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Design and Modeling of 3D Printer

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Abstract: *A 3D Printer to replace the conventional printing method .3D printer is a method of transferring an image onto a 3D surface. To achieve the design and fabrication of a 3D printer we use stepper motor, heat bed, pla filament, extruder, timing belt, arduino. The goal of this project is to make a sustainable modification to the normal conventional printer to and to make a 3d printer which can able to produce real objects which leads to reduce the cost of any object which we want to manufacture with the help of 3d printer we can get a product replica and we can get an idea about the object so we can save money and time because if we want to manufacture a product then we need to design the product and the make a die of the design and then start the production but with the help of 3d printer we can the product with design only . so y using 3d printer we can save the time and cost of manufacturing in the industry.*

Keyword –*Stepper motor, heat bed, pla filament, slider, extruder, timing belt , arduino.*

1. INTRODUCTION

In this project the professional under graduate student of an esteemed institution have decided to modify the conventional printing method to 3D printer. The modification of the project is to make 3D printer. This project relates to new and useful improvements in a 3D printer. 3D printing is any of various processes in which material is joined or solidified under computer control to create a three-dimensional object , with material being added together (such as liquid molecules or powder grains being fused together). 3D printing is used in both rapid prototyping and additive manufacturing. Objects can be of almost any shape or geometry and typically are produced using digital model data from a 3D model or another electronic data source such as an Additive Manufacturing File (usually in sequential layers). There are many different technologies, like stereo lithography or fused deposit modeling. Thus, unlike material removed from a stock in the conventional machining process, 3D printing or Additive Manufacturing builds a three-dimensional object from a computer aided design model or AMF file, usually by successively adding material layer by layer.

With the manufacturing of this project not only the human effort is reduced but also the cost of manufacturing will be reduced and the overall cost of the products will be reduced.

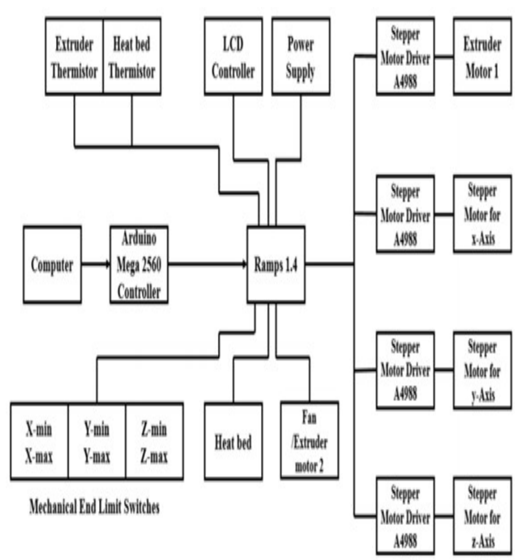

Fig1. Block diagram of 3d printer

2. LITERATURE REVIEW

2.1 According to C.K. Chua et al, "A Study of the State-of-the-Art Rapid Prototyping Technologies" (1998) [1]

Each rapid prototyping (RP) process has its special and unique advantages and disadvantages. The paper presents a state-of-the-art study of RP technologies and classifies broadly all the different types of rapid prototyping methods. Subsequently, the fundamental principles and technological limitations of different methods of RP are closely examined. A comparison of the present and ultimate performance of the rapid prototyping processes is made so as to highlight the possibility of future improvements for a new & generation of RP systems. Gives a general overview of current rapid prototyping techniques including droplet deposition.

2.2 According to Sung-HoonAhn et al, "Anisotropic material properties of fused deposition modeling ABS" (2002) [2]

Rapid Prototyping technologies provide the ability to fabricate initial prototypes from various model materials. Strategy Fused Deposition Modeling (FDM) is a typical RP process that can fabricate prototypes out of ABS plastic. To predict the mechanical behavior of FDM parts, it is critical to understand the material properties of the raw FDM process material, and the effect that FDM build parameters have on anisotropic material properties. This paper characterizes the properties of ABS parts fabricated by the FDM 1650. Using a Design of Experiment approach, the process parameters of FDM, such as raster orientation, air gap, bead width, color, and model temperature were examined. Tensile strengths and compressive strengths of directionally fabricated specimens were measured and compared with injection molded FDM ABS P400 material. For the FDM parts made with a 0.003 inch overlap between roads, the typical tensile strength ranged between 65% and 72% of the strength of injection molded ABS P400. The compressive strength ranged from 80% to 90% of the injection molded FDM ABS. Several build rules for designing FDM parts were formulated based on experimental results.

