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Recent Trend of 3D Printer in Manufacturing Industry

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Abstract—*The Automatic 3D printing is a form of additive manufacturing technology where a three dimensional object is created by laying down successive layers of material. It is also known as rapid prototyping, is a mechanized method whereby 3D objects are quickly made on a reasonably sized machine connected to a computer containing blueprints for the object. The 3D printing concept of custom manufacturing is exciting to nearly everyone. This revolutionary method for creating 3D models with the use of inkjet technology saves time and cost by eliminating the need to design; print and glue together separate model parts. Now, you can create a complete model in a single process using 3D printing. 3D Printers are machines that produce physical 3D models from digital data by printing layer by layer. It can make physical models of objects either designed with a CAD program or scanned with a 3D Scanner. It is used in a variety of industries including jewellery, footwear, industrial design, architecture, engineering and construction, automotive, aerospace, dental and medical industries, education and consumer products.*

1. INTRODUCTION

Printing or additive manufacturing is a process of making three dimensional solid objects from a digital file. In an additive process an object is created by laying down successive layers of material until the object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object. 3D Printing is the opposite of subtractive manufacturing which is cutting out / hollowing out a piece of metal or plastic with for instance a milling machine [1-4].

The initial 3D printers were used in the 1980s where a pattern submerged in a liquid polymer would be traced by a computer. The traced pattern hardened into a layer, thanks to the laser, and that was how you built an object out of plastic [5-7]. Since then tremendous progress has been made in additive manufacturing such that material extrusion is now used. By this method, an object is built out of matter that is pushed from a mechanical head like the way an inkjet printers extrudes ink onto paper [8].

Interestingly, the cost of acquiring 3D printers has been decreasing with the advancement of technology. Domestic usage of 3D printers has been on the rise with the average cost ranging from a few hundreds of dollars going up. However, one major drawback is that it requires expertise to print 3D objects [9-10]. In fact, it requires a competent person to make both the digital file and the final printing. Commercial usage of 3D printers has been on the increase too [11] in sectors such as the automotive industry and aerospace engineering. Spare parts, for example, are being made in the automotive and aero-space industry leading to improved economies of scale. 3D printing is changing how the production line in industries works which made some analysts to dub the emergence of 3D printers as the second Industrial revolution.

It all starts with making a virtual design of the object you want to create. This virtual design is made in a CAD (Computer Aided Design) file using a 3D modeling program (for the creation of a totally new object) or with the use of a 3D scanner (to copy an existing object). A 3D scanner makes a 3D digital copy of an object. To prepare a digital file for printing, the 3D modeling software "slices" the final model into hundreds or thousands of horizontal layers. When the sliced file is uploaded in a 3D printer, the object can be created layer by layer. The 3D printer reads every slice (or 2D image) and creates the object; blending each layer with hardly any visible sign of the layers, with as a result the three dimensional object [12].

3D Printing enables to produce complex (functional) shapes using less material than traditional manufacturing methods. The rest of the paper is organized as follows. Objective of work explained in section II. Experiment Tool and results are presented in section III. Advantages are discussed in section IV. And concluding remarks are given in section V.

2. OBJECTIVE OF WORK

1. To implement additive manufacturing
2. To increase the rapid prototyping technology
3. To design and manufacture simple 3D printer
4. To provide low cost 3D printer to the society
5. To make 3D printer as a domestic product
6. To reduce the casting process and time in industries

3. EXPERIMENT TOOL AND RESULTS

This research works on an "additive" principle by laying down material in layers; a plastic filament or metal wire is unwound from a coil and supplies material to produce a part. The process begins with a software process which processes an STL file (stereo lithography file format), mathematically slicing and orienting the model for the build process. If required, support structures may be generated. The machine may dispense multiple materials to achieve different goals: For example, one may use one material to build up the model and use another as a soluble support structure, or one could use multiple colors of the same type of thermoplastic on the same model. The model or part is produced by extruding small flattened strings of molten material to form layers as the material hardens immediately after extrusion from the nozzle. The different components of this work are explained as follows:

3.1 Controller Board - The controller board as shown in figure 1, also referred to as the motherboard or mainboard, is the brain of the 3D printer. It's the one responsible for the core operation, directing the motion components based on commands sent from a computer and interpreting input from the sensors.

