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Design and Fabrication of 3D Printer of Size (600x600x600) mm^3 using IoT for the Industrial Requirement

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Abstract: Nowadays, 3D printers are used at multiple places in the industry for rapid prototyping. Rapid prototyping is used mostly for industrial applications. For example, for manufacturing bottles, the dye required for manufacturing them can be produced by additive manufacturing i.e. by 3D printing. Also, this reduces the cost of manufacturing the product in a single go at the expense of time. In the market, till now the traditional 3D printer available is of size 300mm*300mm which restricts you from printing larger size objects. To solve this problem, we have created a printer of size 600mm*600mm. Also, it gives us the freedom to print products from a variety of materials. This project includes the Latest technologies of IoTs, Auto bed levelling, Filament sensors, etc. Which are very important to run the machine effectively without much human interference. Although solutions to such problems were available, they were limited to large-scale industries.

Key Words*: *Rapid Prototyping, Additive manufacturing, Larger size, and IoT

Introduction

3d printing or additive manufacturing is the process of converting a CAD model or digital file into a three-dimensional object. Additive manufacturing, as its name implies add materials, layer upon layer in precise shapes until the object is created. On the other hand, the subtractive manufacturing process is completely the opposite of the additive manufacturing process, where cutting or trimming out the piece of material takes place.

This additive manufacturing process starts with creating a CAD model. This CAD model is then converted into the STL file. Then the Slicer program like Cura or Repetier Host converts this STL file into G-code. As this project is IoT-based, Octoprint is used as a web interface for controlling 3D printers which allow us to print objects by inputting G-code to the printer via USB. With Octoprint, we can monitor the status of our print work and printer by just staying at home through WIFI.

This printer is based on Fused deposition modelling (FDM) technology. FDM is an additive manufacturing process where melted material is extruded out from the nozzle and successive layers are created to build an object.

Literature Survey

1. Study on Design and Manufacture of 3D Printer based on Fused Deposition Modelling Technique by Ngoc-Hien Tran, Van-Cuong Nguyen, Van-Nghia Nguyen.

This paper was published in Blue Eyes Intelligence Engineering & Sciences Publication Pvt. Ltd. International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-6 Issue-6, August 2017

This paper presents the results of design and fabricating 3D printer using FDM method. The printing test results have demonstrated the functionalities of the designed machine.

2. IoT based 3D Printer by Prof.Gujar. M. P, Yogita Shinde Ruksar Madaki , Smina Nadaf 03 March,2019.

Published in International Research Journal Of Engineering And Technology (IRJET) ISSN:2395-0056

This paper mainly focuses on IoT. How the IoT based Octoprint provide web interface for Controlling 3D printer. And a way to use 3D printers remotely.

3. Design of a Three Axis Robotic System and its implementation as a 3D printer by Akash Sali , Kushal Patel, Vrishtee Rane, Pradeep Patel 04,April-2016

Published in International journal of engineering Research & Technology ISSN:2278-0181

This paper gives a complete insight on the systematic procedure required to be followed for design of a three-axis robotic system and its implementation as a 3D printer. The mechanical structure of the system is designed based on dimensional and load carrying requirements. The system is equipped with a suitable material extrusion system along with a control system that allows its use as a 3D printer based on the principle of fused deposition modelling.

4. A review paper on 3D printer Aspect and various process used in 3D printing by Vinod G. Gokhare, Dr. D. N. Raut, Dr. D. K. Shinde

Published in International Journal of Engineering Research and Technology (IJERT) ISSN:2278-0181

This is a research paper on 3D printing and the various materials used in 3D printing and their properties which become a notable topic in technological aspects. This paper also talks about the advantages and disadvantages of 3D printing.

I. Objective

The main objective of this 3D printer is to print an object using a variety of printing materials like Acrylonitrile butadiene styrene (ABS), Nylon (polyamide) Filament, Polylactic acid (PLA), Flexible Metal (30% Metal + 70% PLA) combination, (30% Wood + 70% PLA) combination, etc.