2.3 According to C.S. Lee et al, "Measurement of anisotropic compressive strength of rapid prototyping parts" (2007) [3]

Rapid prototyping (RP) technologies provide the ability to fabricate initial prototypes from various model materials. Fused deposition modeling (FDM) and 3D printer are commercial RP processes while Nano composite deposition system (NCDS) is an RP tested system that uses Nano composites materials as the part material. To predict the mechanical behavior of parts made by RP, measurement of the material properties of the RP material is important. Each process was characterizes by process parameters such as raster orientation, air gap, bead width, color, and model temperature for FDM. 3D printer and NCDS had different process parameters. Specimens to measure compressive strengths of the three RP processes were fabricated, and most of them showed anisotropic compressive properties.

2.4 According to A.K.Sood et al, "Parametric appraisal of mechanical property of fused deposition modelling processed parts" (2010) [4]

Fused deposition modeling (FDM) is a fast growing rapid prototyping (RP) technology due to its ability to build functional parts having complex geometrical shape in reasonable time period. The quality of built parts depends on many process variables. In this study, five important process parameters such as layer thickness, orientation, raster angle, raster width and air gap are considered. Their influence on three responses such as tensile, flexural and impact strength of test specimen is studied. Experiments are conducted based on central composite design (CCD) in order to reduce experimental runs. Empirical models relating response and process parameters are developed. The validity of the models is tested using analysis of variance (ANOVA). Response surface plots for each response are analyses and optimal parameter setting for each response is determined. The major reason for weak strength may be attributed to distortion within or between the layers. Finally, concept of desirability function is used for maximizing all responses simultaneously.

2.5 According to A.Bellini et al, "Mechanical characterization of parts fabricated using fused deposition modeling" (2003) [5]

Layered manufacturing is an evolution of rapid prototyping (RP) techniques where the part is built in layers. While most of the previous applications focused on building "prototypes", recent developments in this field enabled some of the prototyping methods to achieve an agile fabrication technology to produce the final product directly. A shift from prototyping to manufacturing of the final product necessitates broadening of the material choice, improvement of the surface quality, dimensional stability, and achieving the necessary mechanical properties to meet the performance criteria. The current study is part of an ongoing project to adapt fused deposition modeling to fabrication of ceramic and multi-functional components. This paper presents a methodology of the mechanical characterization of products fabricated using fused deposition modeling.

2.6 According to J.F. Rodriguez et al, "Mechanical behavior of acrylonitrile butadiene styrene (ABS) fused deposition materials. Experimental investigation" (2001) [6]

An experimental study of the mechanical behavior of fused-deposition (FD) ABS plastic materials is described. Elastic moduli and strength values are determined for the ABS monofilament feedstock and various unidirectional FD-ABS materials. The results show a reduction of 11 to 37 per cent in modulus and 22 to 57 per cent in strength for FD-ABS materials relative to the ABS monofilament. These reductions occur due to the presence of voids and a loss of molecular orientation during the FD extrusion process. The results can be used to benchmark computational models for stiffness and strength as a function of the processing parameters for use in computationally optimizing the mechanicalperformance of FD-ABS materials in functional applications.

2.7According to A.K.Sood et al, "Experimental investigation and empirical modelling of FDM process for compressive strength improvement" (2011) [7]

Fused deposition modeling (FDM) is gaining distinct advantage in manufacturing industries because of its ability to manufacture parts with complex shapes without any tooling requirement and human interface. The properties of FDM built parts exhibit high dependence on process parameters and can be improved by setting parameters at suitable levels. Anisotropic and brittle nature of build part makes it important to study the effect of process parameters to the resistance to compressive loading for enhancing service life of functional parts. Hence, the presence work focuses on extensive study to understand the effect of five important parameters such as layer thickness, part build orientation, raster angle, raster width and air gap on the compressive stress of test specimen. The study not only provides insight into complex dependency of compressive stress on process parameters but also develops a statistically validated predictive equation. The equation is used to find optimal parameter setting through quantum-behaved particle swarm optimization (QPSO). As FDM process is a highly complex one and process parameters influence the responses in a nonlinear manner, compressive stress is predicted using artificial neural network (ANN) and is compared with predictive equation.

