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3D PRINTING MACHINE

A FACTORY AT YOUR DESK

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Abstract: 3D printing is an additive manufacturing technique where the 3D parts are made with the addition of multiple layers on of others with the help of CAD software. The printing can be done with the help of different procedures like SLS (Selective Laser Sintering), LOM (Laminated Object Manufacturing), SLA (Stereolithography), etc. 3D printing machine have 4 axes in which 3 axes are X, Y, Z, and the fourth one is an extruder. The process adopted by us is FDM technology in which different materials such as ABS, HIPS, PLA, etc. can be used. By heating the filament material to its melting point and laying it layer by layer. A combination of multiple layers on top of the other will give the required 3D object. In this project, we explore AI monitoring of the FDM-build process with custom 3D printer equipment and both third-party and custom firmware software. We also theorize on the future of smart monitoring.

Keywords: 3D Printing, Rapid Prototyping, FDM, SLA, SLS, AI Monitoring.

I. INTRODUCTION

Rapid Prototyping is a procedure of taking a computerized 3D model and transforming that advanced document into a physical object. Manufacturing across the globe is utilizing 3D printing as an approach to decrease costs, spare time, and deliver better items. By never again expecting to outsource the prototyping of parts, organizations can easily repeat upon plans on the fly, as a rule sparing a long time of sitting tight for outsiders to return molds or models. From car makers to hardware organizations and anybody in the middle of it, 3D printing is an important innovation. Effective and precise generation of models or low-volume items can lessen an opportunity to market and increment item flexibility. This 3D printing technique is used by the manufacturers like aerospace, automotive, medical, dental, etc. due to the accurate and efficient production of models.

II. LITERATURE SURVEY

3D Printing was concocted by Charles W. Hull in 1986, it is an added substance manufacturing system in which advanced 3D show is changed over document into a physical object. Frame's creation mostly focused on a manufacturing procedure called Stereolithography (SLA). Since that time various other 3D printing advancements have been produced, for example, Stereolithography (SLA), Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Poly Jetting and others, all of which depend on layer-by-layer manufacture and depend on a G-code encouraged to the printer. While various advancements can be utilized to 3D print a question, the larger part of 3D printers one will discover inside a home or an office setting depends on the FDM or SLA forms, as these advancements are presently less expensive and less demanding to actualize inside a machine.

HISTORY

The first record in 3D printing with the addition process was made by Japanese designer Hideo Kodama in 1981. He developed a product that used ultraviolet lamps to strengthen polymers and to make solid materials. Charles Hull invented stereolithography, a process similar to 3D printing that uses technology to create smaller types of objects. The seeds of 3D printing began to take root in the 1980s and have now evolved into a set of different technologies that could eventually change the concept of the production process in various fields. Fused Deposition Modelling (FDM), developed by Scott Crump, is the most common form of 3D printing today. It allows you to do anything by simply creating a computer file. Generally,

according to the size of the printers, can be divided by desktop.

III.METHODOLOGY

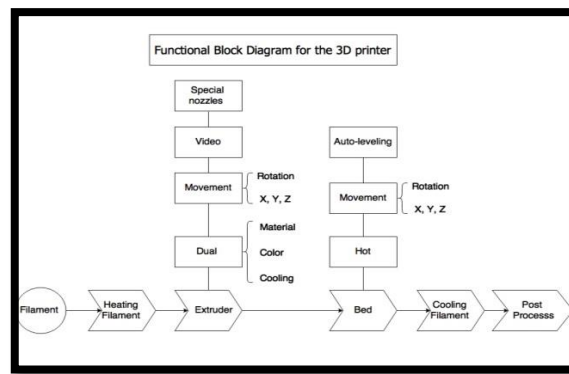


Fig 1.0 Functional Block Diagram

This proposed system begins with a visualization of the structure of the object you want to build. The visual design is used as a template for a visual object to be constructed. The basic premise of FFF technology is to extract the molten material with a microcontroller and insert it into the parts in a defined way.