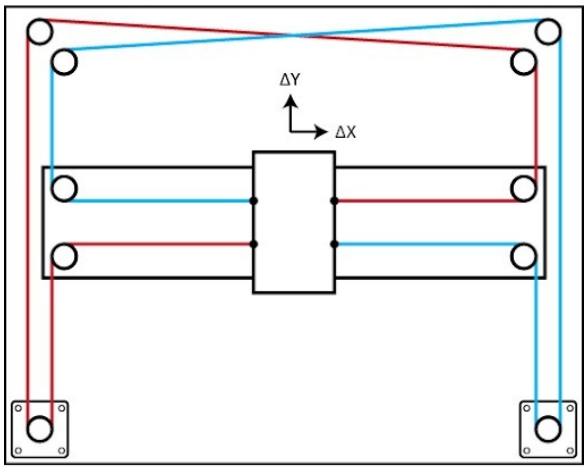
Using guide rails over the linear rods for smooth and effective XY axis motion. Also, by using Auto-Bed smart technique for proper and distort free deploying of materials, layer by layer in an effective way. By using IoT, the printer will print things remotely and monitor the printer's work with the help of Marlin firmware. This printer will print larger objects than the traditional printers which are available in the market.

II. Principle

Motion Configuration in 3D printer: There are many types of motion configuration as follows: Delta configuration, SCARA configuration, Polar configuration, and Cartesian configuration. While the CoreXY configuration is used here.

CoreXY is a very complex configuration where two long drive belts are winded around a series of idlers. These idlers connect both motors to both sides of the hot end or tool head. So, if one end of the belt is pulled manually, the tool head moves diagonally at an angle of 45 deg. But in the case of standard cartesian configuration, it will move with 0 deg or 90 deg.

Due to its design and structural configurations, it has many advantages over other 3D printers. One of the biggest advantages is that it leaves behind no artifacts while printing because the printing speed is more as there are no moving parts compared to other 3D printers. In CoreXY, the motion of the print bed is in vertical direction, i.e. in Z-axis and all the stepper motors are fixed. The extruder or tool head is the only part that is moving at a considerable speed with appropriate mass, causing significantly very little vibration.



CoreXY Mechanism

ΔA=Δx+Δy--------1

ΔB=Δx-Δy---------2

Δx=-Δy+ΔA, Δx=Δy+ΔB

ΔA-Δy=ΔB+Δy

ΔA-ΔB=Δy+Δy

ΔA-Δ**B**=2Δy

Δy=1\2(ΔA-ΔB)

Δy=-ΔA-Δx, Δy=Δx-ΔB

ΔA-Δx=Δx-ΔB

ΔA+ΔB=Δx+Δx

ΔA+Δ**B**=2Δx

Δx=1\2(ΔA+ΔB)

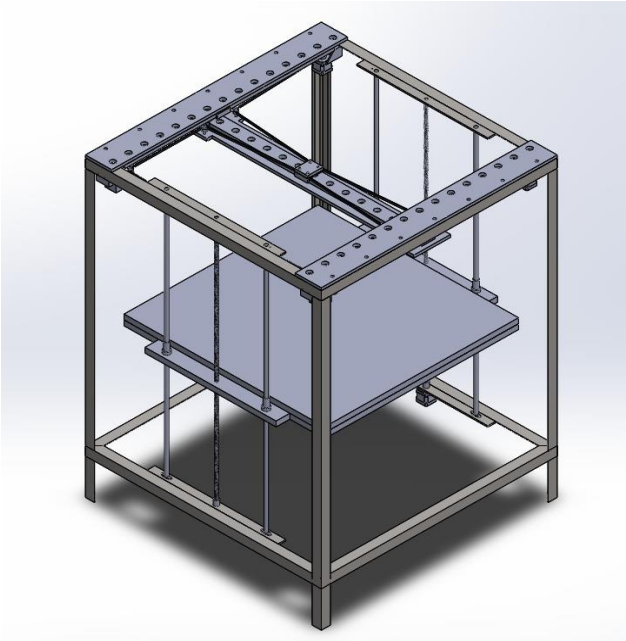
These two equations are the direction of motion in X and Y direction.

III. Design and Modelling

The actual design model of the 3D printer was carried out on software. The development and fabrication involved the consideration of many processes and parameters. However, keeping the print volume as the basic parameter of the design process. The main objective of our project was to

fabricate a 3D printer of print volume (600*600*600) mm^3. Further, the configuration used here is a CoreXY configuration, which involves a 3-dimensional motion. This 3-dimensional motion is achieved by four stepper motors. Among which the two stepper motors are used for XY direction, one for the Z-axis movement and one for the hot end. The printer bed on which the heat bed is mounted is driven by the lead screw, which is connected to the motor. This virtual representation and conceptual design were initially visualized in Solidworks software.