2.8 According to L. Li et al," Composite Modeling and Analysis for Fabrication of FDM Prototypes with Locally Controlled Properties" (2002) [8]

Solid freeform fabrication (SFF) technologies have the ability to manufacture functional parts with locally controlled properties, which provides an opportunity for manufacturing a whole new class of products. To a certain extent, fused deposition modeling (FDM) has the potential to fabricate parts with locally controlled properties by changing deposition density and deposition orientation. To fully exploit this potential, this paper reports a study of the materials, the fabrication process, and the mechanical properties of FDM prototypes. Theoretical and experimental analyses of mechanical properties of FDM processes and prototypes were carried out to establish the constitutive models. A set of equations is proposed to determine the elastic constants of FDM prototypes. The models are then evaluated by experiments. An example of FDM prototype with locally controlled properties is provided to demonstrate the ideas.

2.9 According to J.F. Rodriguez et al, "Design of Fused-Deposition ABS Components for Stiffness and Strength" (2003) [9]

The high degree of automation of Solid Freeform Fabrication (SFF) processing and its ability to create geometrically complex parts to precise dimensions provide it with a unique potential for low volume production of rapid tooling and functional components. A factor of significant importance in the above applications is the capability of producing components with adequate mechanical performance (e.g., stiffness and strength). This paper introduces a strategy for optimizing the design of Fused-Deposition Acrylonitrile-Butadiene-Styrene (FD-ABS; P400) components for stiffness and strength under a given set of loading conditions. In this strategy, a mathematical model of the structural system is linked to an approximate minimization algorithm to find the settings of select manufacturing parameters, which optimize the mechanical performance of the component. The methodology is demonstrated by maximizing the load carrying capacity of a two-section cantilevered FD-ABS beam.

2.10 According to R. Jones et al, "RepRap – the replicating rapid prototype" (2011) [10]

This paper presents the results to date of the RepRap project – an ongoing project that has made and distributed freely a replicating rapid prototype. We give the background reasoning that led to the invention of the machine, the selection of the processes that we and others have used to implement it, the designs of key parts of the machine and how these have evolved from their initial concepts and experiments, and estimates of the machine's reproductive success out in the world up to the time of writing (about 4500 machines in two and a half years).

2.11 According to D. Holland et al, "Open Design and the Reprap Project" (2010) [11]

This paper details investigate on of an emerging trend within technology development: 'open design'. Improvements in communications and computing technology have made collaboration over geographically vast distances possible. This technology has already had a major impact on the field of engineering, from the development of CAD/CAE/CAM practices to the emergence of concurrent engineering. Taking the lead from open source software, open design is an approach to technology development in which technical design information is licensed in such a manner that it can be accessed, utilized, modified and redistributed by anyone. The potential implications of this concept can be inferred from the impact of open source software. A review of the existing literature on the subject was conducted. A practical demonstration of the process was undertaken, via an attempt to contribute to an existing open design technology: the RepRap. This is a low cost rapid prototype capable of manufacturing the parts required to make a copy of itself. The ability to use resin as a construction material was identified as a requirement of the device. An approach to integrating resin extrusion within the device was selected, a suitable material identified, and an experimental rig designed and assembled. Initial test results indicated that resin extrusion is viable for the RepRap.

2.12 According to J.Kentzer et al, "An Open Source Hardware-based Mechatronics Project: The Replicating Rapid 3-D Printer" (2011) [12]

This contribution reviews the execution of an open source hardware (OSHW) project as part of the Master in Mechatronics Degree Programmed at the University of Southern Denmark. There were a number of reasons that motivated us to carry out this project; educational, intellectual and research reasons. Open source projects provide unique opportunities for students to gain experience solving real-world problems. There was also a research consideration in pursuing an OSHW project. Three of the authors of this contribution are working towards a Master's Degree in Innovation and Business and Wanted to carry out an OSHW project as a precursor to doing research work on the Commercialization of OSHW Projects'. The choice of the project was all important and we choose to build a 3-D printer using information provided by the RepRap Open Source Community because this satisfied nearly all our specifications for an OSHW project. Our experiences in constructing a 3-D printer as well as documenting the areas where the open source information currently has deficiencies are documented here.