In extrusion-based 3D printing, the supply method of the material can be in the form of tablets and thread. If the feed is in the form of a thread. PLA and ABS thermoplastics are widely used. FFF/FDM printer content starts as computer-assisted design (CAD) files. Before an item can be printed, its CAD file must be converted into a 3D format that can be understood that is in STL format, printers use two types of building materials, modelling, finished materials, and support materials, which act as scaffolding to support the object as it is being printed. During printing, these materials take plastic strings(filament), or threads, which are opened from the coil and inserted into the extrusion tube. The microcontroller melts the fibers and extends them to the base, Both the mouth and the base are controlled by a computer that converts the size of the object into an X, Y, and Z. This thin layer of plastic cools and hardens, quickly binding the layer below it. Once the layer is finished, the base is lowered. Printing time depends on the size of the item being produced. Smaller objects: a few inches cubic and tall, thin: objects print quickly, longer: more complex objects take longer to print. Compared to other 3D printing methods. When an object is already an FFF/FDM printer, its support items are removed and Items can also be sanded, milled, painted, or covered to improve their performance and appearance. The following flow chart shows the methodology used by us in the construction of a 3D printer. The first step is to select one of the additive manufacturing processes among many processes. Then an appropriate mechanism is been used for X, Y, and Z-axis movements, considering various calculation such as cost of fabrication, easy of design, synchronization, accuracy, etc. Once a 3D demonstration is composed, the document (these generally have augmentations, for example, 3MF, STL, OBJ, and so forth.) must be changed over into G-code. G-code is a numerical control script utilized basically for PC-supported assembling (both subtractive and added substance fabricating). It is a dialect that advises a machine how to move. Software such as Slic3r is required to change over 3D show records into G-code. Once the G-code is made it can be sent to the 3D printer, giving a diagram regarding what its next to a few thousand moves will comprise of. These means all indicate the total creation of a physical protest. There are other scripts out there and maybe many will in the long run pick up fame, yet until further notice, G-code is by a wide margin the most critical.

IV. Various Methods in 3D printing

Different strategies are there to make a model. These strategies are utilized given the many-sided quality of the plan, the material utilized as a part of the plan, the motivation behind the and software then the machine is designed and fabricated. The last step is the synchronization of mechanical, electrical, and software elements of the machine. They are as per the following: mechanism is selected the next step is the integration of electronics.

1. Stereo Lithography –

Stereolithographic 3D printers (SLAs) position a per stage just beneath the surface of a vat of fluid photograph treatable polymer. A UV laser shaft at that point follows the in the first place cut off a question on the surface of this fluid, making a thin layer of photopolymer solidify. The punctured stage is then brought down somewhat and another cut is followed out and solidified by the laser. Another cut is at that point made, and after that another, until the point when a total model has been printed and can be expelled from the vat of photopolymer, depleted of overabundance fluid, and cured.

2. Fused Deposition Modelling (FDM) –

It is a procedure by which a machine stores a fiber (or wax), to finish everything with the same material, keeping in mind the end goal to make a joint by warmth or attachment. Here a hot thermoplastic is expelled from a temperature-controlled print head to obtain high accuracy object at the end.

3. Selective Laser Sintering (SLS) –

The process builds the object with the help of a Laser to fuse the successive layers of wax, liquefied and compacted to consolidate the grains to acquire the last item. Once the model is cooled the abundance powder must be essentially brushed.

4. Laminated Object Manufacturing (LOM)-

In this method, the layered material is moved on a building platform. In this procedure, the adhesive-covered layers are stuck together by the warmed rollers and slice to the coveted shape with the assistance of laser layer by layer. A roller with the material moves over each previous sheet and repeats the same procedure until the model is finished.

