Arduino Based 3D Printer

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Abstract: **—** The 3D Printing Global Market is growing at a very fast pace and is projected to expand even further in a Next few years. The Fused Deposition Modeling (FDM) is an Additive manufacturing process that belongs to the material extrusion family. In FDM an object is built by selectively depositing melted material is extruded through a nozzle and deposed layer wise on a heated table. The material used are thermoplastic polymers and come in a filament form and it is Biodegradable. It is a tool less manufacturing method, it is a high precision & less cost process for making objects. 3D Printers are machine that produce physical 3D model from digital data by printing layer by layer. It can make physical model of objects designed with CAD Program. 3D printer work on G-code (Geometric code) Using G-code a Computer tells a printer when, where how to move and how much to Extrude throughout the entire print process.

Keywords—3D Printer, Arduino, Fused Deposition Modeling (FDM), Additive Process, G-code (Geometric code)

I. INTRODUCTION

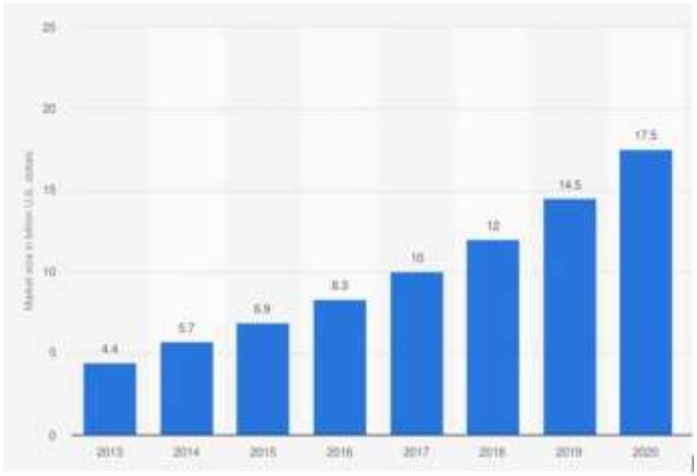
A 3d printer is an additive manufacturing technique where 3D objects and parts are made by the addition of multiple layers of material. It can also be called as rapid prototyping. It is a mechanized method where 3D objects are quickly made as per the required size machine connected to a computer containing blueprints of any object. The main reason to use 3d printer is for 90% of material utilization, increase product life, lighter and stronger. 3D printing is efficiently utilized in various fields such as aerospace, automobile, medical, construction and in manufacturing of many household products. 3D printing majorly dealing with the process of Rapid Prototyping & Additive Manufacturing process plays vital role in it. But major obstacle in to this is speed of rapid prototyping machine. Stereo lithography (STL) is the most common file types that 3D printers can read.

Thus, unlike material removed from a stock in the conventional machining process, 3D printing or Additive Manufacturing builds a 3D object from computer-aided design (CAD) model by successively adding material layer by layer. 3D printing, also known as additive manufacturing (AM), refers to processes used to create a three-dimensional object in which layers of material are formed under computer control to create an object. 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 (AMF) file. There are many different materials which can be used with FDM. In the first place, they are divided between the industrial and the consumer categories. The most commonly used are ABS (Acrylonitrile Butadiene Styrene), PLA (Polylactic Acid) and Nylon (Polyamide), but other exotic varieties of materials can also be used, like a material blend of plastic and wood or carbon.

