iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.42775

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

3D Printed Face Shield

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Abstract: ***In the fourth industrial revolution, a sort of printing technology that has the potential to transform the manufacturing industry is 3D printing. It takes just a few hours to develop a new product with this technology which might take days and months with traditional technologies. This research highlights a low-cost 3D printer's design and its working. The whole printer was developed to make it less expensive than similar products already on the market. The results show that low-cost printers with good accuracy can be designed.***
Keywords: 3D printing, Face shield, CAD Software, stereo lithography, fused deposition manufacturing.

I. INTRODUCTION

3D printing is a way of generating actual 3D products also recognized as additive manufacturing with the help of computer software without any human involvement. Often this technology is referred to as Rapid Prototyping as its function relatively quick producing a physical object from a CAD design model. This is an automatic manufacturing technique that can print an object of any shape with any material. This is achieved using additive processes in various forms, multiple slabs of components are placed down one top after one another. It is different from conventional engineering i.e. subtractive manufacturing in which an object is manufactured by removing unwanted material in form of chips but here additive manufacturing is used where an object is manufactured layer by layer without any wastage in any form. The object is printed from bottom to up in the form of layers in the exact shape and size as required.

This technology spawned a slew of other 3D production methods, like fused filament fabrication (FFF), SLS 3D printing, and so on. The best machine must provide many benefits in terms of cost, flexibility, parameters, processing time, etc.

We can print almost any shape and object without any problem. Also, printing is not limited to the material as they can print materials available in any form say solid, liquid, or powder. Recent developments in this field show that it is being used in fields like medicine to print biomaterials, automobile field to print automobile parts, aerospace industry, space industry, food industry, etc.

The most obvious benefit is that we save resources by eliminating the requirement to remove edges and increasing material use. It's also capable of finishing intricate patterns. It allows designers to construct pieces with a geometric and structural complexity that would be hard to manufacture using traditional methods.

Although this technology has numerous advantages it has one major problem: its cost. Cost is the biggest hurdle for this printer's application in many small and medium scale industries and also it is greatly related to the accuracy and reliability of the machine. The cost of a printer starts increasing as we aim for higher accuracy and reliability.

II. RELATED WORKS

A. Technological Advancements in 3D Printing: Review [1]

The authors of this study have outlined the numerous 3D printing technologies that have been employed since the early 1980s, as well as the hardware and software that have been used.[1]

B. 3D-Printing And Electronic Packaging [2]

This article examines the present state of 3D printing in terms of various processes and technologies, as well as their prospective applications in electronics production and packaging. The research also discusses design and modeling approaches, as well as how they might be utilized to better understand material behavior during 3D printing and reduce residual stress. [2]. The report then summarized the main obstacles that must be solved until 3D printing would become a widespread technology in the electronics sector.

C. Scheming 3D printing applications in the realm of architecture [3]

This study proposes two types of 3D printing equipment for use in the world of architecture design [3]. It may be achieved by doing a realistic design study in order to increase the speed and adaptability of printing technologies in the construction area.

D. Developing low-cost 3D printer [4]

In this paper, the authors describe the various 3D printing techniques that are generally used. They have devised a way to design a 3D printer at a lower cost by describing the various software and hardware components that can be used in the system.

III. METHODOLOGY

3D printing is a new way of making items directly with digital models utilizing a layer-by-layer component build-up procedure. We employs the Fused Deposition Modeling (FDM) process in this design, which allows us to create items out of production-grade thermoplastics. Objects are constructed by melting a thermoplastic filament and extruding it layer by layer through a nozzle. Digital designs are submitted to the 3D printer in FDM. A controller attached to the computer may move the nozzle both in horizontal and vertical directions. Layer by layer, the strands are heated and fed out onto the base. The material cools and solidifies as the nozzle advances across the base, producing a strong link with the prior layer. The nozzle head rises at this stage in order to deposit a further layer of plastic.