V. Applications of 3D Printing

While at first 3D printing was principally an innovation for prototyping, this is rapidly evolving. Presently various makers are delivering end-utilized parts and whole items using added substance fabricating. From the aviation industry to medical displaying and implantation, to prototyping of different sorts, 3D printing is being utilized in each Realtime industry on the planet. Rather than depending on 2D and 3D pictures on a PC screen or a printout, specialists can touch and feel physical copies of the patient's organs, bone structures, or anything that they are going to take a shot at 3D printed models of human organs have been a regular instrument for specialists in the course of the last few years, as they give a more multifaceted perspective of the current issues. Furthermore, there is inquire about progress by many organizations to 3D print fractional human organs, for example, the liver and kidney of human beings. Throughout the following decade, it's part. when the whole layers are framed by flying, to get uniform thickness a processing head has disregarded the layer.

The 3D printer present in the lab, intensively used by the local students and researchers with recognized success, raised the interest of other users, including non-faculty members. This led to providing the printer with online access to allow multiple users to start a print job and monitor its progress. This facility differs from online 3D printer platforms such as Shape ways since it allows direct access to the 3D printer, letting the user have total control of the printing process.

The basic needed functionalities for such remotely operated/monitoring process include the possibility to turn the printer on/off, to upload a print job, to access the printer memory and to stream a real-time video of the process.

The Octo-Print is the chosen solution. It is based on a webserver provided with the easy interfaces for the 3D printer, video camera and relays module. The connection diagram of the implemented solution. The chosen solution uses commercially available hardware and open-source software. The webserver is based on a Raspberry Pi running an open-source application, the Octo-print. This application (Oct-Print) is a host software that can be used with multiple 3D printers providing a web interface to remotely manage and control the printer.

This open-source software tool satisfies the identified needs to remotely operate the 3D printer. Among the provided functionalities, the main ones are: start, pause and stop print jobs, monitor temperature of the printer bed, and extruder, watch the printing. Having an open-source software, there is a large community behind, developing upgrades and plugins. Some of them are like a history list, a STL viewer, a status line and a custom command editor, which gives the control to add custom controls like turn on or off the printer power supply. The implemented solution uses a Raspberry Pi 3B module as a webserver running the Octo-Print under the Octo-Pi operating system. The Octo-Pi operating system is based on the Raspbian. Via USB ports of Raspberry Pi, the 3D printer and a standard webcam are connected to the webserver.

Another feature of this software is the configuration of three different access levels for the users. The Unknowing users can only have access to the read-only data from the web interface. Logged users can start a print job having access to all data, exceptional the settings and the system commands that are the privilege of the administrators.

VI. Design of 3D Printing

Figure 1.2 demonstrates the, rendered perspective of the CAD model of the instrument for development in every way. The Three-Dimensional movements are accomplished by synchronization of developments in X, Y, and Z direction. The Extruder nozzle is the main part of the printer in which the plastic which is in the form of filament melts and prints on a heated bed. The main goal of the instrument is to make sure that this extruder nozzle will have the capacity to print anyplace inside the predetermined print volume. This component utilizes 3 stepper motors, one for X-axis development (Lateral development or Left-Right development), one for Y-axis development (back and forth development), and one for Z-axis development (Vertical development). This component utilizes a single-engine to control 4 lead screws to which the print bed is associated for the development in the lead screws are driven by the engine which thus moves the bed vertical way. For the development in the Y-axis direction, two separate motors are utilized to move two separate carriages. Two motor have been utilized here because the print volume is huge, there will be a disturbance in development if just a single motor is utilized. For littler print volumes, a single motor might be adequate. For the event is coordinate axis direction of one motor is employed that is mounted onto the carriage that moves in coordinate axis bearing. The point-by-point working and outline of the system in particular ways are clarified in additional areas. This system is intended for exactness, the stepper motors utilized is having the determination of 0.360, i.e., 1000 steps per revolution which provide high precision, the mechanism used for movement in Z-axis provides precision, control, and easy synchronization.

