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IMPLEMENTATION OF 3D PRINTER

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Abstract: ***3D printing is a process of making a three-dimensional solid object of virtually any shape from a digital model. A 3D printer is just like a normal color printer. The main difference is that it prints with plastic and 3-imensional objects. The printer prints small plastic threads in layers forming the object as required. 3D printing is achieved using an additive process where successive layers of material are laid down in different shapes. So, in this I have used five stepper motor and one extruder from which layer by layer object forming by serial communication with pc and communicate 3D printer by using CAD software to receive 3D object with help of controller Arduino 2560.***
Keywords: Motor Driver L293D, G-Code, Marlin Software, Printed Head (EXTRUDER), ABS Plastic, Power Supply.

I. INTRODUCTION

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. A 3D printer is a limited type of industrial robot that is capable of carrying out an additive process under computer control. 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.
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. So using 3D printer it is possible to make complete model in a single process. The basic principles include flexibility of output, and translation of code into a visible pattern.

II. SCOPE OF WORK

In today's scenario, making of die is very much difficult, time consuming and costly as well. Purpose of serving 3D printing technology is to make all kind of die in more easier way, very much less time consuming and cost effective. For example, if user wants to make die of soap, then it may cost INR. 25,000, where the same die can be made by 3D printer in very much less cost compared to the previous. Similarly, die for the jewellery, statues, enclosures of any product, architectural models etc. can be made by using 3D printer. In automobile industries, for making die of any part of the automobile, 3D printer is very much helpful. So, instead of making die manually or by existing technologies, 3D printer is far better, less time consuming, more accurate, cost effective and easy system.

III. OVERVIEW OF THE SYSTEM

As shown in fig 1 is a block diagram of 3D printer. Arduino 2560 processor is used to control entire system. It uses to control stepper motor which is used set the position of printing head, motor driver is used to drive stepper motor. Extruder is a used to inject a printing material.

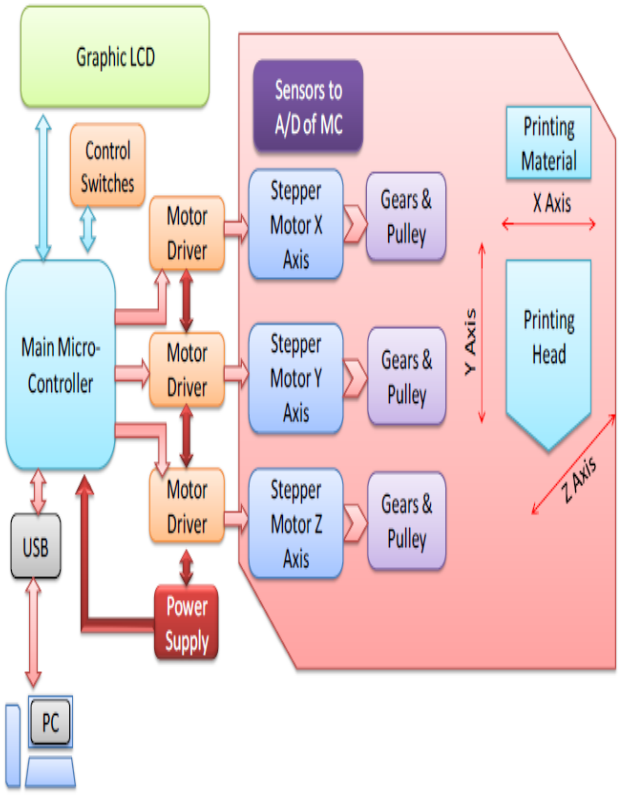

Fig 1. Block Diagram of 3D Printer

1. Arduino Mega 2560

The Arduino Mega 2560 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 16MHz 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 an AC-to-DC adapter or battery to get started.

Fig 2. Arduino Mega 2560[2]

2. Feature of Arduino Mega 2560:
The Arduino Mega2560 differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the ATmega 16U2 programmed as a USB-to-serial converter of the Mega2560 board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode.

