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3D Printer Assembly And Text Logo Printing

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***Abstract* – The project, "3D Printer Assembly and Text Logo Printing," aimed to achieve a dual objective— meticulous assembly of a 3D printer and the development of its capability to accurately print text-based logos on diverse surfaces. The project embraced a comprehensive methodology, encompassing research, assembly planning, calibration, configuration for logo printing, and knowledge transfer through hands-on training. Results indicate successful assembly, precise logo printing, effective knowledge dissemination, and thorough documentation. This endeavor showcases a structured approach, ensuring functionality, precision, and skill acquisition in the realm of 3D printing technology.**

***Keywords* – 3D printer assembly, Digital design, Prototype creation, Customized manufacturing.**

I. INTRODUCTION

In today's world, manufacturing a product with traditional methods are getting replaced with the new technologies. It helps in reducing human effort and maximizing the production of goods. The production that involves additive or subtractive manufacturing is stepped with the process like 3D modelling which comes under the rapid prototyping process. Before manufacturing any product, a CAD (Computer Aided Design) model is designed with the help of different 3D modelling software like SolidWorks, Creo Parametric, Blender, etc., with proper dimensions. Such a model is transferred into an STL file where each part is converted into the triangulated and slice form, so the machine understands the way of manufacturing. CNC Cutters, CNC Lathe, and 3D printers are some advanced manufacturing machines. In this report, additive manufacturing machine, 3D printer is detailed with its design along with manufacturing for the laboratory use. 3D printer gets STL file of any CAD model designed by the user, that is further sliced into a machine defined form and then prototype product is manufactured.

Prototyping process is important before manufacturing any kinds of product. It helps in identifying the error or any things that might occur to the product by having visual inspection to the sample product and different experiment like wind tunnel testing, dimensional accuracy, etc. Similarly, for creating die for any casting of material, prototype product is used. Picture below shows the 3D printer model.

II. LITERATURE REVIEW

3D printing, also known as additive manufacturing, is the process of constructing three-dimensional objects from digital 3D models, often created using computer-aided design (CAD) software. This innovative technology allows for the deposition, joining, or solidification of materials under precise computer control. Typically, materials are added in layers, which can include plastics, liquids, or powdered grains that are fused together.

The roots of 3D printing can be traced back to the early 1980s. In April 1980, Hideo Kodama, working at the Nagoya Municipal Industrial Research Institute, pioneered two additive methods for producing three-dimensional plastic models using photo-hardening thermoset polymers. These methods controlled the exposure of ultraviolet (UV) light through a mask pattern or scanning fiber transmitter.

On July 2, 1984, American entrepreneur Bill Masters filed a patent (US 4665492) for his computer automated manufacturing process and system, marking the first-ever 3D printing patent in history, as recorded by the United States Patent and Trademark Office (USPTO). In 1984, Chuck Hull invented stereo lithography, a technique in which layers are added by curing photo polymers using UV lasers. Notably, owning a 3D printer in the 1980s came at a staggering cost of over $300,000.

The technology continued to evolve over the years. By the 1990s, layer-by-layer printing with a 0.1mm depth per layer became a standard. In 1995, the Fraunhofer Society developed the selective laser melting process. In 1999, 3D printing saw its first medical application. By 2000, the technology advanced to the point where human body parts such as ears and fingers were being fabricated. In 2005, 3D printing became open source, spurring innovation in the field
In 2006, the first selective laser sintering (SLS) machine became variable, and in 2008, the first self replicating printer emerged, allowing it to print a significant portion of its own components. This same year, 3D printing technology also

progressed to create complex and artistic designs. In 2009, atom-by-atom printing was achieved, opening the door to bio3D printing.

In 2011, the world witnessed the first 3D-printed robotic aircraft, along with the first commercially available 3Dprinted car. Precious metals like gold and silver were also used for jewelry production using 3D printing techniques.