The first step of printing is creating the object design of the face shield and its headband. The design of the object can be made using Computer-Aided Design (CAD) for the machine to use as a guideline for printing. 3D printers read the design of the model and create the thing by laying down layers of material till the desired shape is achieved.

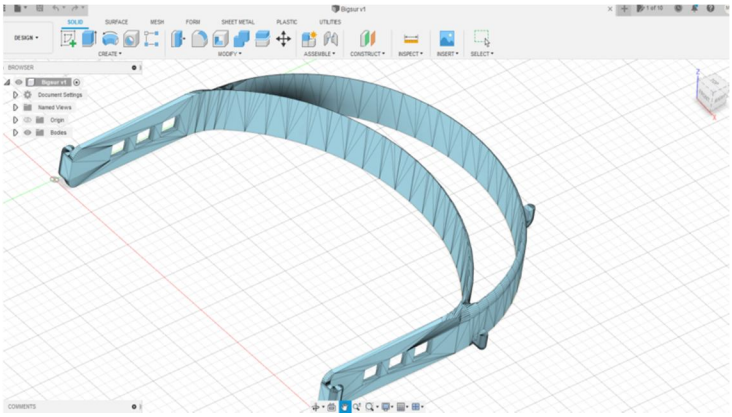

Figure 1: 3D model of face shield headband

The stereo lithography file type, abbreviated as "STL," is created by mathematically separating the surfaces of 3D-built objects into several triangles. Surfaces are represented in STL format as a collection of triangles. Simple triangles form the surface, which fit together with a jigsaw puzzle. As a result, a step-by-step printing procedure is carried out. The .STL file format is used to load the designed file into the machine.

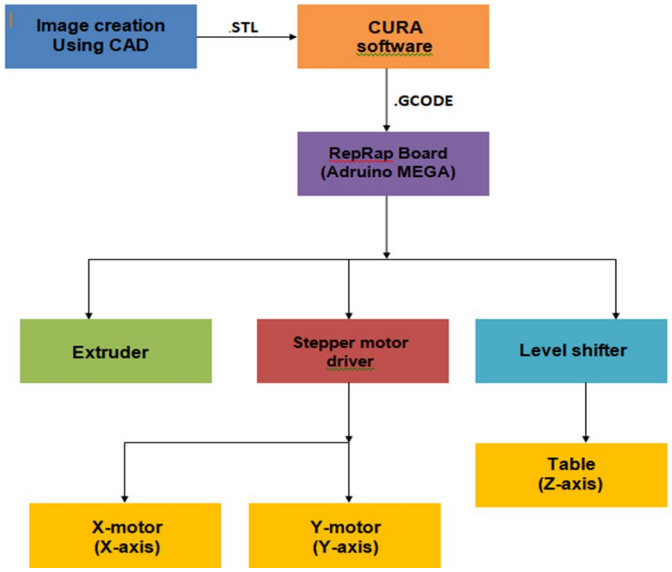

Figure 2: Flow diagram of 3D printing working process

Now we have to slice the object file. The object file is sliced into G as well as M codes, which are utilized to operate the machine. A.STL file created with CAD software is imported into the CURA program. This program divides the object code into several horizontal levels for layer-by-layer printing. It provides flexibility in slicing layer thickness and printer settings. Each layer's particular data will be transmitted to the Arduino software in order for it to run.

Figure 3: Different file formats throughout the printing process

An Arduino circuit board is used in this design, which would be an open-source, single-chip microcomputer, electronic prototyping platform. There are two elements to it: hardware and software. The user is given the software portion in order to compile the application. The hardware portion is responsible for running the appropriate application. Arduino is a low-cost output/input interface board with a Processing/Wiring programming environment that is similar to Java and C. Using stepper motors, we control the Arduino to move the pieces of a 3D printer such as the nozzle, bed, as well as extruder.

