Medimaker-enchancing Patient Care with 3D Printer

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ABSTRACT

AS TECHNOLOGY CONTINUES TO ADVANCE, HEALTHCARE IS EVOLVING WITH INNOVATIVE SOLUTIONS TO ENHANCE PATIENT CARE. ONE SUCH TECHNOLOGY IS 3D PRINTING, WHICH HAS GAINED SIGNIFICANT ATTENTION FOR ITS POTENTIAL TO REVOLUTIONIZE VARIOUS ASPECTS OF HEALTHCARE DELIVERY. THIS PAPER EXPLORES THE ROLE OF 3D PRINTING IN PATIENT CARE FROM THE PERSPECTIVE OF MEDIMAKER, A LEADING PROVIDER OF MEDICAL-GRADE 3D PRINTING SOLUTIONS. WE EXAMINE THE BENEFITS, CHALLENGES, AND FUTURE PROSPECTS OF INTEGRATING 3D PRINTING INTO CLINICAL PRACTICE, FOCUSING ON ITS APPLICATIONS IN PERSONALIZED MEDICINE, SURGICAL PLANNING, MEDICAL EDUCATION, AND PROSTHETICS.BY LEVERAGING MEDIMAKER'S EXPERTISE AND CUTTING-EDGE TECHNOLOGY, HEALTHCARE PROFESSIONALS CAN HARNESS THE FULL POTENTIAL OF 3D PRINTING TO IMPROVE PATIENT OUTCOMES AND ADVANCE THE STANDARD OF CARE.

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 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, prototypeproduct is used. Picture below shows the 3D printer model.

LITERATURE SURVEY

3D printing or additive manufacturing is the construction of a three-dimensional object from a CAD model or a digital 3D model. It can be done in a variety of processes in which material is deposited, joined or solidified under computer control, with material being added together (such as plastics, liquids or powder grains being fused), typically layer by layer.3D printing is a new technology, In April 1980, Hideo Kodama of 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 fiber transmitter, On 2 July 1984, American entrepreneur Bill Masters 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,in 1984 at the hands of Chuck Hull 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 After that, 1990 layer by layer technology used each layer has 0.1mm depth. In 1995 the Fraunhofer Society developed the selective laser melting process., 2005 3D printing technology became open source, in 2008 the first self-replication printer which made the printer able to print the majority of its own components also at the same year 3Dtechnology developed to do a very hard shapes and artists for designers ,in 2009 Atom by atom printing were done which allows for Bio 3D printing FDM technology was invented after the other two most popular technologies, stereolithography (SLA) and selective laser sintering (SLS), FDM is typically the most inexpensive of the three by large margin.

EXPERIMENTAL PROCEDURE

3.1.1 Brainstorming

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.

- **CoreXY printers**

CoreXY printers are a relatively new type of FDM 3D printer, first made in 2013 by an MIT engineer. CoreXY printers are classified as Cartesian with regards to the printer's operational coordinate system but use a clever motion system. Motion on CoreXY printers incorporates a system of belts and pulleys to move the printhead on the XY plane. In particular, CoreXY printers use two stepper motors that move one belt each to positiontheprinthed.The end result is sort of like a complex but coordinated tug of war. Meanwhile, the print bed is mounted on a Z-axis motion system, such as threaded rods. This system moves the print bed up and down so that the printhead can print layers for the desired part. CoreXY printers are usually cube-shaped to maximize stability

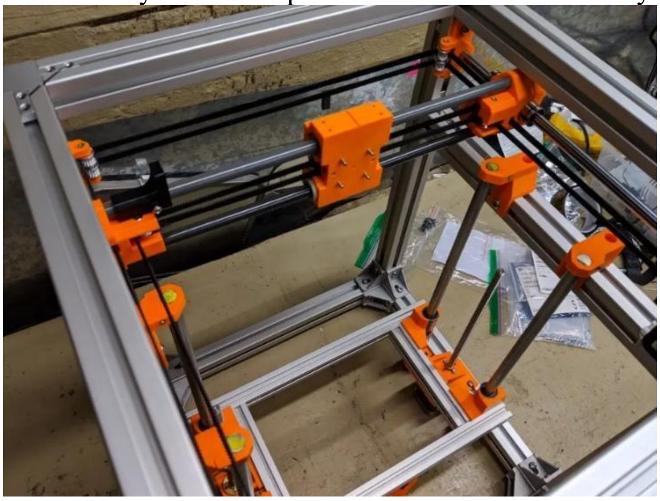


Figure 1. Frame

- **Delta 3D Printers**

Delta 3D printers are a type of FDM printer that also use Cartesian coordinates. Yet, they'remechanically unique from rectilinear printers in a few different ways.Delta 3D printers work with three (or sometimes even more) arms attached to vertical rails. The printhead is connected to the end of each arm with hinges, and the arms work together to adjust the printhead's position.The coordinated movement of a delta printer's arms controls the printhead's height (Z-axis) and location (X- and Y-axes) relative to the print bed.

