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Assembly of Multi Filament 3D Printing Machine

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ABSTRACT

The Multi Filament is a cutting-edge industrial 3D printing machine designed for high-speed, high-precision printing. With its advanced print head technology and robust mechanical design, the A1 achieves print speeds of up to 300 mm/s while maintaining an impressive print resolution of 50 µm. This machine is ideal for industrial applications, including aerospace, automotive, healthcare, and consumer products.

1.INTRODUCTION

The A1 3D printer is a machine that uses plastic filament to create 3D objects. It can transform digital models into physical objects. First, generate a 3D model or obtain an existing digital model using computer-aided design software, online resources, or other means. Next, Bambu Studio slices the digital model into multiple thin layers. Each layer's information is converted into "G-code," a language understood by the printer. The G-code provides instructions to the printer regarding movement paths and speeds of the different axes during the printing process. Before initiating the printing process, the printer needs to be prepared. This involves loading the printing filament, positioning the build plate, and calibrating the printer's parameters to ensure optimal print quality. Once all preparations are complete, the A1 printer gradually constructs the object layer by layer on the print platform. The A1 utilizes a Cartesian coordinate motion system, with a maximum print volume of 256 * 256 * 256 mm^3. The X-axis motion system consists of a high-precision linear rail and a beam. The tool head is mounted on a linear guide slider, allowing it to freely slide along the horizontal rail. By controlling the slider's left and right movement, the tool head can achieve precise motion along the X-axis. The Y-axis motion system comprises a high-precision horizontal guide rail and a print bed. The print bed is mounted on a guide rail slider, enabling it to freely slide along the horizontal guide rail. By controlling the slider's forward and backward movement, the print bed can achieve precise motion along the Y-axis.

The Z-axis motion system controls the vertical position of the tool head relative to the print bed.

1.2 SCOPE OF THE CAPSTONE PROJECT

- The process starts with a digital 3d Model of the object to be printed. This model can be created using Computer-aided design (Cad) Software.
- User-friendly Software, Emphasizing Speed, Accuracy, and A Seamless Printing Experience.
- Our lab focuses on developing High-performance 3D printers with Advanced Materials.
- Core XY motion system, powerful microcontrollers, High-precision sensors, advanced cooling systems, High-quality hot ends, Automatic bed levelling systems.
- Print quality tests (accuracy, surface finish), Material compatibility tests, Feature reproduction tests, Temperature and humidity testing, Vibration and shock testing, Long-term endurance testing, Failure analysis and root cause investigation

The A1's "Multi-Color Printing" capability, when combined with the AMS lite, lends itself to projects where visual complexity is important.

The "Full-auto Calibration" Feature, means that more time can be spent on the project itself, and less time on printer calibration.

2. LITERATURE REVIEW

Early Beginnings (1960s-1980s)

1. First Patents: The first patents for 3D printing technologies were filed in the 1960s by Japanese researcher Hideo Kodama.

2. Early Experimentation: In the 1970s and 1980s, researchers began experimenting with various 3D printing technologies, including stereo lithography (SLA) and fused deposition modeling (FDM).

Chuck Hull

In the 1980s, Hull patented the first 3D printer, which used a technique called stereo lithography (SLA). SLA is still used today. (SLA). An American furniture builder who was frustrated with not being able to easily create small custom parts, Hull developed a system for creating 3D models by curing photosensitive resin layer by layer.

Hideo Kodama

In 1981, Kodama developed a Layer-by-layer approach to manufacturing using Photosensitive Resin and UV Light. This was an Early Attempt at Rapid Prototyping. The First Documented Iterations of 3D printing can be Traced Back to the early 1980s In Japan. In 1981, Hideo Kodama was trying to find a way to develop a Rapid Prototyping system. He came up with a Layer-by-layer Approach for manufacturing, using a Photosensitive Resin that was polymerized by UV Light.

Technological Advancements (Late1980s-Early1990s):

1. 1989: Scott and Lisa Crump invent Fused Deposition Modelling (FDM), where a Plastic Filament is Melted and Deposited layer by layer.
2. 1989: Hans Langer establishes Electro Optical Systems (EOS) focusing on Direct Metal Laser Sintering (DMLS) Technology

Dr. Ye Tao

Bambu Lab was founded by Four Engineers but the main engineer is Dr. Ye Tao. Dr. Tao was born and raised in China and Graduated with a doctorate from MIT'S Department of Chemistry. Before he founded Bambu Lab, he worked at DJI where he experimented with 3D printers.