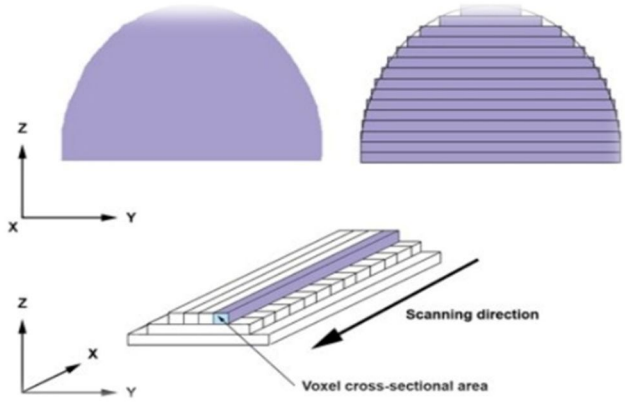

Figure 4: Representation of how slicing happens in Cura software

The final shape is formed by connecting or fusing all such layers, which directly relate to the model's remote cross-sections. At last, a little post-processing or finishing might be required depending upon the object being printed.

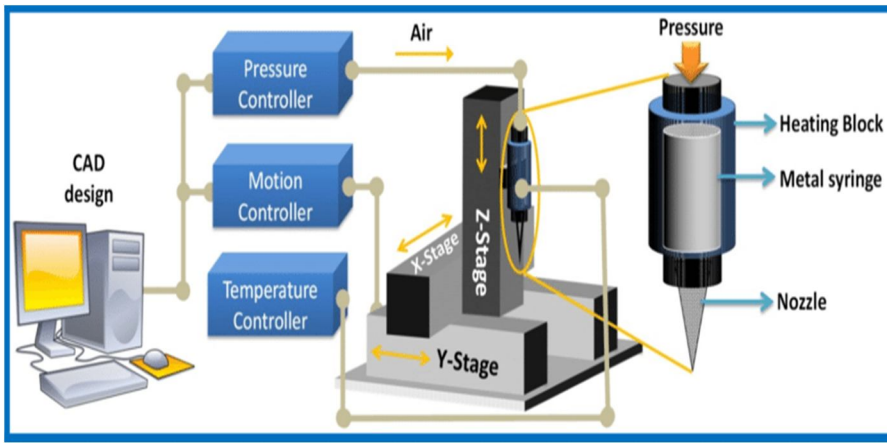

Figure 5: 3D printer overview

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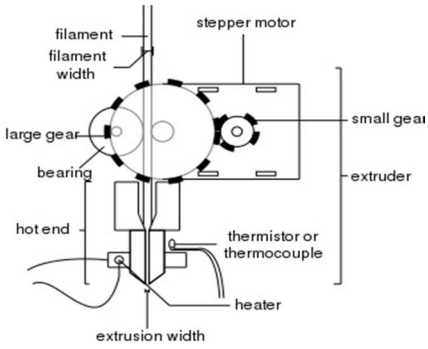
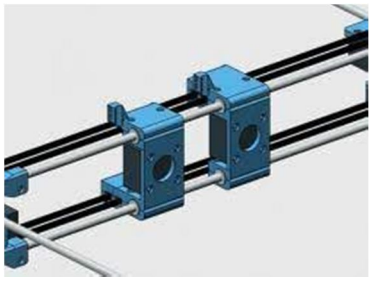
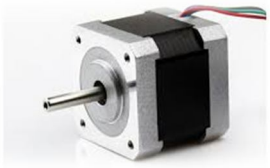
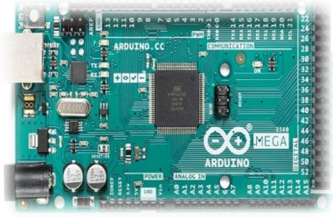
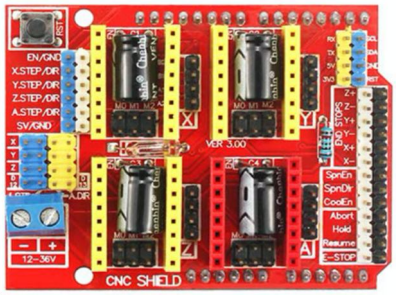
IV. PRINTER COMPONENTS