In 2012, Fila Bot introduced a system for broadening the range of plastics that Fused Deposition Modeling (FDM) or Fused Filament Fabrication (FFF) 3D printers could use. FDM, one of the most cost-effective 3D printing technologies, followed the popularity of stereo lithography (SLA) and selective laser sintering (SLS). Notably, by 2020, entry-level 3D printers of decent quality could be obtained for less than $200, making the technology more accessible to a wider audience.

III. OBJECTIVES

Certainly, here are some simple objectives for the project titled "3D Printer Assembly and Text Logo Printing.

- Assembly of 3D Printer: The primary objective of this project is to successfully assemble a 3D printer from its individual components, ensuring that it is fully functional and calibrated for precise printing.
- Text Logo Printing Capability: Develop and configure the 3D printer to have the capability to print text-based logos accurately on various surfaces and materials.
- Knowledge Transfer: Train team members or end-users on the assembly and operation of the 3D printer for text logo printing.
- Documentation and Reporting: Create comprehensive project documentation and reports, including an assembly manual, troubleshooting guide, and a final report on project outcomes.

These objectives provide a clear road map for successfully completing the project and achieving the desired outcomes of 3D printer assembly and text logo printing.

IV. METHADOLOGY

1. Assembly of 3D Printer Methodology:

a. Research and Component Identification: Begin by conducting in-depth research on the specific 3D printer model and components. Identify and gather all necessary parts, tools, and materials.
b. Assembly Sequence Planning: Develop a step-by-step assembly plan. Organize the assembly process by dividing it into logical stages, ensuring proper sequencing.
c. Assembly Team: Assemble a skilled team with expertise in mechanical assembly and electronics, if required. 4. Assembly and Calibration: Follow the assembly plan meticulously, assembling the 3D printer. After assembly, perform initial calibration to ensure precise printing.
d. Testing and Troubleshooting: Rigorously test the 3D printer for any defects or issues. Address and troubleshoot any problems encountered during the assembly process.
e. Documentation: Document the assembly process, including detailed assembly instructions, diagrams, and photographs for reference.

2. Text Logo Printing Capability Methodology:

a. Printer Configuration: Configure the 3D printer settings to optimize it for text logo printing, including resolution, material compatibility, and print speed.
b. Design Software Selection: Choose appropriate design software for creating and modifying text-based logos, ensuring compatibility with the 3D printer.
c. Logo Preparation: Prepare text-based logos in the chosen design software, ensuring correct dimensions, orientations, and support structures.
d. Printing Test Runs: Conduct several test runs to fine-tune the 3D printer settings, materials, and printing parameters for accurate logo printing.
e. Quality Control: Implement quality control checks to ensure that the printed logos meet the predefined standards in terms of clarity and accuracy.
f. Documentation: Document the configuration and printing process, including settings and results, for future reference.

3. Knowledge Transfer Methodology:

a. Training Plan: Develop a training plan outlining the content, methods, and schedule for training team members or end-users.
b. Hands-on Training: Provide hands-on training sessions, including assembly, operation, maintenance, and troubleshooting of the 3D printer.
c. User Manuals and Guides: Create user-friendly manuals and guides that summarize key training points for easy reference.
d. Q&A Sessions: Organize regular question-and-answer sessions to address any concerns or uncertainties among trainees.

e. Skill Assessment: Assess the knowledge and skills of trainees through practical tests and demonstrations

4. Documentation and Reporting Methodology:

a. Documentation Standards: Establish clear documentation standards for the project, including formats, templates, and version control.
b. Regular Updates: Maintain up-to-date project documentation throughout the project's lifecycle.
c. Assembly Manual: Develop a comprehensive assembly manual with detailed instructions, diagrams, and troubleshooting guidelines.
d. Troubleshooting Guide: Create a troubleshooting guide that outlines common issues and their solutions.
e. Final Report: Compile a final project report summarizing the project's objectives, methodologies, outcomes, challenges, and recommendations.
f. Review and Approval: Ensure that all documentation undergoes review and approval processes.