3. CAPSTONE PROJECT WORK

3.1 CAPSTONE PROJECT PLANNING

3.1.1 Work breakdown structure (WBS)

Focuses on Speed and Accuracy, ideal for demanding projects. A market survey can help you improve the Quality of your decisions by providing insights into your target and Optimal Price for your products. Define the Needs and Requirements for the purchase, Purchase the 3D printing lab machine Parts directly from the 3D printing Shops. The process of Combining Individual parts to create a Functional product. Check that individual components of the Model are Correct. Checks whether the model breaks and tests for previously Encountered bugs. Collect, Process, Store and present information within a Machine.

1. Motion System:

X-Axis Motion:

- Linear rail and beam.
- Tool head and slider.

Y-Axis Motion:

- Horizontal guide rail.
- Print bed and slider.

Z-Axis Motion:

- Dual optical shaft-linear bearing guides.
- Dual lead screws and nuts.
- Stepper motors.
- Synchronous belt drive.

2. Tool head Module:

Hot end Assembly:

- Hot end heating assembly.

- Nozzle and heat sink.
- Hot end fan.
- Silicone sock

Extruder Unit.

- Cutter Unit.
- Filament Hub.
- Filament Sensor.

3. Print Bed System:

- Heated bed.
- Build plate (e.g., textured PEI plate).

4. Filament Handling:

- Filament loading/unloading mechanisms.

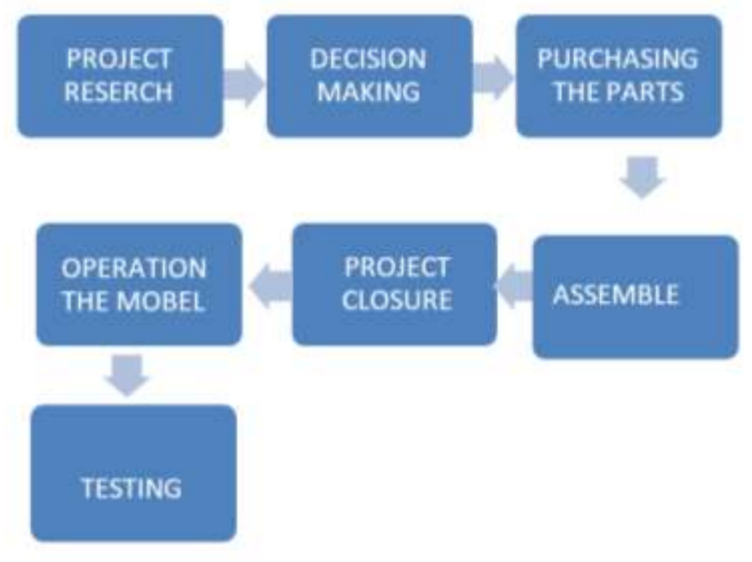

Figure 3.1 Flow chart of work breakdown structure

3.1.2 Time Line Schedule

1. Release Timeline:

To find precise release dates of Multi filament products, looking at online forums, and news articles related to 3d printing can be very helpful.

Based on information found, the Multi filament was released around December of 2023.

It is important to remember that Multi filament, like many tech companies, regularly updates its products. So keeping up to date with the Companies news is always a good idea.

2. Maintenance Schedule:

This is less about fixed dates and more about usage-based and periodic tasks. Key points:

2.1 Usage-Based Lubrication:

- The printer will give prompts, often around 150 print hours, for lubrication. This is a primary driver of your maintenance schedule.
- This means that someone who prints heavily will have a more frequent lubrication timeline than someone who prints occasionally.

2.2 Periodic Checks:

- Regularly inspect belts for tension.

- Clean the nozzle and hot end as needed.
- Check for any debris or build up on the rails.

3. Print Timeline:

This is entirely variable. Factors include:

- **Model Complexity:** A highly detailed model will take much longer than a simple shape.
- **Print Settings:** Layer height, infill density, and print speed all heavily influence print time.
- **Filament Type:** Some filaments require slower print speeds.
- **Printer Speed:** The Multi filament is known for its speed, but you can adjust this.

SL. No	Task	Estimated Time	Start Date	End date
1	**Planning and research**	2 Weeks	Week 1	Week 2
2	**Market survey**	2 Weeks	Week 3	Week 4
3	**Purchasing components**	3 Weeks	Week 5	Week 7
4	**Implementation And assembling the components**	3 Weeks	Week 8	Week 10
5	**3D Models design & Testing**	3 Week	Week 11	Week 13
6	**Reporting**	3 Week	Week 14	Week 16

