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Assembly of Flexible 3D Printing Machine

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A B S T R A C T

This aims at enabling power resume option, auto bed-levelling, remote monitor, and control feature using IoT to manufacture high temperature, good impact light and tensile strength materials. Thus, this machine serves the purpose of making a low-cost 3D printer acting as a plug and play device (smart machine). The technology is used for both prototyping and distributed manufacturing jewelry footwear, industrial design, architecture, engineering and construction (AEC) automotive, aerospace, dental and medical industries, education, geographic information systems, civil engineering, and many other fields.

Keywords: Solid Edge, Creality

1. Introduction

3D printing machine, also known as a 3D printer, is a revolutionary device that creates three-dimensional objects by layering materials based on a digital model. Using additive manufacturing techniques, it builds objects layer by layer, enabling the production of intricate designs and prototypes. These machines use various materials, including plastics, metals, and ceramics, opening up possibilities in fields like manufacturing, healthcare, and design.

Certainly! 3D printers work by reading a digital file (typically in STL format) and then depositing material layer by layer to construct the physical object. The process begins with a design created using computer-aided design (CAD) software. The 3D printer interprets the design and builds the object layer upon layer, allowing for complex geometries and customization.

2. Literature Review

Hideo Kodama [1] In April 1980, Nagoya Municipal Industrial Research Institute invented two additive methods for fabricating three- dimensional plastic models with photo-hardening thermoset polymer, where the UV exposure area is controlled by a mask pattern or a scanning fibre transmitter,

Bill Masters [2] On 2 July 1984, American entrepreneur filed a patent for his computer automated manufacturing process and system (US 4665492). This filing is on record at the USPTO as the first 3D printing patent in history,

Chuck Hull [3] In 1984 who invented a process known as stereolithography, in which layers are added by curing photopolymers with UV lasers. Owning a 3D printer in the 1980s cost upwards of $300,000.

Fraunhofer [4] In 1995 developed the selective laser melting process. in 1999 the first use in medicine, in 2000 the first parts of human such as ears, fingers were done.

3. Design Specifications

Frame Design: Choose a sturdy frame to minimize vibrations during printing. Consider materials like aluminum or steel for stability.

Extruder System: Opt for a high-resolution extruder for precise filament deposition.

Motion Control: Implement an accurate motion control system using stepper motors. Consider a precise and smooth linear guide system for movement.

Print Volume: Determine the desired print volume based on intended applications. Ensure flexibility to accommodate various project sizes.

Material Compatibility: Support a range of filament materials (PLA, ABS, etc.) for versatility.

Safety Features: Integrate features like thermal sensors to prevent overheating Implement emergency stop mechanisms for user safety.

Filament Handling: Include a filament sensor to detect jams or spool depletion. Design an efficient spool holder for smooth material feeding.

User Interface: Develop an intuitive and user-friendly interface for easy operation. Consider adding features like touchscreen controls for convenience.

Testing and Optimization: Conduct iterative testing to identify and address potential issues.

Future Expansion: Design the system with modular components for future upgrades. Consider compatibility with evolving 3D printing technologies

4. Objective

The primary objective of a 3D printing machine is to create physical objects layer by layer from a digital design or model. Here are some specific objectives and goals of a 3D printing machine:

- **Prototyping:** Rapidly produce prototypes and functional models for product development, allowing for iterative design improvements and testing.
- **Customization:** Enable the creation of customized and personalized products tailored to specific user needs or preferences, such as prosthetics, dental implants, or jewellery.