V. 3D PRINTING ASSEMBLY

In market, there are various kind of 3D printer. Those types can be used for different purpose. With the help of market research, some of 3D printers are listed below. Among them, one printer is selected for the development process.

1. Selection of 3D Printer Model

Based on the application and purpose Miscellaneous Rectilinier (Cartesian) type of printer is selected. As Cartesian devices, rectilinear printers are distinct from polar printers in that they position their nozzles using X-, Y-, and Z- coordinates.

Otherwise, rectilinear printers differentiate themselves from non-rectilinear printers in that they employ simple linear motion to position the nozzle relative to the print bed. In most cases, motion along one axis is completely independent of motion in the other axes (i.e. a single motor is responsible for each of the three axes). For this reason, rectilinear printers appear square or boxy. This type of printer is relatively cheap, simple to understand and implement, comparatively easy to upgrade and fix.

2. Parts used in 3D printer

There are several parts involved in manufacturing of 3D printer. Same materials and component are not always being used during fabrication. Parts and system is mainly classifies into three categories which are electronics, hardware and softwares. Detail description about the components are discussed below.

3. Electronic component

- **RAMPS 1.4 Shields**

RAMPS is a board the serves as the interface between the Arduino mega, controller computer and the electronic devices on the 3D printer[11]. The computer extracts information from files containing data about the object you want to print and translates it into digital events like supplying s voltage to a specific pin. It organizes and amplifies the information coming from the mega so that they're properly directed down the correct channels.

Figure 1 RAMPS 1.4 Shield

For example, if the hot end carriage needs to move one step to the left, the RAMPS board routes the signals from the Mega to the X axis stepper motor via the appropriate pins and wires. Figure below shows an assembled RAMPS board[11].

- **ARDUINO MEGA 2560**

The Arduino Mega is a micro controller board based on the ATmega2560. It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the micro controller; simply connect it to a computer with a USB cable or power it with a AC- to-DC adapter or battery to get started. Figure below shows the Arduino mega 2560[12].

Figure 2 Arduino Mega 2560

- **NEMA 17 Stepper Motor**

A Nema 17 stepper motor has a face plate size of 1.7 x 1.7 inch (42 x 42 mm). Nema 17 high torque stepper motors offer excellent value without sacrificing quality. The 0.9° step angle version of the motor is more precise than the standard 1.8° version. These motors are designed to deliver maximum torque while minimizing vibration and audible noise. A variety of motor winding's and stack lengths are readily available, or the motors can be customized to meet the needs of your machine[12]. Figure below shows the nema 17 stepper motor.

Figure 3 Nema 17 Stepper Motor

- **End Stop**

End stop is a kind of switch also known as mechanical end stops which are contact based manual switches that determine when an object is at the end of the axis path. It work using simple touch sensor that functions as a switch where the switch is touched by an object. It signals to the motherboard that the main object is at the end of the path[12].

Figure 4 End stop

- **Power Supply**

Power supply are usually clunky metal boxes with a row of screw terminals or a bundle of wires at one end and a fan on the side. It receives up-to the 110 to 240 volts from the wall and steps them down to a more reasonable 12 to 24 volts. Figure below shows the power supply unit required for the 3D printer.

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Figure 5 Power supply

- **A4988 Polulu Stepper Driver**

The A4988 is a complete micro stepping motor driver with built in transistor for easy operation. It is designed to operate bipolar stepper motors in full-, half-, quarter-, eighth-, and sixteenth-step modes, with an output drive capacity of up to 35 V and ±2 A. The A4988 includes a fixed off-time current regulator which has the ability to operate in Slow or Mixed decay modes[13].

- **Heated Bed**

Heated beds are a 3D printer bed that heat up to various temperatures in order to regulate the cooling temperature of a print. Heated beds are a good choice for filaments and projects that are prone to warping, as the temperature stops a print from cooling too quickly and losing its shape mid-print[14].

Figure 6 Heated Bed

- **Coupler**

It connects the shaft of the axis motor to the long-threaded rod that spins to raise or lower the print head. Usually, these are two rods of different sizes. So, the coupler may accept a different diameter on either end.