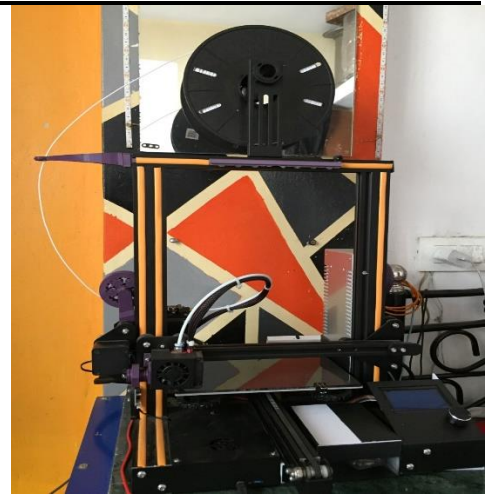


Figure 1.2: Model of the Printer

VII. Implementation

Manufacturing and implementing the look in real world is that the method that starts from obtaining the primary part that is that the frame, aggregation mechanical, electrical and management systems, to obtaining the ultimate product as follow:

The following step is that the mounting linear bearing, axes linear shaft and linear bearing shaft support. the linear bearing, that has (4.5mm) bore diameter, is mounted to X Z axes linear shafts that has constant shaft diameter, then holding linear bearing shaft supports (4.5 millimetre bore) to frame. Then mounting the mixture of linear bearing and axes linear shafts to linear bearing shaft supports as shown in Figure three. This method will calibrate exactly to result in two parallel facing axes linear shafts to satisfy linear bearings slippery motion. The solid components as shown in Figure four area unit formed in a selected form and dimensions to satisfy the style necessities. Such requirements like fixing stepper motors with frame to carry the 3D printer extruder, Y axis linear shaft and warmth (Print) bed. The stepper motors and mechanical transmission systems installation area unit shown in Figure five. The X Y Z stepper motors installation method had done by mounting these stepper motors to border victimization a specifically style solid elements

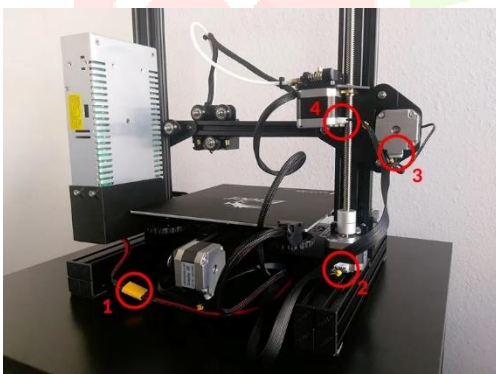


Fig 1.3: - Electrical Connections

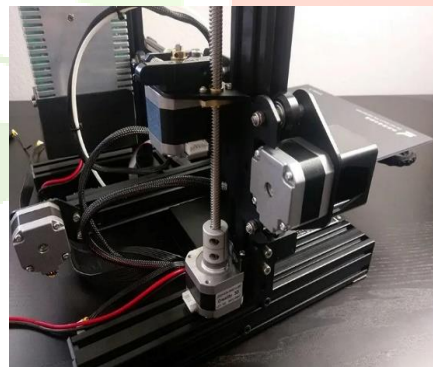


Fig1.4: - Solid Components

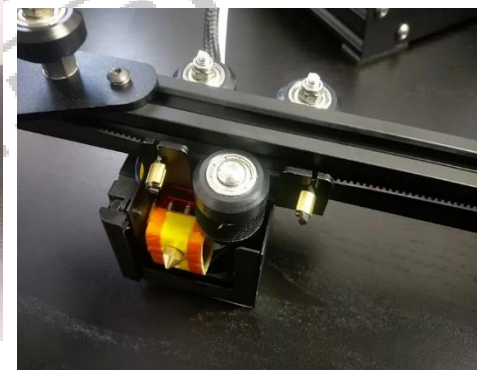


Fig 1.5: - Hotend - X-

Axis

After that the installation of the limit switches to 3D printer body is realised. The minimum position limit switches are put in to 3D printer body as shown in Figure ten. The switch is used to indicate the point that any printing process starts from (Homing position or minimum position). This installation method plays a significant role in limitation of printing space

dimensions, since the position of axis perhaps taken relative to minimum limit switch which can be defined in firmware or by installing another limit switch to indicate the maximum position.