Sl.No.	Component Name	Description
1.	X-Axis, Y-Axis and Z-Axis 	To move the printer bed and the printer head we use rods which provide the required degree of freedom of movement. To control its movements we use motors, pulleys, and belt arrangement. The Y-axis provides one degree of freedom by moving the frame back and front with the help of a stepper motor and pulley arrangement. Movements in the Z-axis are controlled by another rod. This axis is an integral part of Y-axis construction and it provides the movement to the extruder axis i.e. it moves X-axis (extruder/nozzle) up and down with respect to the printer bed.
2.	Extruder with cooler 	To control the movement of the filament an extruder is used which acts as a feeding system which has a filament fed through a chilly top portion to it with the help of a motor and gear and a hot part which has a heating arrangement to heat and melt the filament. The extruder is attached to a DC fan in order to prevent the extruder from overheating.
3.	X- Carriage 	An X-axis carriage supports the extruder assembly. It includes printed pieces as well as an X-end idler, an X-end motor, and two smooth rods. The whole arrangement is known as X-carriage.
4.	Stepper Motor 	The motors are used to provide the necessary movements to different parts of the printer. It is a heavy-duty motor that provides higher torque and greater control in comparison to DC motors.
5.	Arduino Mega 	In Arduino Mega 2560 microprocessor board a USB connection, 54 digital input/output pins, a reset button, 4 UARTs (hardware serial ports), 16 digital-analog input/output, an ICSP header, and a 16 MHz crystal oscillator are all included. It is based on the ATmega2560 and includes everything required to run the microcontroller.

6.	Filaments	These are polymers made of PLA (Polylactic Acid), which is heated by the extruder up to 160-190 degrees Celsius into a semi-solid state, and layer by layer, the object is printed.
7.	Frame Components	The frame is the body of the printer, it provides the necessary stiffness to the machine, and to construct the frame we require components such as acrylic sheets.
8.	Printing Plate/ Head Bed	The objects are printed on the printing plate. Different axis controllers are used to control the movement of the plate and the nozzle so that all shapes can be printed easily.
9.	End Stop Switches 	These switches act as a protection to save the machine from striking by cutting off the power when the axis reaches the endpoint. The end stops are needed at every axis.
10.	CNC- computer numerical code 	These give an Arduino microcontroller the power it needs to operate stepper motors and execute all of the other operations that make the machine work. CNC shields should be able to control at least three stepper motors, though some can drive four or more.
11.	SMPS- switched-mode power supply 	When more power conversion efficiency, reduced size, or reduced weight is desired, these are utilized to replace linear regulators.
12.	Bushing & Bearing (optional)	The bearings have balls in them due to which rods can move without friction. Bushings are one of the plain types of bearings, they are also used to remove friction sliding over the rods.
13.	LCD with Keypad (optional)	The LCD screen displays the input & output signals. Also, it is used for controlling the system when a computer is not used.

V. RESULT

3D printing is a new technology having lots of potentials. Proper analysis of its impact on society, environment, industries, etc. must be done. This technology creates custom fit objects in the least possible time with good accuracy. Recent developments in this field show that the accuracy of 3D printers is improving day by day. Further developments in this technology will remove all barriers to this technique and all parts/objects will eventually be manufactured entirely with 3D printers. 3D printers will completely eliminate the conventional manufacturing systems and have the potential to create the next industrial revolution. Here we are printing a face shield using a 3D printer which will be useful for frontline workers and people during these pandemic days in a cost-efficient way.

VI. ACKNOWLEDGMENT

We would like to thank various people, as well as HKBK College of Engineering, for their help and support during our graduate education. Predominantly, we want to express our gratitude to Prof Aarthy Gunasekar for her enthusiasm, patience, interesting and thoughtful observations, practical assistance, and ideas, all of which have considerably assisted us during our studies. Because of her wide knowledge, deep competence, and professional abilities in Quality Control, we were able to successfully complete our research. This endeavor might not have been feasible without her assistance and instruction, and we couldn't have requested a finer study guide. We'd also like to express our gratitude to Visvesvaraya Technological University for admitting us to the degree program. In addition, we believe this is due to appreciation for the whole staff at our college.

