- 5 x 8 Shaft Coupler(4 no)
- 8 x 22 x 7 mm Radial Bearing(5 no)
- Limit Switch(3 no)
- Wood cutting
- Acrylic

Software:

- Ulitmark Cura Software
- Xloader
- Pronterface: main software

5*8 Shaft coupler and bolts


Stepper motor driver

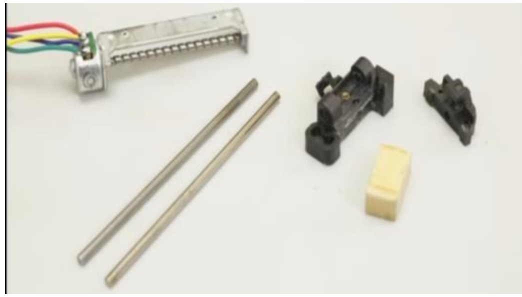
Ramps for Arduino


Hot End


Hot End

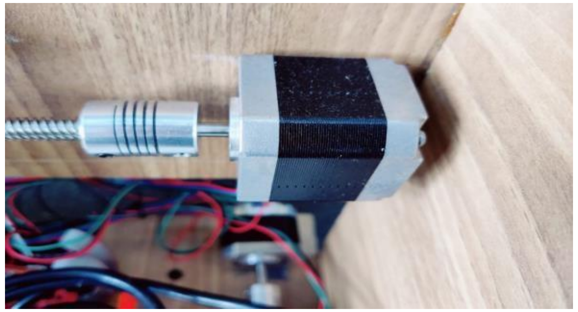

Extruder


Parts of Arduino kit


DVD Writer parts


power supply


Limit switches


stepper motor


wires

METHODOLOGY

Method

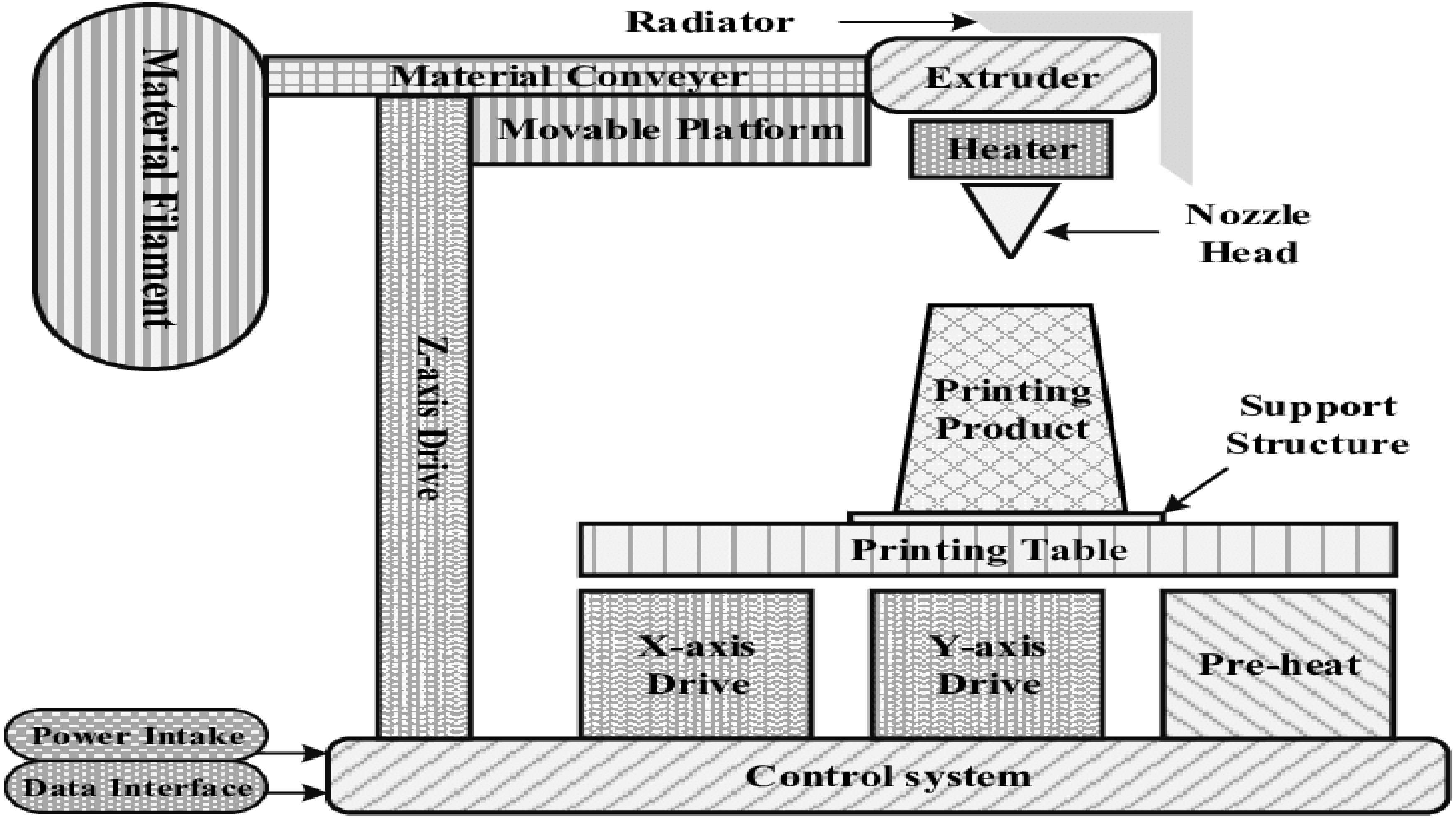


Fig : Block Diagram

METHODOLOGY

Method

The methodology of 3D printing involves a series of steps :

- It starts with designing a digital model using **Cura** software.
- This includes adding support structures, slicing the model into layers, and selecting the appropriate printing material.
- The printer is then loaded with the necessary material, and the printing process begins.
- The printer builds the object layer by layer, based on the design specifications, which can take anywhere from a few minutes to several hours.
- Once the printing is complete, the object may require post-processing, such as removing support structures or cleaning up rough edges.
- The final object is then ready for use, and depending on the application, additional steps such as painting or coating may be necessary.

METHODOLOGY

Work carried out

- As soon as we completed research on the required components.
- At 1st we made a separate list of components and searched for them, as this was a huge project, we could not easily get the material we were searching for.