Fig 1.6: - Trigger Switch

Finally, the mounting the extruder and hot bed is distributed. The extruder and heat bed can be mounted in different ways and to different axes. The extruder and heat bed are often mounted completely different in several or numerous ways two different axes. Within the given style the extruder is mounted to Y axis and the heat Bed is mounted to the Z axis as shown in Figure 1.7



Fig 1.7 Heat Bead

VIII. 3D Printer Controlling and Monitoring

The first step in controlling the 3D printer for operation is uploading the code to Arduino Mega 2560 controller by using the Arduino Integrated Development setting (Arduino IDE) laptop code. This code can be managed by the 3D printer systems. After uploading code to the controller, it is easy to communicate with 3D printer. Using Liquid Crystal Display (LCD) as a controller interface, as shown in Figure 1.8 is used as secondary methodology to communicate and show the most necessary printing parameters of 3D printer



Fig 1.8 Display and Controller

IX. OctoPrint

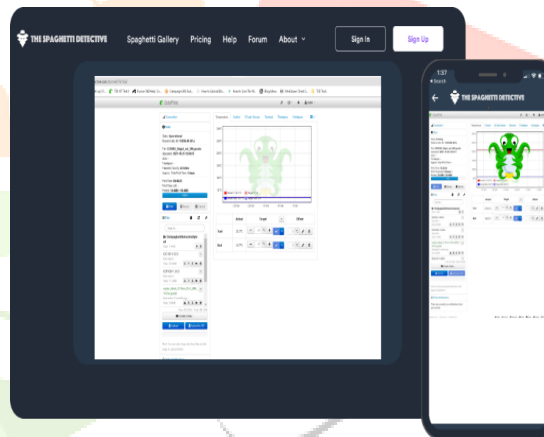
OctoPrint, created and launched in 2012 by German software engineer Gina Häußge, it is to become one of the top remote, management, monitoring, and control software applications of our 3D printer. The ease of use and simplicity of the software are the primary reasons for many adopters, and the features and functionality have for long-life users. Monitoring a print is difficult if you and your printer are not in the same room. Most of us keep the printers in a separate room, such as your basement, and your workspace is in another room. In such cases, you are busy to the printing room due to an ongoing print, and sitting and watching the whole process. OctoPrint is an open-source software program that runs on the Raspberry Pi. It connects to your 3D printer via a USB cable and easily takes control of it. It is used to control and operate the 3D printer by sending commands. The commands simply represent the g-code files generated by the slicer software. It also represents almost all of the time-consuming and inefficient work required to print a part. In short, when Raspberry Pi is connected to your 3D printer, OctoPrint removes the hassle of leaving the print unattended. It allows you to control the print from the condolence of your workspace and keep the printer in your basement, attic, or anywhere else in the world and have a part printed.

X. Wireless 3D printing

The actual process of downloading g-code files to your SD card and uploading them to your 3D printer is time-consuming, the back-and-forth is when you want to print a new design/model. And then back again to the slicer if the file requires any further changes. This is fatigue, and it may cause you to lose interest in the technology itself. So, to overcome this just installed once on the Raspberry Pi, the OctoPrint software allows you to wirelessly send g-code files to your 3D printer. You can control your printer wirelessly, modifying and monitoring all of its parameters such as temperature settings, fan speeds, part orientation, and so on. With this OctoPrint wireless 3D printing has ability that you can stay in touch with and control your 3D printer over the local network.