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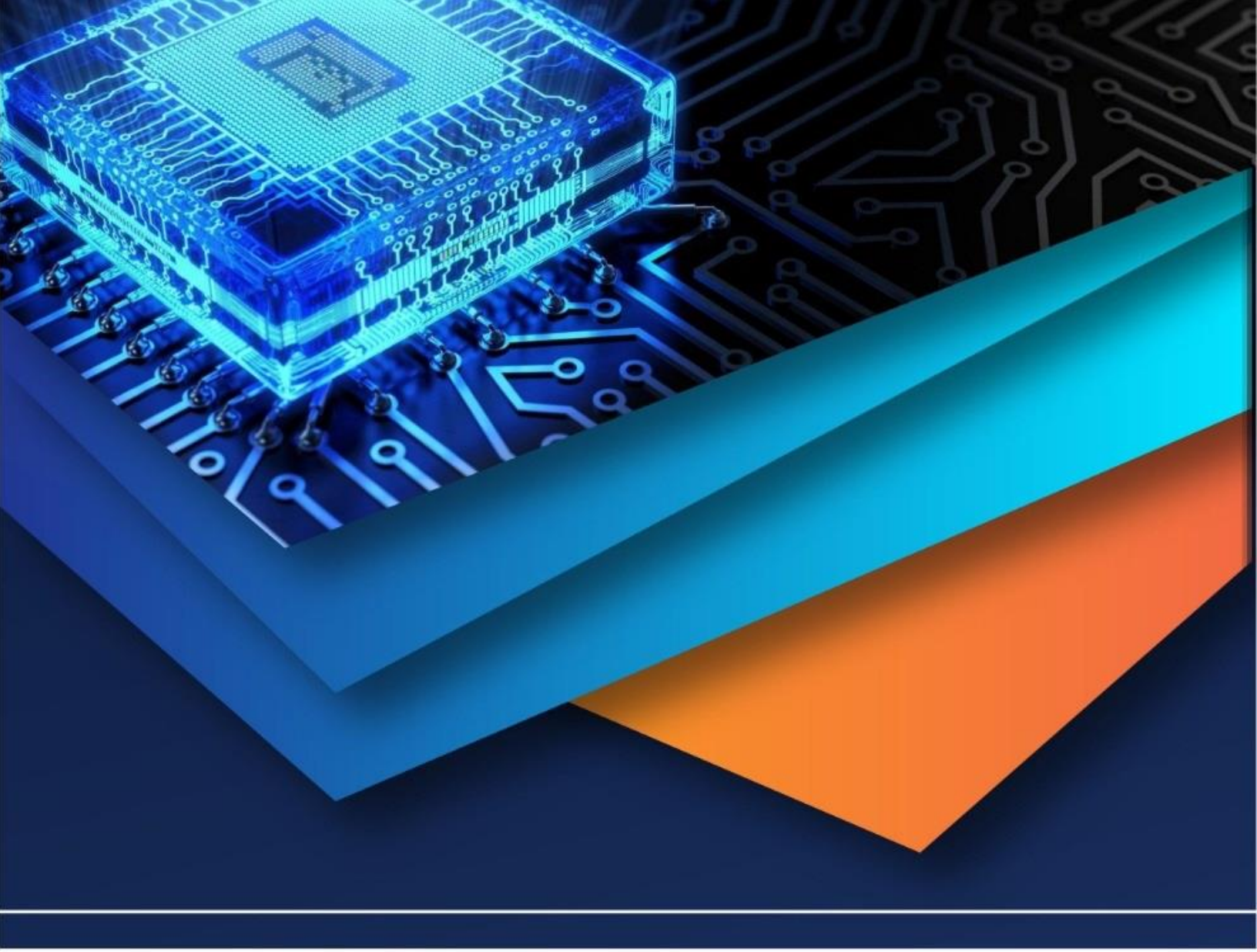

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