Figure 8 Coupler

- **M5 Thread Rod**

Fully threaded rod made of 18-8 stainless steel for corrosion resistance used for providing movable path for the stepper motor that are attached with the rod. Figure below shows the M5 thread rod.

Figure 9 M5 Thread rod

4. Software and file codes

Here is some software, which are compatible for the model to operate. Those softwares will help to prepare prints with a few clicks, integrate with CAD software for an easier workflow, or dive into custom settings for in-depth control. Some of them are listed below.

- Cura
- Simplify 3D
- Repetirt Host

The model is companionable for the files like STL, OBJ and G-Code

5. Assembly Process

The product is many based on assembly process rather than manufacturing. Most of the parts are available in the market so it was easy and efficient to buy and assemble the product. Steps involved in assemble are;

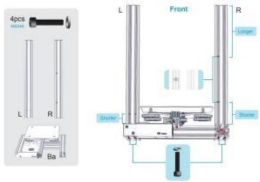

Figure 10 Assembly step 1

- At first printer base plate was screwed with two rails left and right in vertical manner which will support the nozzle and extruder.
- Then power supply unit was connected behind the vertical trails with LCD display in front of the base plate.

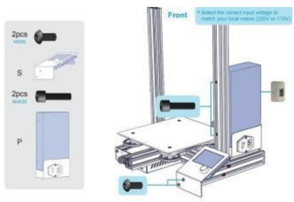

Figure 11 Assembly step 2

- Then, z-axis limit module was attached in vertical rails in order to restrict abrupt collision of nozzle to the base plate.

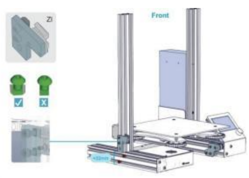

Figure 12 Assembly step 3

- After connection z-axis limit module, z-axis motor was assembled with lead screw for vertical motion of nozzle.

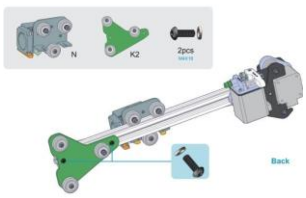

Figure 13 Assembly step 6

- When nozzle and roller bracket were attached the belt was connected.

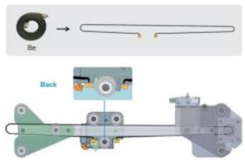

Figure 14 Assembly step 7

- After the attachment of the belt, belt tensioner was attached to make belt sufficiently steady.

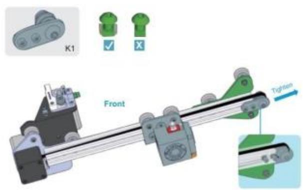

Figure 15 Assembly step 8

- After tightening the belt, the sub-assembly was slide down in the vertical supports.

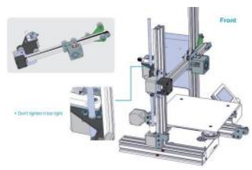

Figure 16 Assembly step 9

- Then after, top-rail was screwed on top of vertical rails to restrict the vertical motion.

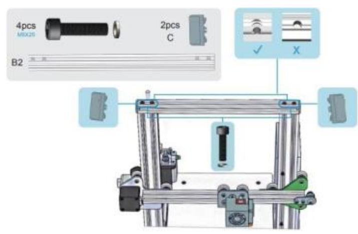

Figure 17 Assembly step 10

VI. Conclusion

The project "3D Printer Assembly and Text Logo Printing" demonstrated a systematic and successful approach in achieving its set objectives. The assembly methodology resulted in a fully calibrated 3D printer, ready for precise printing. The text logo printing capability was realized through meticulous configuration and quality control. Knowledge transfer was effectively facilitated, empowering individuals with comprehensive skills. The documentation and reporting methodologies ensured a reliable record of the project's journey. Overall, the project showcased efficiency, precision, and knowledge dissemination, contributing to the advancement of 3D printing technology

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