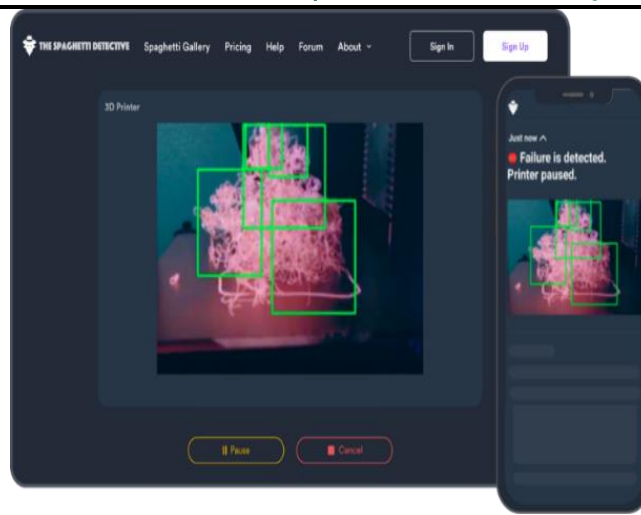
XI. Monitor your 3D printer with a webcam

Monitoring a 3D printer from away from desk can become a bit troubleshoot when you are not able to see the printing operation. You may even become worried because you are not in close proximity to it. However, OctoPrint, has a great solution to this problem in the form of connecting a webcam to the printer. Using the webcam, you can see the live streaming of the printing operation from anywhere using the webcam.



XII. Early Failures Catch - Save Time and Money

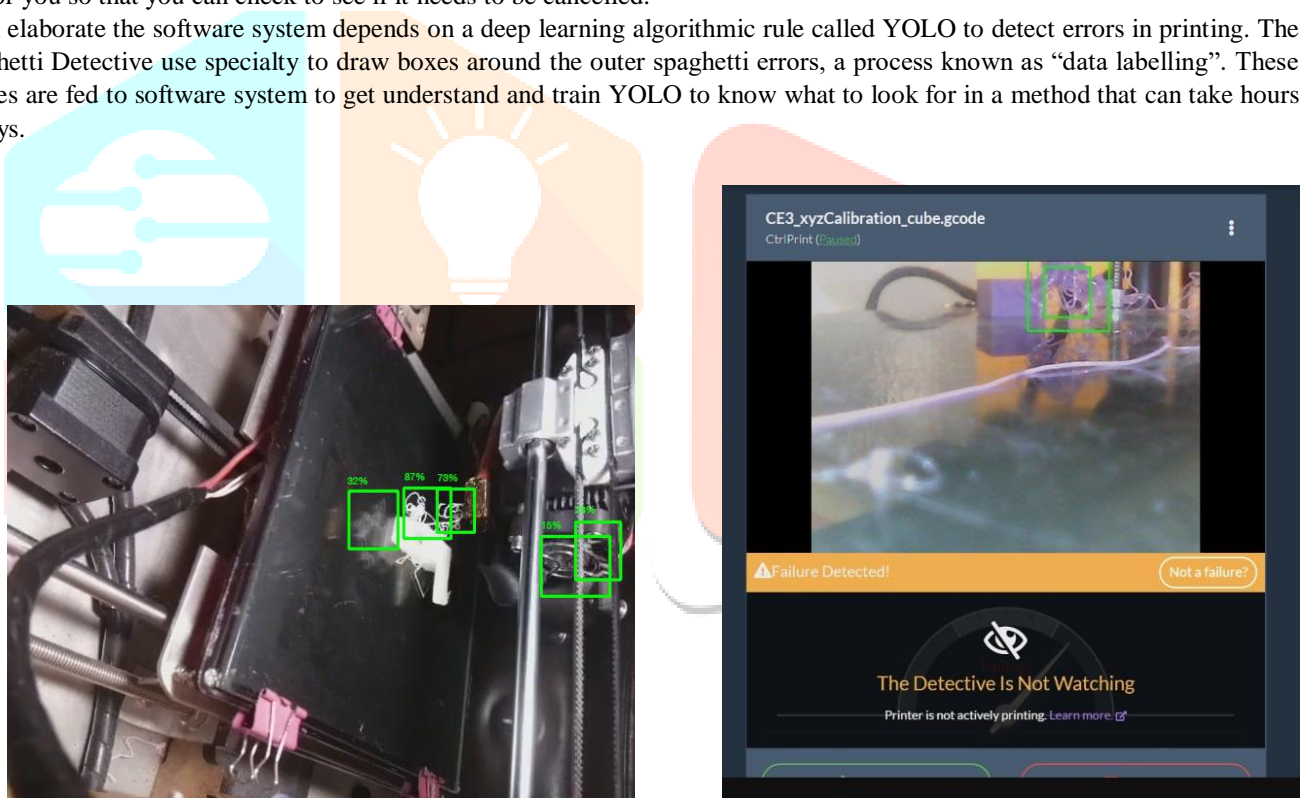
OctoPrint plugins has the power of Spaghetti Detective have created AI-powered error detection algorithms to detect and take corrective actions to avoid fire hazards or other printing issues such as Spaghettis. The Spaghetti Detective doesn't just let you monitor and control your printer from anywhere, it will even watch your printer for you, alert you if something goes wrong while printing, or even stop the print for you entirely!