Table 3.2 Time Line Schedule

3.1.3 Cost breakdown Structure

COMPONENTS	COMPANY NAME	QUANTITY	{₹}PRICE
Bambu lab complete hot end, Thermistor hot end silicone , cooling hot end, AMS life automatic, active support, hub, feeder motor, filament funnel.	**Wold3D Printer**	9no’s	Rs23470/-
Bambu lab replacement , filament sensor, extruder gear, silicon sock, heat bed nozzle, glue stick for build and smooth, bus cable, screw kit, cooling fan, signal cable .	**Wold 3D Printer**	10no’s	Rs2500/-
BambulabPTFEtubeforA1 Mini,3D effect sheets ,spool holder for A1 Mini ,textured PE1 plate, Bus cable 6 pin Activated carbon, 6A fuseTHboardForA1, PTFE Tube connecter	**Wold 3D Printer**	7no’s	Rs5800/-
Bambulab2Motor ,2belt, glass cover plate , display connector and front housing	**Wold 3D Printer**	5no’s	Rs3210/-
Bambu lab right and left side panel , X1 series extruder, X axiscoverforA1carbonrods, print head rear and middle Cover, lab print head rear and Front cover	**Wold 3D Printer**	5no’s	Rs13600/-
Power switch cable, Nozzle wiper ,MC to AP cable, MC board, Lab internal power	**Wold 3D Printer**	5no’s	Rs7320/-
High Resolution Screen , Heated Unit V3 & Surface Sensor	**Wold 3D Printer**	3no’s	Rs10000/-
Multifilament	**Wold 3D Printer**	4no’s	Rs4000/-

Total		**48no's**	**Rs 69900/-**

Table 3.3 Cost breakdown Structure

3.1.4 Capstone Project Risk Assessment

TECHNICAL RISKS:-

- Hardware Malfunction
- Software Issues
- Material Compatibility
- Connectivity Issues

OPERATIONAL RISKS:-

- User Error
- Project Delays

SECURITY RISKS:-

- Data breaches
- Cyber Attacks

FINANCIAL RISKS:-

- High Initial Investment
- Maintenance Costs

SAFETY RISKS:-

- Fire Hazards
- Chemical Hazards

4. OBJECTIVE

The objective of the Multi Filament 3D printer is to provide a user-friendly, high-speed, and reliable 3D printing experience, particularly for users who want to create multi-color prints with features like auto-calibration and intelligent print monitoring.

- High-Quality 3d Printing
- Ease Of Use
- Speed And Efficiency
- Innovation
- Print Quality and Speed

5. METHODOLOGY

The Multi filament 3D printer utilizes a methodology focused on speed, automation, and precision, employing a Core XY motion system, automated calibration, and features like multi-color printing and filament monitoring to streamline the 3D printing process.

Research and Development Methodology

Design and Development Methodology

Testing and Validation Methodology

Quality Control and Assurance Methodology

Manufacturing and Assembly Methodology

Maintenance and Support Methodology

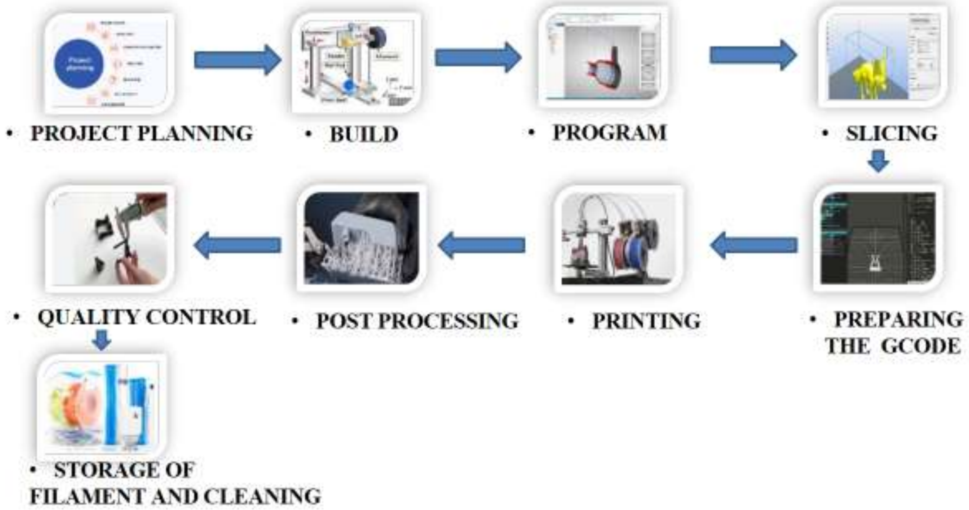

Figure 5.1 Chart of Methodology

6. DETAILED DESCRIPTION OF COMPONENTS/ SUBSYSTEM

6.1 THE MOTION SYSTEM:

The A1 utilizes a Cartesian coordinate motion system, with a maximum print volume of 256 * 256 * 256 mm³. Its motion system includes the following components.