II. LITERATURE SURVEY

A. Survey Existing System

One of the fastest-growing technological developments has been that of 3D printing. It is the process of depositing successive layers of material such as plastic, metal, or wax in a 3D printer to create a physical object based on a digital model. 3D printing, also known as additive manufacturing, is already heavily adopted in industries such as aerospace, automotive, and industrial goods. Engineers in these industries use 3D printing for making parts that cannot be manufactured through conventional machining or laser processing techniques. According to the survey of 3D Printing Market size worldwide from 2013-2020



B. Challenges Of 3D Printing

The global 3D printing market is expected to reach $21 billion by 2020 — quadrupling its size in just four years. While 3D printing, also referred to as additive manufacturing, comes with many benefits, such as freedom of design, easy prototyping, customization and streamlined logistics, it also poses many challenges. With all of these benefits you would think 3D printing would be as common as the internet by now, but that's not the case. Companies are still struggling to find ways to incorporate the technology into their product development and manufacturing operations. These include High manufacturing cost, High development cost, Additive manufacturing impacts the environment, More time required for printing the object. The success of 3D Printer depends on the properties of the material, more specifically, the fresh properties of 3D printable materials such as workability, viscosity, and green strength. Typically, to avoid the deformation/settlement of bead layers (printing layers), no-slump yet pumpable material is required for 3D Printer. Another option could be soft material, i.e., allowing some slump value but regain hardness as soon as the material is deposited through the nozzle head. The required viscosity profile of any acceptable 3D printable material it can be seen that before extrusion (i.e., before deposition through the nozzle head) material must have a higher viscosity, which then reduces during the printing period. This allows the material to be pumped from the mixing machine to the hose pipe and deposited through the nozzle head smoothly. Once deposited, the material must regain its previous viscosity so that the next layer can be deposited over it. In this way, the deformation of the bead layers can be controlled.

III. PROPOSED SYSTEM

In this system we are using Fused Deposition Modeling (FDM). The Fused Deposition Modeling (FDM) is an Additive manufacturing process that belongs to the material extrusion family. In FDM an object is built by selectively depositing melted material is extruded through a nozzle and deposed layer wise on a heated table.

The material used are thermoplastic polymers and come in a filament form and it is Biodegradable. It is a tool less manufacturing method, it is a high precision & less cost process for making objects. 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 (AMF) file. It can make physical model of objects designed with CAD Program. 3D printer will work on G-code (Geometric code) Using G-code a Computer tells a printer when, where and how to move and how much to Extrude throughout the entire print process.

IV. MAIN METHODS

Methods of additive manufacturing (AM) have been developed to meet the demand of printing complex structures at fine resolutions. Rapid prototyping, the ability to print large structures, reducing printing defects and enhancing mechanical properties are some of the key factors that have driven the development of AM technologies. The most common method of 3D printing that mainly uses polymer filaments is known as fused deposition modelling (FDM).

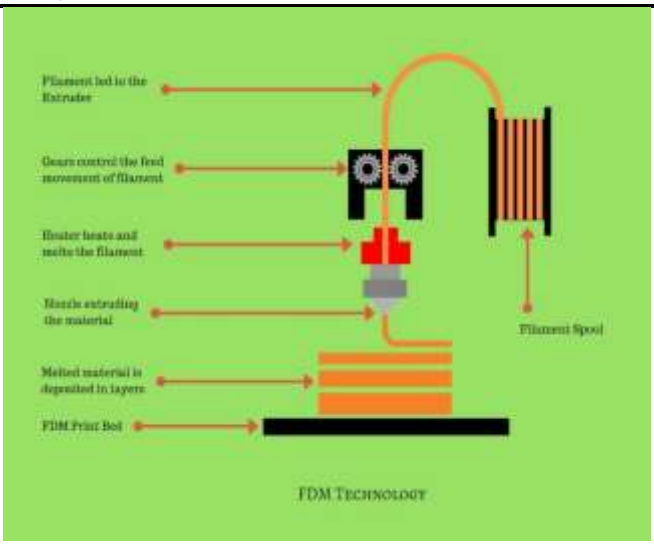
In addition additive manufacturing of powders by selective laser sintering (SLS), selective laser melting (SLM) or liquid binding in three-dimensional printing (3DP), as well as inkjet printing, contour crafting, stereolithography, direct energy deposition (DED) and laminated object manufacturing (LOM) are the main methods of AM.