5. Methodology

- **Build:** Consider referring to open-source 3D printer designs for guidance during the building process.
- **Program:** To create a program for a 3D printing machine, you typically need a 3D model in a supported file format (e.g., STL), slicing software to convert the model into layers, and machine control code (G-code). Popular slicing software includes Cura or Prusa Slicer. Design your model or download one, import it into the slicing software, configure settings, generate G-code, and then transfer the G-code to your 3D printer.
- **Creating or obtaining a 3D Model**: The process starts with a digital 3D model. This can be created using 3D modelling software like Blender, AutoCAD, Tinker cad, or downloaded from online repositories like Thing verse My Mini Factory, or created through 3D scanning.
- **Slicing:** The 3D model is then sliced into thin horizontal layers using slicing software. Slicing software calculates the path the printer's nozzle will take to create each layer and generates a G-code file. This file contains instructions for the printer, such as the print speed, temperature, layer height, and more.
- **Preparing the Printer:** Before printing, the printer needs to be set up and prepared. This involvesnChecking the printer bed for cleanliness and proper adhesion (using tapes, glues, or specific bed surfaces like glass or PEI).Loading the 3D printer filament material (commonly PLA, ABS, PETG, etc.) into the printer. Setting the print temperature and other parameters based on the material being used.
- **Printing**: The sliced file (G-code) is transferred to the 3D printer, either via USB, SD card, or wirelessly. The printer starts the printing process layer by layer, following the paths outlined in the G-code. The print head (extruder) heats up the filament, which melts and is deposited in precise locations on the print bed, building up the object layer by layer.
- **Cooling and Solidifying:** As each layer is deposited, the material needs time to cool and solidify before the next layer is added. Some printers have built-in fans or heated beds to aid in this process.
- **Post-Processing:** Once the print is complete, it may require some post-processing depending on the desired finish.
  - Removing supports and rafts.
  - Sanding or smoothing rough edges or surfaces. Painting, dyeing, or applying other finishes.
  - Assembling multiple printed parts if creating something complex.
- **Quality Control:** Checking the printed object for any defects, warping, or errors. Adjusting printer settings if needed for future prints.

6. Description of components

Arduino Mega 2560

- The Arduino Mega is a microcontroller 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 microcontroller; simply connect it to a computer with a USB cable or power it with an AC- to-DC adapter or battery to get started. Figure below shows the Arduino mega 2560Diameter: 100-130 mm

Nama 17 Stepper Motor

A Nama 17 stepper motor has a faceplate size of 1.7 x 1.7 inch (42 x 42 mm). Nama 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 windings and stack lengths are readily available, or the motors can be customized to meet the needs of your machine.

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 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.

Filament Sensor

A filament sensor is a component in a 3D printer that detects the presence or absence of filament. It helps prevent printing errors by pausing the print or alerting the user when filament runs out, reducing the likelihood of incomplete prints

Display Screen

The display screen in a 3D printing machine serves as a user interface to control and monitor the printing process. It typically provides options to load models, adjust settings, and view progress. The screen may be a touchscreen or have physical buttons for navigation, depending on the printer model. If you have specific questions or issues with a 3D printer display, feel free to provide more details.

C R Touch Levelling

C R touch levelling, or Capacitive Resistance touch levelling, is a method used in 3D printing to automatically adjust the bed level. It utilizes a sensor to detect the capacitance changes caused by the distance between the print nozzle and the print bed. This information helps the printer compensate for any unevenness in the bed, ensuring that the first layer of the print adheres properly and is of consistent quality.

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d e f

Fig 1- (a) Arduino Mega 2560, (b) Nama 17 Stepper Motor, (c) Power Supply, (d) Filament Sensor, (e) Display Screen, (f) C R Touch Levelling

6. Assembly

Step 1. Frame Assembly:

Build Base: Start by assembling the base of the frame. This often involves connecting the bottom extrusions or base plates together to form a stable foundation.

Vertical Supports: Attach the vertical extrusions or rods to the base to create the upright sections of the frame. Ensure they are aligned properly and secured firmly **Horizontal Beams:** Install the horizontal beams or crossbars between the vertical supports to reinforce the frame structure. These beams provide additional stability and support.

Check Alignment: Double-check the alignment and squareness of the frame to ensure it is stable and level. Adjust as necessary to correct any misalignments.

Final Adjustments: Fine-tune any settings or adjustments to optimize print quality and performance.

Step 2. Filament sensor Assembly:

A filament sensor assembly in a 3D printing machine is a component designed to detect the presence or absence of filament as it feeds into the extruder. It typically consists of a sensor module positioned along the filament path, which can detect the movement or tension of the filament. When the filament runs out or encounters a problem such as a jam, the sensor triggers an alert or p abuse in the printing process to prevent printing errors or damage to the printer.

Step 3. Extrusion kit Assembly:

The extrusion kit assembly in a 3D printing machine is responsible for feeding filament into the hot end and controlling its flow during the printing process. It typically consists of the following components:

Extruder Motor: This motor drives a gear or hob bed bolt mechanism that grips the filament and pushes it through the extruder.

Extruder Body: The body of the extruder contains the motor and other components necessary for filament feeding. It usually includes a filament guide tube to direct the filament into the hot end.

Hot end Assembly: The hot end melts the filament and deposits it onto the print bed layer by layer. It consists of a heating element, a temperature sensor, and a nozzle through which the molten filament is extruded.

Idler or Tensioning Mechanism: This mechanism ensures proper tension on the filament to prevent slipping or jamming.