- It almost took more than 2 weeks for us to analyse the materials we were looking for.
- Later in 3-4 weeks, a month we managed to get few major elements of the project.
- We proceeded on the frame work and went on with the fixing and adjustments.
- Made proper connections on the board.
- We worked and dumped the customized code onto the Arduino board
- Then finally, we get the required output.

Work carried out

- As soon as we completed our project Phase 1 presentation, we started to collect the information of the project to buy the required materials.
- At 1st we made a separate list of components and searched for them, as this was a huge project, we could not easily get the material we were searching for.
- It almost took more than 2 weeks for us to analyse the materials we were looking for.
- Later in 3-4 weeks, a month we managed to get few major elements of the project.

Fig : Frame work X, Y, & Z axis

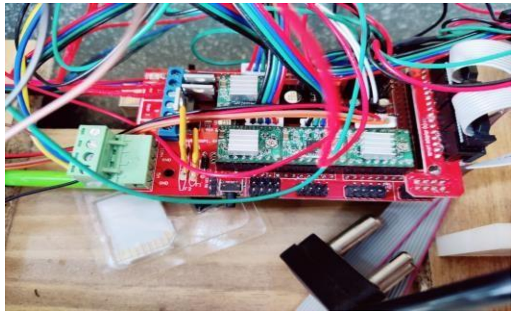


Fig : Arduino Connection

KSCST

Design

The filament spool : Fused filament material is generally supplied in spools, carrying from 500g to 1kg filament.

Extruder: With a direct-drive extruder, the motor pushing the filament is stalled by the hot end and pushes the filament directly into the nozzle.

Heater Block: Usually made from aluminium, the heater block joins the nozzle to the heat break and holds the heater cartridge and thermistor.

Nozzle: This is the part where the filament comes out.