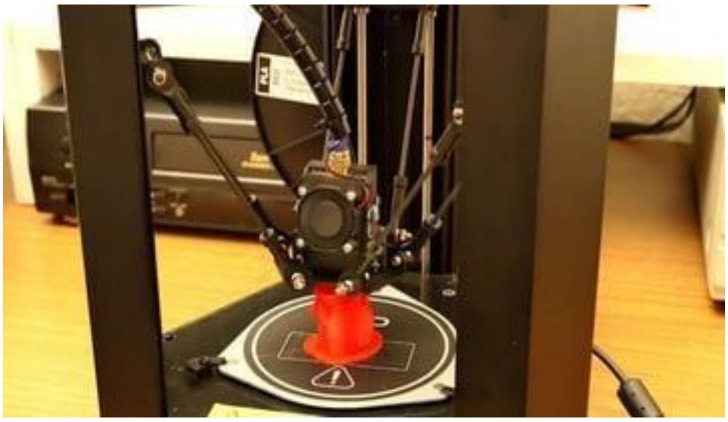


Figure 2.Delta Type

- **Belt 3D printers**

Belt 3D printers are slightly different from the other Cartesian styles because, mechanically speaking, they use a large movable belt for the print bed. Belt 3D printers are the treadmills of the 3D printing world.With respect to the printhead's motion system, the majority of belt printers are essentially Cartesian-XY-head printers or Core XY printers with the frame (but not the bed) tilted at a 45-degree angle Then, the print surface is replaced by a sort of conveyor belt, which moves one way or the other in the combined Z- and Y-axes. This belt can print a single infinitely long piece or it can continuously print many smallparts. The coordinatesystem of belt printers is considered to tilt along with the frame. Thus, the belt provides movement along the Y- and Z-axes.

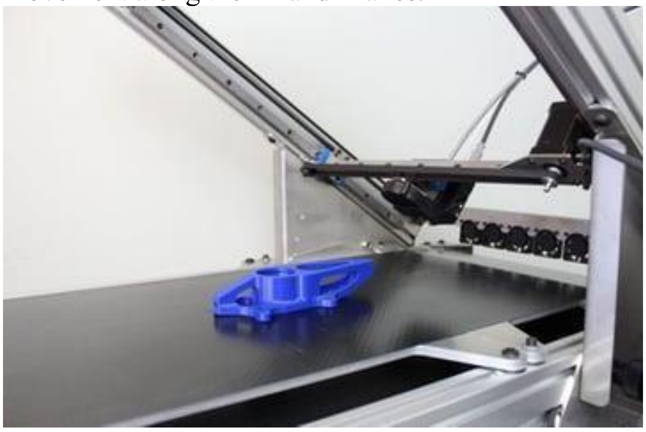


Figure3.3DPrinterBelt

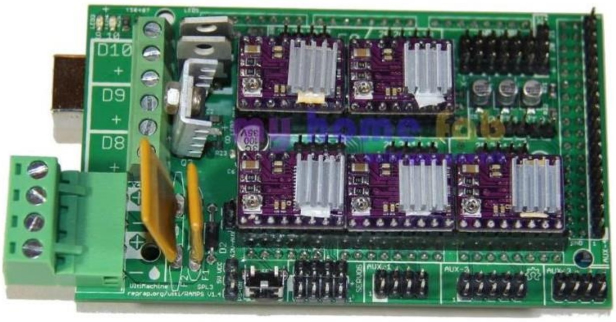
- **H-Bot 3D Printers**

H-bot 3D printers represent a different approach to box-like printer design. Like all the previous printers, the belong in the Cartesian category because they operationally use a Cartesian coordinate system. An H-bot printer uses a single belt to move the printhead within the XY plane. Typically, the printhead runs across an X-axis gantry, which in turn moves along the Y-axis. To move along the Z-axis, the build plate starts at the top, close to the nozzle, and moves downward.Using the previous description of a Core-XY printer's motion system, that of an H-bot printer is like a slightly less complex but also less coordinatedtugofwar

Figure 4.H- Bot 3D printer

- **Miscellaneous Rectilinear**

Let's start by understanding more about rectilinear printers, especially those falling under"Other" in the image above. These are the ones most often referred to as "Cartesian" printers, which again, isn't a very descriptive term. As mentioned above, rectilinear printers are the most commonly used among consumer 3D printers. They are the "stereotypical" 3D printer, with right-angled frames and linear axes. Subtypes include the Cartesian-XZ- head and the



Ultimaker-style crossed printers.Rectilinear printers move components linearly along the X-, Y-, and Z-axes to position theprinthead and print within three-dimensional space. The printhead generally moves along an X or Y gantry, which in turn moves along the Z-axis, though other motion variations are also possible, depending on the printer.

Figure 5. Cartesian Model

3.1.2 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.