A. Fused Deposition Modeling (FDM)

Fused filament fabrication (FFF) also known as fused deposition modeling, is a 3D printing process that uses a continuous filament of a thermoplastic material. Filament is fed from a large spool through a moving, heated printer extruder head, and is deposited on the growing work. The print head is moved under computer control to define the printed shape. Usually the head moves in two dimensions to deposit one horizontal plane, or layer, at a time; the work or the print head is then moved vertically by a small amount to begin a new layer (fig.1). In FDM method, a continuous filament of a thermoplastic polymer is used to 3D print layers of materials.

The filament is heated at the nozzle to reach a semi-liquid state and then extruded on the platform or on top of previously printed layers. The Thermoplasticity of the polymer filament is an essential property for this method, which allows the filaments to fuse together during printing and then to solidify at room temperature after printing. The layer thickness, width and orientation of filaments and air gap (in the same layer or between layers) are the main processing parameters that affect the mechanical properties of printed parts. Inter-layer distortion was found to be the main cause of mechanical weakness.

Low cost, high speed and simplicity of the process are the main benefits of FDM. On the other hand, weak mechanical properties, layer-by-layer appearance, poor surface quality and a limited number of thermoplastic materials are the main drawbacks of FDM.



Material	Description
PLA	PLA (Polylactic Acid) is one of the two most commonly used desktop 3D printing materials (with the other being ABS). It is the 'default' recommended material for many desktop 3D printers, and with good reason - PLA is useful in a broad range of printing applications, has the virtue of both odorless and low warp and it will not require a heated bed. PLA plastic is also one of the eco-friendlier 3D printer materials available; it is made from annually renewable resources (cornstarch) and requires less energy to process compared traditional (petroleum-based) plastics. Printing Temp. 180 – 220° C Bed Temp. 20-55° C.
ABS	ABS (Acrylonitrile Butadiene Styrene) is another commonly used 3D printer material. Best used for making durable parts that needs to withstand higher temperatures. In differentiating to PLA, ABS plastic is less brittle. It can also be post-processed with acetone to provide a glossy finish. Printing Temp. 220-235° C Bed Temp. 80-110° C.

V. ANALYSIS

In this project it is analyzed that the 3d printer is very innovative technology to print any object in a 3 Dimensional format Now a days 3d printing is used in every field such as Educational, Electronics, Automobile, Aerospace. Apart from this it is widely used in Medical field for printing many parts of the body such as Tooth, Bone etc. using plastic as a material with moderate complexity and very good finishing taking medical application to a very next level.

Working Criteria

3D printing ensures usage of operational relationships between software and hardware components for better and smooth processing. The working cycle can be defined as follows:

- Design of CAD CAM model in designing software like CATIA.
- Transfer of the CAD file to SLICER software to be divided and broken down in form of G codes which can be compatible for further operational processes.
- Syncing the G codes in Pronterface which will decide and direct the stepper motors used in the model of 3D printer.
- G codes defining the direction of stepper motor will direct the motors in X, Y and Z direction for the specifically assigned stepper motor for each directional axis.
- Movement of the stepper thus ensures movement of heat bed and extruder in the stated direction as the motors. This transfer of motion takes place through threaded rods.
- Extruder containing polymer base will deposit the polymer on the heat bed in the shape and direction prescribed with respect to the G codes.
- Fan for additional cooling effect of the polymer ensures reduction in the operational time of the process of 3D printing.