The print bed, also known as the build plate, is one of the most important components of any FDM 3D printer.

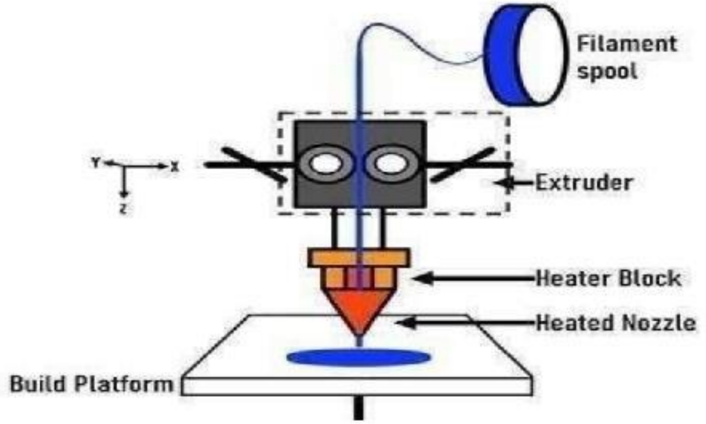


Fig : Designing model

SUMMARY OF PROGRESS (DESIGN,

Design

Schematic representation of the 3D printing technique known as fused filament fabrication;

a) The plastic filament material is fed through a heated moving head.

b) It melts and extrudes it depositing it, layer after layer, in the desired shape

c) Moving platform

e) Lowers after each layer is deposited.

d) Vertical support needed to sustain overhanging parts.

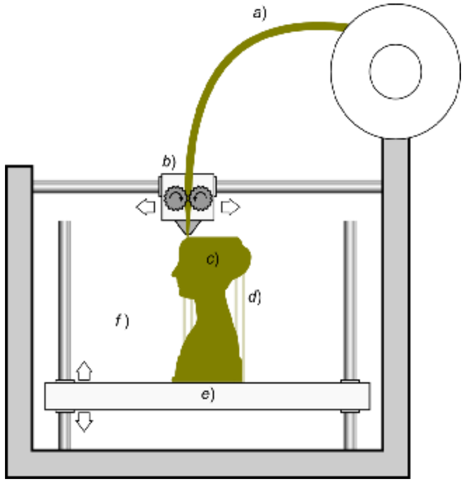


Fig : Schematic Representation

KSCST

Experiment

1. The process of 3D printing starts from designing the object in software to the actual hardware printing.
2. The first step is to create a 3D model of the object using Marlin software. The design can be made from scratch or obtained from existing 3D models.
3. The 3D design file is imported into slicing software, which divides the model into a series of horizontal layers. It determines the path and parameters for the printer to follow during the printing process.
4. Before printing, the 3D printer must be prepared. This includes ensuring the print bed is clean and level, loading the appropriate printing material (filament or resin), and setting the printer's temperature and other parameters.
5. Once the printer is ready, the sliced file is transferred to the printer. The printer's extruder or other printing mechanism starts depositing the material layer by layer, following the instructions from the sliced file. The material may be melted and extruded (in the case of filament-based printers) or solidified using UV light (in the case of resin-based printers).

6. After the printing is complete, the object may require some post-processing. This can involve removing support structures that were printed to ensure stability during the printing process, smoothing rough surfaces, or curing the object further (in the case of resin-based printers).
7. Depending on the desired outcome, additional steps like sanding, painting, or applying coatings may be performed to enhance the appearance and functionality of the printed object.