Figure 6.1 Motion System

6.2 TOOL HEAD MODULE

The tool head unit is a crucial component of the A1. It comprises several key modules, including the hot end assembly, extruder unit, cutter unit, filament hub, and filament sensor.

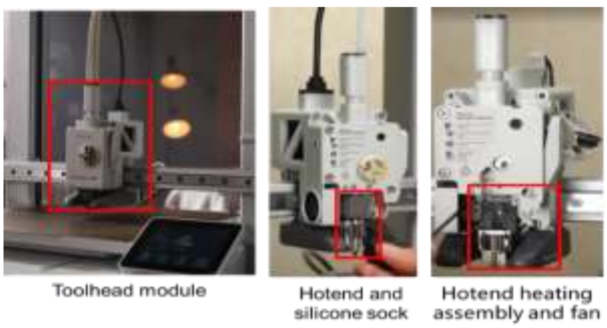

Figure 6.2 Tool Head Module

6.3 EXTRUDER UNIT

The extruder motor and extruder gears are essential components of the extruder unit. The extruder motor pulls the filament from the spool and feeds it into the hot end.

Figure 6.3 Extruder Unit

6.4 FILAMENT HUB AND FILAMENT SENSOR

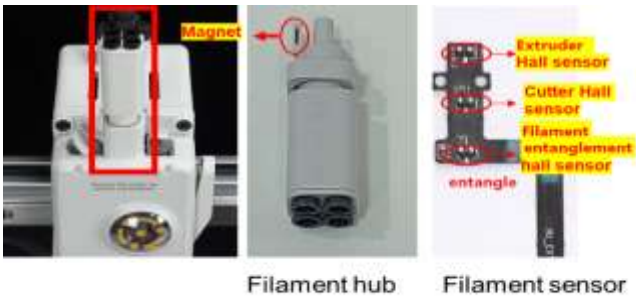

Figure 6.4 Filament Hub And Filament Sensor

The PTFE tubes are connected to the filament hub on the tool head. This allows the tool head to accommodate four different filaments, enabling multi-color printing combined with a multi-color printing module. In addition, the filament hub contains a magnet inside, which works in conjunction with a filament entanglement hall sensor to check for filament entanglement.

6.5 COOLING SYSTEM

Efficient cooling of the printed model is essential for fast printing. The A1 has a custom 5015 centrifugal fan, featuring two opposing air outlets. This design directs the cooling air precisely towards the vicinity of the nozzle, ensuring rapid cooling of the printed parts.

Figure 6.5 Cooling System

6.6 HEAT BED UNIT

Figure 6.6 Heat Bed Unit

7. ASSEMBLY OF MULTI FILAMENT 3D PRINTING MACHINE

Figure 7.1 Frame Assembly

1. Assemble the frame by attaching the legs, sides, and top plate using screws and Allen wrenches.

Figure 7.2 Base Assembly

2. Attach the Y-axis rods to the frame using screws and Allen wrenches.
3. Install the Z-axis stepper motor and lead screw.
4. Assemble the Z-axis carriage and attach it to the X-axis carriage.

Figure 7.3 Y-Axis Assembly

Figure 7.4 X-Axis Assembly

Figure 7.5 Z-Axis Assembly

Figure 7.6 Extruder and Hot end Assembly

1. Assemble the extruder and hot end components

Figure 7.7 Electronics and Wiring

Figure 7.8 AMS Assembly

1. AMS (Automated Manufacturing System) assembly involves a precise and sequential integration of mechanical, electrical, and software components, ensuring seamless communication and efficient production workflow.

8. TESTING AND ANALYSIS

TESTING OBJECTIVES

1. Verify Machine Performance: Verify that the Multi Filament machine meets its specified performance criteria, including print speed, accuracy, and reliability.

2. Ensure Print Quality: Ensure that the machine produces high-quality prints with minimal defects, warping, or layer shifting.

3. Validate Safety Features: Validate that the machine's safety features, such as emergency stop and thermal protection, function correctly.

4. Evaluate User Experience: Evaluate the user experience, including the ease of use, intuitiveness, and overall user satisfaction.

Figure 8.1 Trails

9. CONCLUSION

We know the version 1,2,3 3D Printing machine in our lab's This machines are slow printing speeds, limited material options, It is take more time to prepare a small models and it is not able to print the models with Multiple Color's because this are single filament 3D printing machine.

So we are decided multi filament 3D printing machine is better, because what are the disadvantages we know our previous 3D printing machine we have tried to correct.

We are improve the speed and Efficiency, Reduce printing time, Prepare a single model with 4-colors, User-Friendly Interface, Automated Features, Built-in Camera and App Control and Automated Calibration.

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