2.13 According to J.M. Pearce et al, "3-D Printing of Open Source Appropriate Technologies for Self-Directed Sustainable Development"(2010) [13]

The technological evolution of the 3-D printer, widespread internet access and inexpensive computing has made a new means of open design capable of accelerating self-directed sustainable development. This study critically examines how open source 3-D printers, such as the RepRap and Fab @home, enable the use of designs in the public domain to fabricate open source appropriate technology (OSAT), which are easily and economically made from readily available resources by local communities to meet their needs. The current capability of open source 3-D printers is reviewed and a new classification scheme is proposed for OSATs that are technically feasible and economically viable for production. Then, a methodology for quantifying the properties of printed parts and a research trajectory is outlined to extend the existing technology to provide complete village-level fabrication of OSATs. Finally, conclusions are drawn on the potential for open source 3-D printers to assist in driving sustainable development.

3. RESEARCH METHODOLOGY

we are going to make a 3D printer. To achieve the design and fabrication of a 3D printer we use stepper motor for the movement of the printing nozzle axis in X,Y,Z direction and heat bed is the place where the object manufacture is to be manufacture on the heat bed and pla filament is the raw material which is used for the production and manufacturing of the product ct and extruder is used from where the material will flow and the timing belt is used to set the time for the movement of the nozzle and the arduino chip is used for the coding and the functioning of the 3D printer and slider are used for the movement of the pointer nozzle for printings.

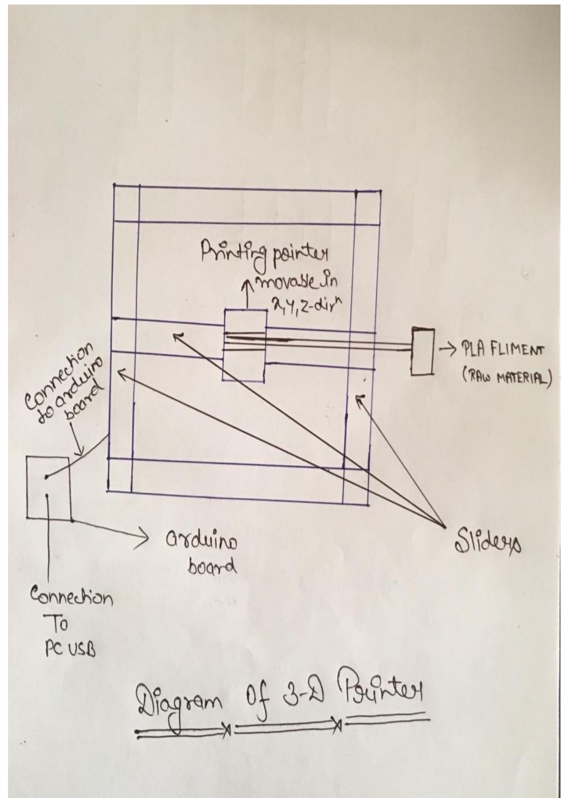

Fig-Design of 3d printer

4. ADVANTAGES AND DISADVANTAGES AND APPLICATIONS

4.1 ADVANTAGES

4.1.1 Customization – 3D printer can print any design no matter how complex it might be.

4.1.2 Constant prototyping and increased productivity – This helps designer to improve their prototype, for any design flaws that may affect the quality of the product.

4.1.3 Affordability - The initial cost for setting up a 3D printing is high; however, it is much cheaper compare to labour cost and manufacturing cost while using the conventional way.

4.1.4 Storage – In 3D printing technology product can be printed when needed so no storage cost is required.

4.1.5 Employment opportunities – Technicians who are skilled at maintenance and designer to design blueprint of the product and more job will be created.

4.2 DISADVANTAGES

4.2.1 Decrease in manufacturing jobs – The decrease in manufacturing job will greatly affect the economy of countries that rely on a large number of low skill job.

4.2.2 Limited size – The size of objects created with 3D printer is currently limited.

4.2.3 Limited raw material – 3D printer can work up to approximate 100 different raw materials and creating product that uses more raw material are still under development.

4.2.4 Violation of copyright – Anyone who gets hold of a blueprint will be able to counterfeit product easily.

4.3 APPLICATIONs

- Rapid prototyping
- Production parts
- Manufacturing tooling

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