3.2 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.

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. 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.For example, if

the hot end carriage needs to move

Figure 6.RAMPS 1.4 Shields

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.

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.

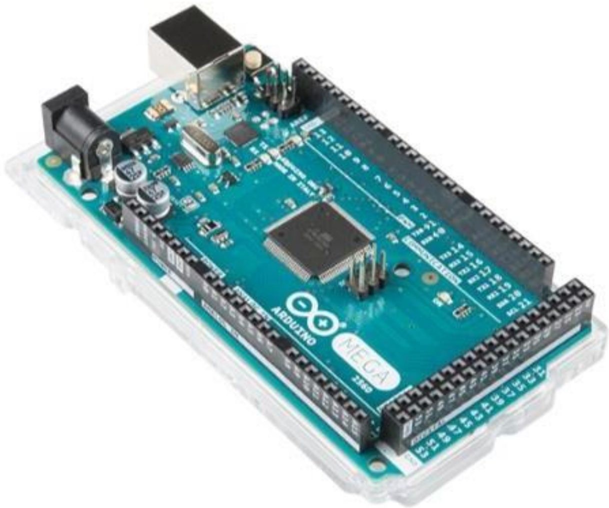


Figure 7. Arduino Mega 2560

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 works usingsimple 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.

Power Supply

Power supply are usually clunky metal boxes with a row of screw terminals or a bundle ofwires at one end and a fan on the side. It receives upto the 110 to 240 volts from the walland steps them down to a more reasonable 12 to 24 volts. Figure below

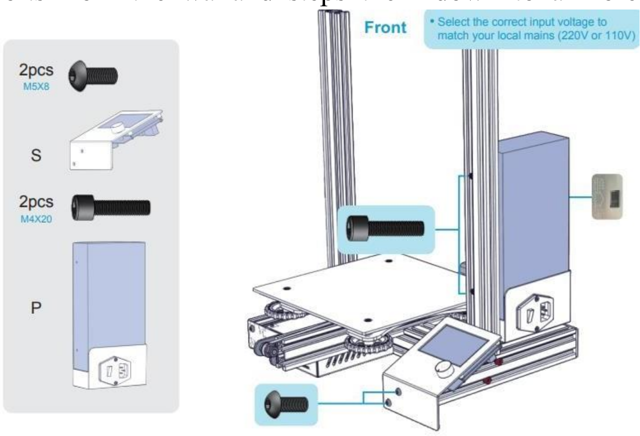


Figure 8.Power Supply

E3D Hotend

E3D hotends is a metal deign with high temperature performance. It is an incrediblyversatile HotEnd allowing a wide range of filaments to be used as standard.

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 projectsthat are prone to warping, as the temperature stops a print from cooling too quickly and losing its shape mid-print

Figure 9.Heated Bed

3.1.3 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

3.2 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

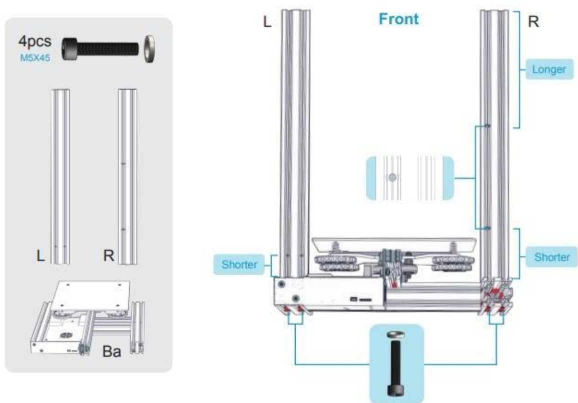


Figure 10.Assembly step 1

- 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 displayin front of the base plate.

Figure 11. Assembly step 2

PRODUCT IDEOLOGY

4.1 Ideology

The product ideology of an engine assembly nozzle dispenser using a 3D printer involves leveraging advanced manufacturing techniques to create a precise and efficient tool. Here are some key points:

1. Innovative Design:

The nozzle dispenser is designed with a focus on functionality and durability, integrating intricate features

that optimize the assembly process.

2. **Material Selection:**

Utilizing suitable materials compatible with 3D printing technology ensures the dispenser meets the necessary strength, heat resistance, and precision requirements for engine assembly tasks.

3. Customization and Prototyping:

3D printing allows for rapid prototyping and customization, enabling iterative improvements and tailored designs based on specific engine assembly needs.

4. Precision and Accuracy:

The product ideology emphasizes the use of 3D printing's high precision capabilities to produce nozzles with exact specifications, critical for precise fluid application in engine assembly.

5. **Efficiency and Cost-Effectiveness**:

By employing 3D printing, the manufacturing process can be streamlined, reducing production time and costs associated with traditional machining methods.

6. **Integration and Compatibility:**

The design considers integration into existing assembly processes, ensuring compatibility with standard equipment and enhancing overall workflow efficiency.

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