Filament Drive Gear: Also known as an extruder gear, this gear grips the filament and moves it forward when driven by the motor.

Cooling Fan: Some extruders include a cooling fan to prevent the hot end from overheating and to cool the printed filament quickly after extrusion.

Mounting Hardware: Bolts, screws, and brackets are used to secure the extruder assembly to the printer frame.

Step 4. Stepper Motor Assembly:

Assembling a stepper motor in a 3D printing machine involves several steps: Identify Motor Position: Determine where the stepper motor will be located in the **printer assembly.** Stepper motors are commonly used for driving the X, Y, and Z axes, as well as for extruders in some setups.

Mounting: Securely mount the stepper motor to the printer frame or designated mounting brackets using screws or bolts. Ensure that the motor is aligned correctly and securely fastened to prevent vibrations during operation.

Connecting Components: Connect the stepper motor to the appropriate components using cables or wiring harnesses. For example, the motor might

connect to a lead screw or belt pulley system for translating rotational motion into linear motion in the X, Y, or Z direction.

Wiring: Connect the wires from the stepper motor to the control board of the 3D **printer. Typically,** stepper motors have four or six wires that need to be connected to the appropriate stepper motor driver outputs on the control board.

Adjustment: Depending on the specific configuration of your printer, you may need to adjust the position or tension of belts or lead screws connected to the stepper motor to ensure smooth and accurate motion.

Testing: Once the stepper motor is installed and connected, power on the printer and perform test movements to verify that the motor is functioning correctly. Use the printer's control interface to manually move the axis associated with the stepper motor and observe its behavior.

Calibration: Fine-tune the stepper motor settings in the printer's firmware to ensure accurate movement and precise positioning. This may involve adjusting steps per millimeter (or steps per degree for rotary motion) to achieve the desired print dimensions.

Step 5. Pulley and Belt Assembly:

Assembling the pulley and belt system in a 3D printing machine is crucial for transferring motion from the stepper motors to the various moving parts such as the print head or build plate. Here's a step-by-step guide:

Identify Components: Gather the pulleys, belts, stepper motors, and any necessary hardware provided with your 3D printer kit.

Mount Stepper Motors: Install the stepper motors onto their designated mounts on the printer frame. Ensure they are securely attached and aligned properly.

Attach Pulleys: Slide the appropriate pulleys onto the shafts of the stepper motors. Make sure they are positioned correctly and tightened securely to prevent slipping during operation.

Prepare Belts: Cut the timing belts to the required lengths according to the specifications provided by the manufacturer. Be sure to leave a bit of extra length for adjustments.

Thread Belts: Thread the belts around the pulleys and through any idler pulleys or tensioners provided. Follow the recommended belt path specified in the printer's assembly instructions.

Tension Belts: Adjust the tension of the belts to ensure they are snug but not overly tight. Proper tension is essential for accurate and reliable motion. Most printers have tension adjustment mechanisms built into the design.

Secure Belts: Once the belts are tensioned properly, secure them in place using the provided fasteners or clamps. Double-check that they are properly seated in the pulley grooves to prevent slipping.

Test Motion: Manually move the print head or build plate along the axes to ensure that the belts are correctly installed and moving smoothly. Check for any signs of binding or skipping.

Fine-Tuning: Make any necessary adjustments to belt tension or pulley alignment to optimize performance. This may involve tweaking the position of the idler pulleys or adjusting the tensioning mechanisms.

Final Checks: Double-check all connections, belts, and pulleys to ensure everything is securely in place before proceeding with printing operations.

By following these steps, you should be able to properly assemble the pulley and belt system in your 3D printing machine, ensuring reliable and accurate motion for high-quality prints.

Step 6. Display screen Assembly:

The display screen assembly in a 3D printing machine serves as the interface for users to interact with the printer, control settings, and monitor the printing process. Here's how you can assemble it:

Identify Components: Gather the display screen, control board, cables, and any mounting hardware provided with your 3D printer kit.

Mount Control Board: Install the control board in its designated location within the printer's frame. This is typically a secure area where it won't interfere with moving parts or be exposed to excess heat.

Connect Cables: Attach the cables from the display screen to the appropriate connectors on the control board. Follow the wiring diagram provided in the printer's assembly instructions to ensure correct connections.

Mount Display Screen: Determine the mounting location for the display screen on the printer's frame. This is often in a visible and easily accessible location for the user.

Secure Display Screen: Use the provided mounting hardware to securely attach the display screen to the printer's frame. Ensure it is positioned at a comfortable viewing angle for the user.