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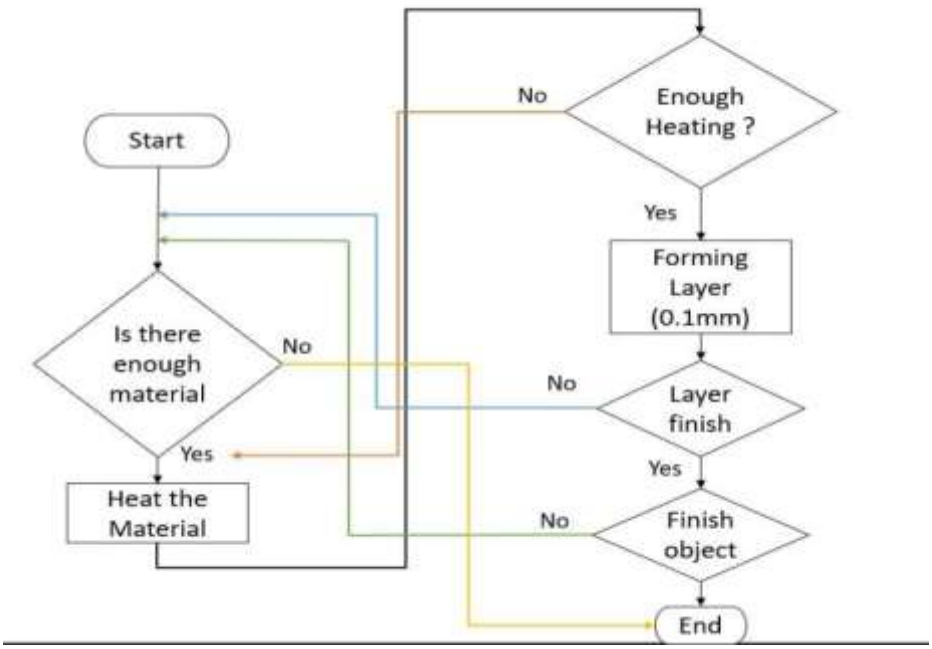
B. Methodology

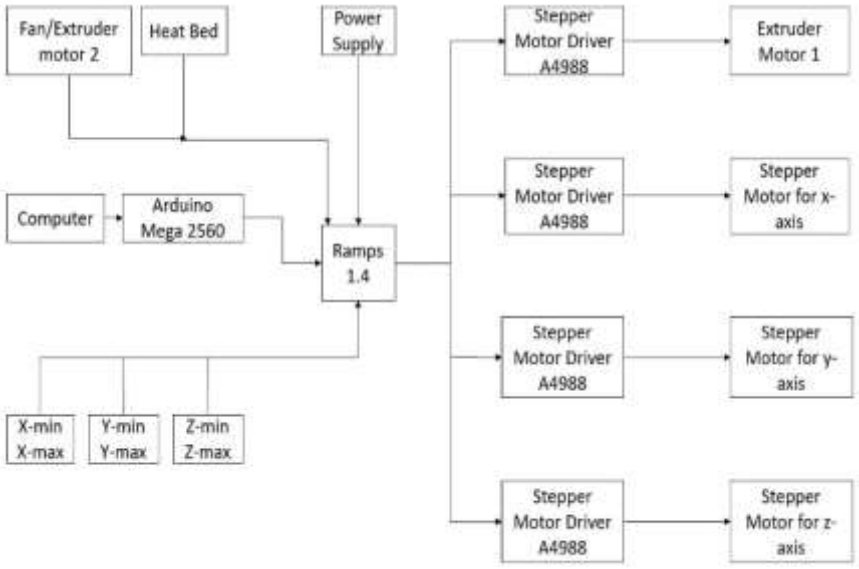
3D printable models may be created with a computer aided design (CAD) package, via a 3D scanner, or by a plain digital camera software. CATIA version of CAD designing can be used to design conventional 3D printed models created with CAD result in lower errors and higher flexibility that can be adjusted before printing, allowing verification in the design of the object before it is printed. The manual modeling process of preparing geometric data for 3D computer graphics is based of primary designing with respect to different axis. 3D scanning is a process of collecting digital data on the shape and appearance of a real object, creating a digital model based on it. CAD models can be saved in the stereolithography file format (STL), a de facto CAD file format for additive manufacturing that stores data based on triangulations of the surface of CAD models. This STL file sent to the slicer software for formation of G codes.