CoreXY



Final Assembly

IV. Hardware Selection

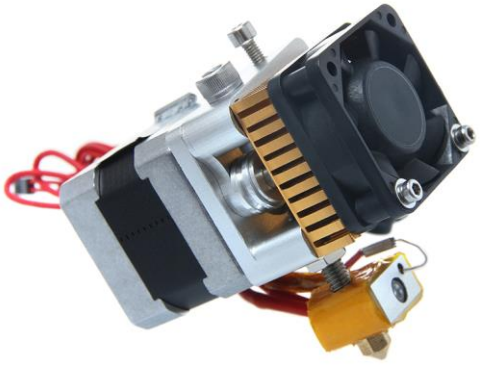
1. MKS Base

Arduino Mega 2530 is used here as the controller board. It acts as the brain of a 3D printer fully loaded with an all-in-one electronic solution for Reprap. It has 5 motor outputs powered by a Stepper driver. Works on a power supply from 12V-24V. Arduino Mega 2560 is compatible with all Ramps class firmware. However, The firmware being used here is Marlin. This four-layered PCB is optimized for heat dissipation.

2. Stepper Motors:

A stepper motor is a brushless DC electric motor that divides the full rotation into a number of equal steps. We have utilized stepper motor to move the bed carriage and different gatherings individually in their X-axis, Y-axis and Z-axis. Nema 17 and Nema 23 are the stepper motors used here.

3. MKK8 Extruder

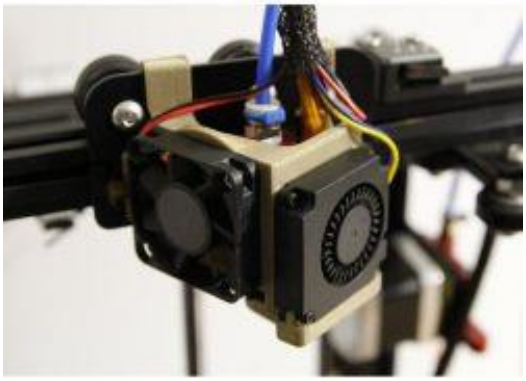


Extruder is a device that is used to extrude the filament on the heated bed to form the shape as specified by the program. Extrusion nozzle size used here are 0.4 and 0.8 as per the requirement. This Extruder and heating nozzle work on the power supply of 12V.

4. LCD Display

This is a full graphic display of 128*68 with an SD card base on back. Which directly selects a file and prints. This LCD controller is fully supported by Marlin Firmware.

5. Layer cooling fan



This fan cools off the plastic right away when it's deposited by the nozzle.

6. Temperature Sensor

Thermistor is 3D printer functions as a temperature sensing device. Thermistor are place for determining the temperature of hot end and heat bed. 100K thermistor is used here.

7. Heat Bed

Heat bed is attached to the printer bed. Its main functions is to cool 3D printed materials in more effective or controlled way.

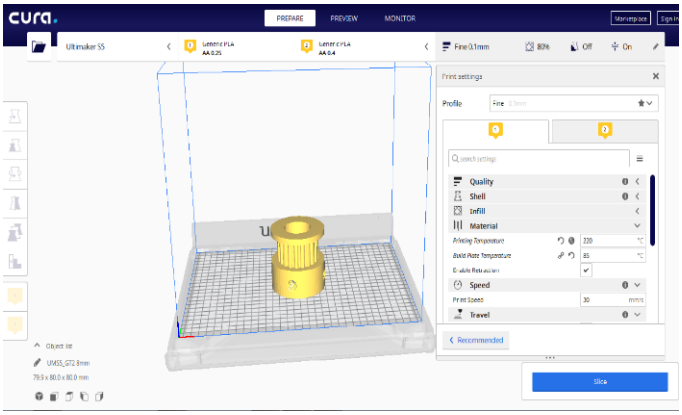
8. Bed Levelling sensor

It is a type of levelling sensor which accurately sense the misalignment in the print surface. It improves the building quality of 3D printer.

V. Software

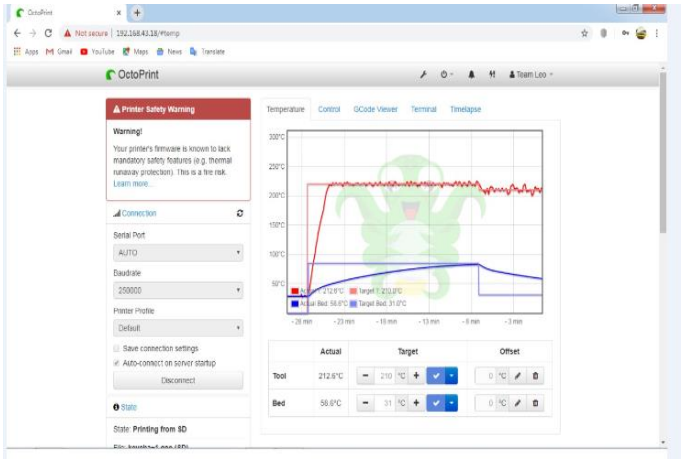
For printing the material two type of software are been considered, one is required to control 3D printer remotely and the other software is used to create G-CODE of the component to be printed.