Connect Power: If the display screen requires a separate power source, connect it to the appropriate power supply unit according to the manufacturer's instructions. **Power On and Test:** Once the display screen is securely mounted and connected, power on the printer and test the functionality of the display. Make sure it lights up and displays the printer's interface properly.

Navigate Menu: Use the controls on the display screen to navigate through the printer's menu options. Test various functions such as preheating, bed levelling, and starting a print job to ensure everything is working correctly.

Adjust Settings: Depending on your printer model, you may need to calibrate or adjust settings through the display screen interface. Follow the manufacturer's recommendations for optimal printer performance.

Final Checks: Double-check all connections and ensure that the display screen is securely mounted. Confirm that it responds properly to user input and displays information accurately before proceeding with printing operations

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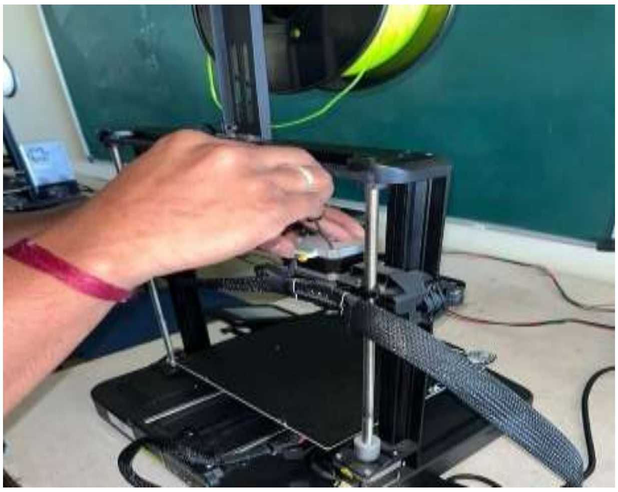

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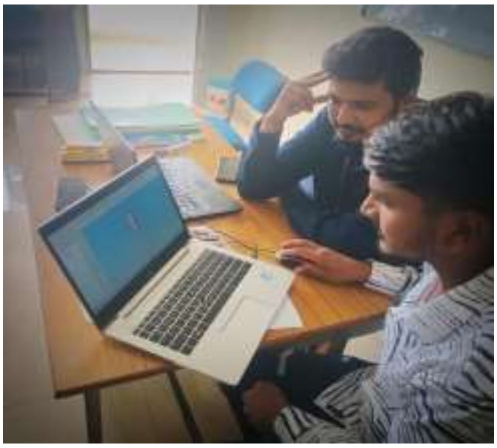

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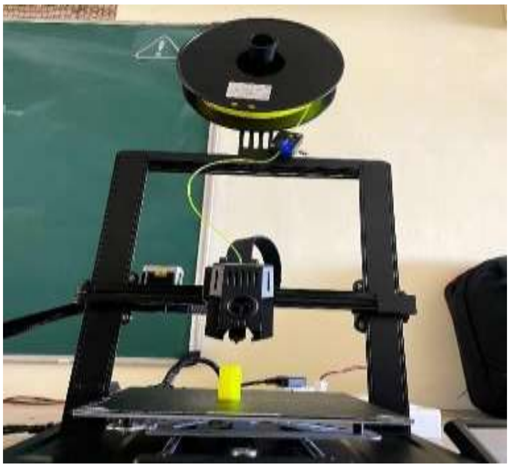

Fig 2- (a) Frame Assembly, (b) Filament sensor Assembly, (c) Extrusion kit Assembly, (d) Stepper Motor Assembly, (e) Pulley and Belt Assembly, (f) Display screen Assembly,(g) Preparation of model using solid edge,(h) 3D Printing.

7. Conclusions

The current state of 3D printing machines is hindered by slow printing speeds, limited material options, and high production costs. This project is developed a next-generation 3D printing machine that overcomes these challenges, improving efficiency, versatility, and affordability for various industries, can lead to enhanced competitiveness, increased flexibility, and greater responsiveness to customer demands in a rapidly evolving marketplace.

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References

Advanced Manufacturing Technology ME 306 KTU by S. Jose (Author), Ahammad Vazim K. A. (Author)

Advance Manufacturing Technology by Dr. Kiran Gowd M. R (Author), Dr. Manjunath Gowda M. R (Author), Dr. AshokR Banagar (Author), Mr. Arjun M (Author), Mr. Mohammed Umar (Author)

https://www.creality.com/products/ender-3-3d-printer

https://www.createeducation.com/about-us/introduction/

https://www.twi-global.com/technical-knowledge/faqs/what-is-3d-printing