STL is not adapted for additive manufacturing because it generates large file sizes of geometric G Codes, optimized parts and lattice structures due to the large number of axis and surface involved. A new CAD file format, the Additive Manufacturing File format (AMF) was introduced in 2011 to solve this problem of large size data capturing. It stores information using curved designing of the CAD model designed. We will be using Arduino Mega 2560 microcontroller as the central controller which will be controlling all the actions and it will be the Brain of the system. It will be connected series interface with Ramps and other components such as Stepper motor, Motor drivers, Hot bed etc. Stepper motors are used to move the header in the direction of the particular axis, Stepper motor are used for fine precision. Printing head is the actual printing part having a heater. The printing head heats up and extrudes the material provided by feeder. Temperature sensors are used for PID controller to control the temperature of bed and printing head.

Flow chart For Hardware Process:



Hardware unit also consist of drivers required to drive the motors and heaters. Hardware part also have a 12V 30A DC power supply for powering up the heaters and motors. Power supply is SMPS and isolated type. The motor drivers are used for driving the high power motors with very low power control signals.



Block diagram of 3D Printer

C. Design Detail

It is a Big structure which will have rectangular dimension with length and width of approx. (53*45cm) with height is around 43cm. We have to cut aluminium channel using hacksaw Dimension- 53cm (3Pcs), 45cm (2Pcs), 43cm (2Pcs), 10cm (2Pcs- for bed) and join all aluminium channel using L shaped clamp. After making frame we have to install Y axis motor at front side of the printer. I have used zip tie to fix motor.

Now install 608 bearing using L shaped clamp & install GT2 timing belt to GT2 timing pully To make a smooth liner motion I have used here 2 pcs 50cm – 8mm – smooth rod & 2pcs 10cm aluminium channel is base of the printer Y axis bed making Y axis ,X axis For Z axis we have to use two NEMA 17 motors & two Trapezoidal Lead Screw connected by Flexible Coupling. For making X axis structure I have used cheap plastic clip board you can also use acrylic sheet.

After assembling Y,Z& X axis we have to do assembly Mk8 Extruder block (here is MK8 Extruder assembling) I have used 3 minimum position mechanical end stop switch. you can also use 3 pin end stop. My end stop switch pin is NC (normally closed) & NO (normally open) but 3 pin end stop switch connection is may little bit different.

VI. CONCLUSION

If every individual uses this 3D technology, there will be a massive production in the industrial world and the important thing is that no one needs to visit the manufacturing units for the prototyping objects, one can create his/her own objects by just importing the model into the 3D printer and get the desired object. In the coming decades, there will be a chance of cloud 3D printing which will allow you to create objects for yourself and for your beloved once by sitting away from them. This Rapid prototyping technology will allow creating a massive production with less time and less capital. However 3D is not a dream, it is already in the current market, few industries are using them for massive production, and that are building very complex models.

VII. REFERENCES

[1]C. Balletti, M. Ballarin, and F. Guerra, "3D printing: State of the art and future perspectives", J. Cult. Herit., vol. 26, pp. 172–182, 2017.

[2]Berman B. 3-D printing: the new industrial revolution. Bus Horiz 2012;55(2):155–62.

[3]Ujwal Bhatia „3D Printing Technology "ISSN: 2321-0869, Volume-3, Issue-2, February 2015.

[4]Marshall peck „Enable Auto Bed Levelling for 3D Printer with an inductive sensor".

[5]https://www.mdpi.com/2073-4360/12/7/1529/htm.

[6]https://www.irjet.net/archives/V5/i11/IRJET-V5I11341.pdf.

[7]https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7160453

[8]https://www.machinedesign.com/3d-printing-cad/article/21837834/survey-reveals-how-professionals-are-using-3d-printing.

[9]https://www.researchgate.net/publication/308905412_3D_Printing_Enabling_a_New_Era_of_Opportunities_and_Challenges_for_Manufacturing.

[10]https://www.irjet.net/archives/V6/i5/IRJET-V6I598.pdf