XIII. The Spaghetti Detective

The Spaghetti Detective is a plugin for OctoPrint, which is the most popular 3D printing monitoring programs. OctoPrint runs on a Raspberry Pi, and have the ability to remotely control your 3D printer and view a live video feed as it runs. But, with OctoPrint standalone, you still have to actually check that video feed frequently to make sure that is anything is wrong with the print job. The Spaghetti Detective plugin uses a deep learning AI model to automatically detect print failures, and will pause the job for you so that you can check to see if it needs to be cancelled.

As in elaborate the software system depends on a deep learning algorithmic rule called YOLO to detect errors in printing. The Spaghetti Detective use specialty to draw boxes around the outer spaghetti errors, a process known as “data labelling”. These images are fed to software system to get understand and train YOLO to know what to look for in a method that can take hours to days.



The software system seems to be so powerful that it can catch errors in printers not meant to be in its line of sight. Across the various additive manufacturing (AM) technology families, 3D printing is evolving to become pure repeatable and quality controlled. For industrial systems, this might mean incorporating Sigma Labs’ Print Rite3D quality assurance software into the metal powder bed fusion system to reimburse for distortions in a printed process. For desktop 3D printers, it’s another story. There isn’t the same commercial being undertaken to automate and improve the quality control of cheap extrusion systems. Automated bed levelling is now a more standard feature or “professional” desktop 3D printers. Built-in filament storage dryer from some companies is meant to improve the quality of the material. Some machines include automatic stop printing option for failed prints.

XIV. Conclusion: -

The availability of the 3D printer software on the Internet is found to be of great value for monitoring and controlling the printer. It gains bigger stress once printing elements that take many hours. User enthusiasm is fostered by getting an effective proof of concept for their works, enabled them to reach higher goals in their theses and so the standard increased results, in general, and within the experimental results, too.. This machine is intended for accuracy. Utilizing a solitary motor for vertical development makes Bed leveling easy and the bed development can be observed with determination in microns. In some machines, the extruder nozzle is made to move in Z-axis direction, and the bed is made to move in Y-axis direction, these mechanisms face the problem of mutilation if written components whereas printing at high rates thanks to the quick development of bed in Y-

hub bearing. Of printed parts while printing at high rates because of the fast development of bed in Y-hub bearing. Other constraints are inherent to the printer: the lack of an automatic system for filament material exchange and for removal of printed parts. The outcome of this paper was to build a portable 3D Printer which has been completed. The design of the frame is made compact and strong using aluminum sections. The selection of the material depends on the economical strategies. The use of the single motor for vertical movement along with a proximity sensor makes bed leveling uncomplicated and the bed movement is monitored with resolution in microns. The drawback in few of the 3D Printer that uses bed movement.

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