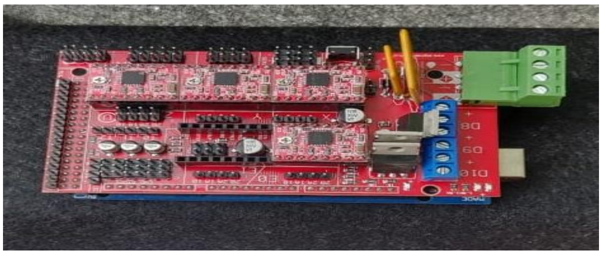

Figure 1: RAM of 3D Printer

3.2 Filament - The filament as shown in figure 2 is the material used to print objects on a 3D printer. It's the equivalent of the ink used on a regular office 2D printer. It comes in a spool, which is loaded into the spool holder of the 3D printer, with the end of the filament inserted into the extruder. There are different kinds of filaments, each with their own properties and pros and cons. When it comes it filament compatibility, not all 3D printers are on the same level.

Figure 2: Filament of 3D Printer

3.3 Frame - The frame is the chassis of the 3D printer. It holds the other components together and is directly responsible for the stability and durability of the machine. These days, 3D printer frames are made of either acrylic or metal, but in the early days of consumer-level 3D printers, wood is often the go-to frame material.

Figure 3: Frame of 3D Printer

3.4 Motion Components - The motion components are the parts responsible for the movement of the 3D printer in the three axes. They are the ones that move the print bed and the print head. Basically, the controller board directs how the 3D printer should move while the motion components are the ones that do the actual moving.

3.4.1 Stepper Motors - The stepper motors, which are run by stepper drivers, are the keys to the mechanical movement of a 3D printer. Stepper motors are connected to all three axes and drive the print bed, the print head, and the threaded rods or lead screws.

Figure 4: Stepper Motor

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3.4.2 Belts - In a Cartesian 3D printer, the belts, which are connected to motors, move the X-axis and the Y-axis from side to side and are integral to the overall print speed and precision. In a delta 3D printer, belts are often used to drive the movement on the Z-axis.

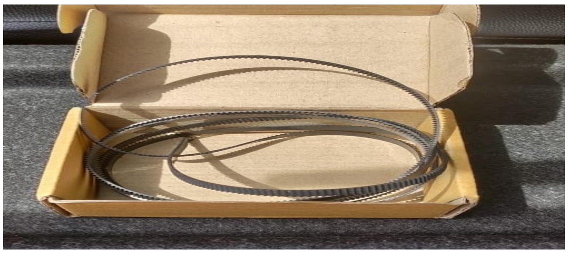

Figure 5: Belt for 3D Printer

3.4.3 End Stops – Simply put, end stops are like markers that allow the 3D printer to identify its location along the three axes, preventing it from moving past its range, which can result in hardware damages. While many 3D printers use mechanical end stops, there are also those who use optical end stops.

Figure 6: End Stops for 3D Printer

3.4.4 Threaded Rods - In the Z-axis, the movement relies on threaded rods, which are also connected to stepper motors. As the threaded rod rotates, the print head moves up or down. Threaded rods or lead screws can also be used to the drive the movement along the X and Y. But most 3D printers use belts because they are cheaper, lighter, and faster. On the other hand, threaded rods or lead screws offer more precision but are heavier and more expensive.

Figure 7: Thread Rod

3.5 Power Supply Unit - The power supply unit supplies power to the entire 3D printer. If you want to print with more advanced materials on a regular basis, make sure you have the right PSU for the job, as some are not built for high-temperature prints. Cheap 3D printers like the Anet A8 often come with an underpowered PSU good enough for PLA but not for ABS and other materials that need a sustained heating for an extended period.