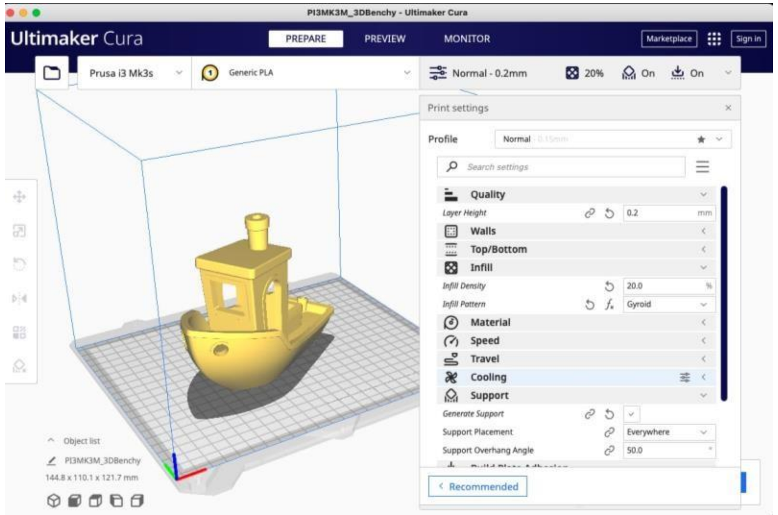


Fig : Creating the 3D model in software

Fig : Printing of the 3D model in the Hardware

Result

The 3D printer reads the sliced model and starts building the object by depositing material layer by layer. The specific material used depends on the type of printer and application, but common materials include plastic filaments, resins, and even metals. The printer's nozzle or other deposition method melts or cures the material, adhering it to the previous layer and gradually forming the final object. The speed of the printing process varies depending on factors such as the size and complexity of the object, the chosen print settings, and the capabilities of the printer itself. Once the printing is complete, the object may require post- processing, such as removing support structures or applying finishing touches. 3D printers have a wide range of applications across industries. They are used for prototyping, enabling quick and cost-effective iterations of product designs. They are also utilized in manufacturing, producing customized or low-volume parts. Additionally, 3D printing finds applications in areas like medicine, architecture, education, and art, enabling innovative solutions and creative expressions.

SUMMARY OF PROGRESS (DESIGN,

Result:

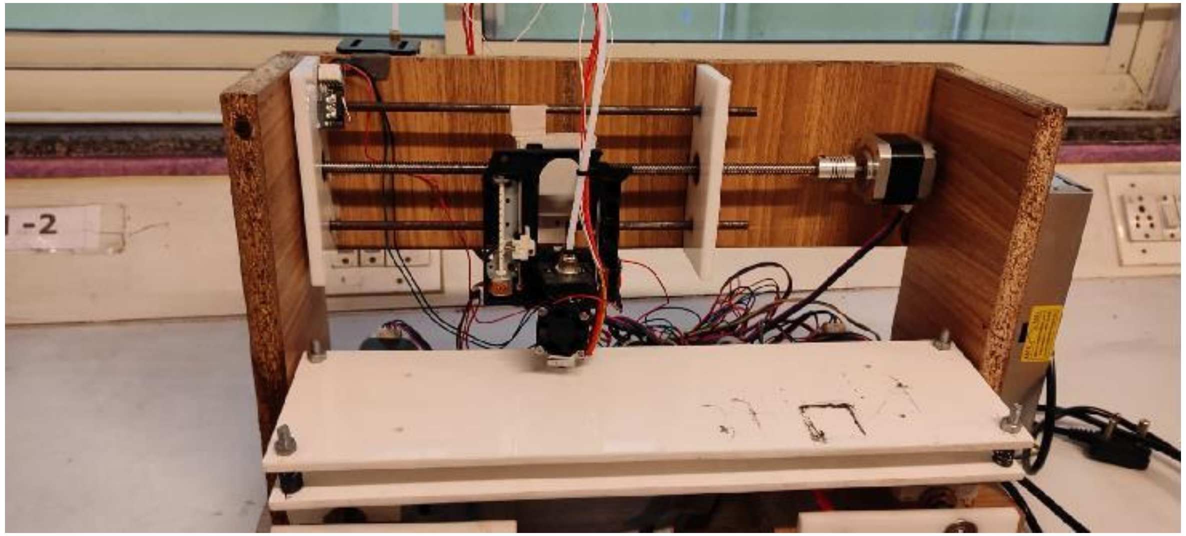


Fig : 3D Printer

Fig : cube

Fig : ship

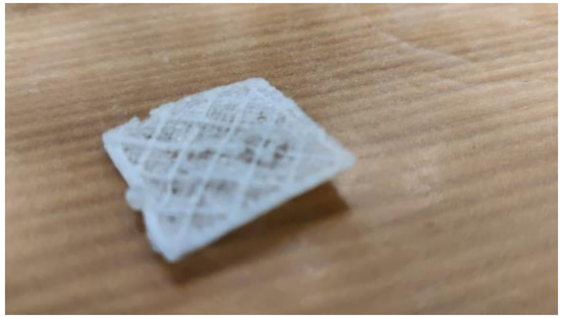


Fig : Square plate

SCIENCE & TECHNOLOGY COMPONENT / OF THE PROJECT

1. 3D printer has its ability to transform digital designs into physical objects by layering materials one upon another.
2. 3D printing enables the creation of highly customized objects.
3. Designers and engineers can quickly iterate and refine their ideas by producing physical prototypes within hours or days
4. This accelerated development cycle allows for faster innovation and reduces time-to-market for new products.
5. The availability of consumer-grade 3D printers has made this technology more accessible to a wider audience.
6. 3D printers capable of using metals, ceramics, composites, food-grade materials, and even living cells. This versatility allows for diverse applications across various industries, including aerospace, healthcare, fashion, and more.
7. 3D printing enables the fabrication of complex geometries that are challenging or impossible to produce with traditional manufacturing techniques.
8. 3D printing typically generates less waste since it adds material only where needed. Additionally, it can enable local production, reducing transportation needs and associated carbon emissions.
9. One of the most exciting frontiers of 3D printing is in the field of bioprinting, where living tissues and organs are printed using specialized printers and bioinks.

CONCLUSION

1. The 3D printer reads the sliced model and starts building the object by depositing material layer by layer.
2. The specific material used depends on the type of printer and application, but common materials include plastic filaments, resins, and even metals.
3. The printer's nozzle or other deposition method melts or cures the material, adhering it to the previous layer and gradually forming the final object.
4. The speed of the printing process varies depending on factors such as the size and complexity of the object, the chosen print settings, and the capabilities of the printer itself.
5. Once the printing is complete, the object may require post- processing, such as removing support structures or applying finishing touches.
6. The project may conclude that 3D printing is a viable and effective method for creating prototypes or manufacturing certain products.
7. Cost-effectiveness, production speed, and quality of printed objects support the feasibility of 3D printing.

CONCLUSION

8. 3D printing offers potential time and cost savings compared to traditional manufacturing methods.
9. Production time, material costs, and labor requirements are assessed for advantages or limitations.
10. 3D printing enables the production of highly customized and complex objects.
11. Intricate designs are successfully created, surpassing traditional manufacturing limitations.
12. 3D printing has limitations and challenges to consider.
13. Material limitations, print quality inconsistencies, post-processing requirements, and skill/equipment demands are identified.

FUTURE WORK

Here are some areas where 3D printers are expected to make significant advancements:

1. We can anticipate advancements in bioprinting, where living tissues and organs are created using specialized bio-inks and cells. This has the potential to revolutionize organ transplantation and regenerative medicine.
2. We may see 3D printing in aerospace and automotive for printing larger and critical parts, resulting in reduced weight, improved fuel efficiency, and enhanced performance in these industries.
3. We can expect larger-scale 3D printers capable of printing entire structures in buildings and infrastructure, leading to faster and more cost-effective construction methods.
4. With advancements in materials and printing technologies, we may see widespread adoption of 3D printing for customized and personalized consumer products.
5. 3D printers could play a larger role in research and development, allowing for rapid prototyping and innovation across various scientific disciplines.
6. 3D printers could be utilized in space to manufacture tools, replacement parts, and even habitats, making long-duration space travel and colonization more feasible.

FUTURE WORK

7. 3D printing holds the potential for personalized nutrition and the creation of complex dishes with precise ingredient placement.
8. 3D printing could play a crucial role in manufacturing necessary tools, equipment, and even habitats using local resources found on other celestial bodies.
9. 3D printing presents an opportunity to revolutionize the fashion industry by allowing for the creation of unique, customizable clothing, accessories, and wearable technology.
10. Artists and designers can leverage the 3D printing technology to create intricate sculptures, installations, and interactive artworks that were previously impossible to produce.