1. CURA



It is an open-source software, probably the most widely used in the global additive manufacturing. Cura is the advanced 3D printer slicing software. It is used for modifying desired parameters for printing. At first the 3D model or CAD model is saved as in STL file format. This STL file is opened in slicing software. CURA slices the model ready for print, also gives us the freedom to change the parameters like quality, infill, shell, printing Material, speed, travel, etc.

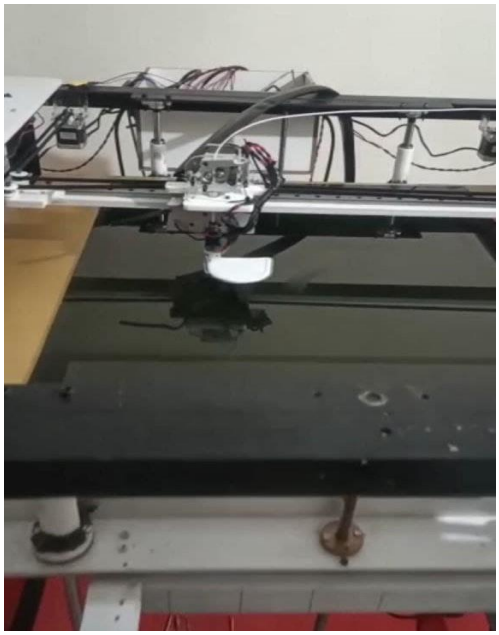
2. Octoprint



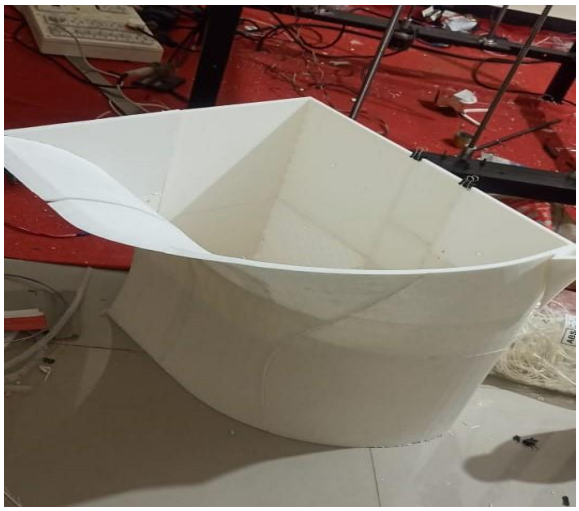
Octoprint is an open-source software. A web interface, which allows the user to control and monitor every aspect of the 3D printer and to print jobs right from the comfort of their home through the browser. Also, one can keep a watch remotely on their printer work through the embedded webcam placed on the 3D printer, which helps to get a constant feedback of the printing process. By Octoprint, one can keep an eye on the temperature of hotend and printer bed and also allows user to start, stop or pause the current print job.

VI. Results

Fabricated Machine



Printing Layers



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Printed Parts

VII. Conclusion

This paper shows that we are creating this machine for industrial applications, as bigger objects cannot be printed using small traditional 3D printers that are available in the market. Fdm technology is the cheapest technology that can be used in the 3D printing industry for the manufacturing of rapid prototyping products. Using this technology, we can create large-size products within a single piece without multiple joins. Till now whatever the machine assisting in the market has Linear rods but for the transfer of the motion, we are using Guide rails which can provide effective motion of CoreXY, and also provide accuracy in a printing job. Then in the Z-axis, we are using 10 mm of the lead screw which provides stability to our machine while moving in the Z direction. The most important thing which we are using in this machine is we are using a CoreXY configuration which provides an 80% accuracy to a machine to prevent slippage of the belt. IoT will play an important role in the automation of a machine i.e., octoprint will allow the user to control every aspect of the 3D printer and to print jobs right from the comfort of their home. Our main objective is to create this machine to meet the industrial requirement.

Acknowledgement

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