Figure 8: Power Supply for 3D Printer

3.6 Print Bed or Heat Bed -- The print bed is where the extruder deposits the filament to form a solid object. Calling back to the 2D printer analogy earlier, the print bed is the equivalent of a piece of paper. It's either heated or non-heated, with the latter being common among starter 3D printers like the Flash Forge Finder and the Dremel Digilab 3D20. A non-heated print bed as shown in figure 9 is good enough for PLA, but for high-temperature materials, a heated print bed is a must in order to cut down on warping issues, improving the overall print quality.

Figure 9: Print Bed or Heat Bed

3.7 Feeder System - Cartesian and delta 3D printers use either a Bowden feeder system or a direct feeder system. In a Bowden setup, the cold end and the end are separate from each other, and by which we mean the cold end is placed in a different location on the frame. A Bowden setup uses a filament tube to direct the filament into the hot end. Due to the lighter load, the print head moves faster, which means you get faster prints.

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Figure 10: Feeder

3.8 ARDUINO MEGA 2560 - The Arduino Mega 2560 which is used in the work, is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 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 a AC to-DC adapter or battery to get started.

Figure 11: ARDUINO MEGA 2560

4. ADVANTAGES

Faster Production:- 3D printing is quicker than conventional manufacturing including injection moulds and subtractive production.

Easily Accessible:- The explosion of 3D printing interests has brought easier to use software and hardware to consumers as more competition has entered the space. ***Creative Designs and Customization Freedom***:- Making each design unique with these techniques is extraordinarily hard.

Unlimited Shapes and Geometry:- Old methods of manufacturing rely on moulds and cutting technologies to generate the desired shapes. Designing geometrically complex shapes can be hard and expensive with this technology. 3D printing takes on this challenge with ease and there's not much the technology can't do with the proper support material.

Can Implement Assorted Raw Materials:- Mass manufacturing doesn't support the blending of raw materials as it can be expensive. Furthermore, combining chemical and physical elements is complicated. 3D printing easily accommodates a diverse range of raw material including glass, metal, paper, ceramics, biomaterial, silver, etc.

Less Waste Production:- CNC cutting and injection moulding result in a lot of wasted resources. Both involve the removal of materials from solid blocks. Unlike these two, 3D printing only uses material that is needed to create a prototype part – no more, no less. Additionally, reusing the materials from a 3D print is relatively straight forward. As a result, additive manufacturing creates very little waste, and saves a company a lot of money.

Risk Reduction:- When it comes to product manufacturing, a good designer knows that proper design verification is crucial before investing in an expensive moulding tool. 3D printing technology enables product

This rapid development of open source 3D printers is gaining interest in both the developed as well as the developing world and it enables both hyper-customization and the use of designs in the public domain to fabricate open source appropriate technology through conduits such as Thing verse and Cubify. This technology can also assist unsustainable development as such technologies are easily and economically made from readily available resources by local communities to meet their needs.

5. CONCLUSION

The intention behind this research was to develop a low cost 3D Printer by using materials which are easily available and cost effective. We have been successful in reducing the cost to a considerable extent i.e about 10 to 15 %. The parts made in 3D design software are successfully imported in the printing software and the product obtained has the same dimension given during the design stage of the product i.e. an accuracy close to 100%.We were able to successfully fabricate the 3D printer according to its virtual design proposed at reduced cost. As 3D printers become more affordable, they will inevitably be used for local, small scale manufacturing, largely eliminating supply chains for many types of product. Consumer units for home use will even become feasible, allowing end users to simply download a design for the product they require and print it out. There will be major challenges for the conventional manufacturing industry to adapt to these changes. The opportunities for technology and engineering are clearly huge, however, and the creative possibilities in product design and printing material formulation are nearly endless. 3D printing enables you to turn a concept into reality faster than you can imagine. Products are built quickly and cheaply. The technology will no doubt continue to transform every industry, changing the way we work and live in future.

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