3. Power
The Arduino Mega can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The board can operate on an external supply of 6 to 20 volts. The power pins are as follows: VIN. Input voltage to the Arduino board when it's using an external power source. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA. GND Ground pins. IOREF This pin on the Arduino board provides the voltage reference with which the microcontroller operates.

4. Memory
The ATmega2560 has 256 KB of flash memory for storing code (of which 8 KB is used for the boot loader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library).

5. Input and Output
Each of the 54 digital pins on the Mega can be used as an input or output, using pinMode(), digitalWrite(),and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor of 20-50 kohms.

6. Communication
The Arduino Mega2560 has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega2560 provides four hardware UARTs for TTL (5V) serial communication. An ATmega16U2 on the board channels one of these over USB and provides a virtual com port to software on the computer. A Software Serial library allows for serial communication on any of the Mega2560's digital pins. The ATmega2560 also supports TWI and SPI communication. The Arduino software includes a Wire library to simplify use of the TWI bus.

7. Stepper Motor
Stepper motors are electromechanical devices that convert a pattern of inputs and the rate-of-change of those inputs into precise rotational motion. The rotational angle and direction for each change (step) is determined by the construction of the motor as well as the step pattern input. As shown in the figure 3 is the stepper motor for 1.2 degree rotation.

8. Two Phase Stepper Motor

9. Unipolar Stepper Motors
A unipolar stepper motor has one winding with center tap per phase. Each section of windings is switched on for each direction of magnetic field. Since in this arrangement a magnetic pole can be reversed without switching the direction of current, the commutation circuit can be made very simple.

Fig 3. Stepper Motor[5]

10. Bipolar Stepper Motor
Bipolar motors have a single winding per phase. The current in a winding needs to be reversed in order to reverse a magnetic pole, so the driving circuit must be more complicated, typically with an H-bridge arrangement.

11. Motor Driver (L293D)
L293D are quadruple high-current half-H drivers.L293D motor driver is shown in the figure 4. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. Both devices are designed to drive inductive loads such as relays, solenoids, dc and

bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

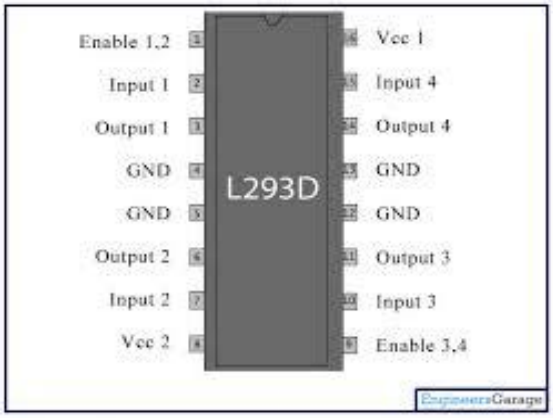

Fig 4. L293D[4]

12. Extruder

Extrusion of plastics, like injection molding, is a relatively simple concept, but the design and application of extruders is a complex field. In injection molding the purpose of the screw extruder is simply to obtain a melt, a dedicated extrusion machine works on the same principle but also must mix, homogenize and melt the material Higher back pressures may be generated in single screw extrusion machines compared to injection molding machines and the screws may be longer for better mixing. The extruder diagram is shown in figure 5.

Fig 5. Extruder

13. Printing Material

Three mainly used materials for 3D printer are: ABS, PLA.

14. ABS (Acrylonitrile Butadiene Styrene)

ABS is generally very durable and strong, slightly flexible and quite resistant to heat. Printers able to process ABS plastics normally operate with a hot end at a temperature around 210-250°C. Considering cost, ABS is the cheapest plastic of the three filament types analyzed. Printed or broken parts can simply be glued together with ABS glue and it is easily dissolvable in acetone. ABS is generally available in white, black, red, blue yellow and green colors.

15. PLA (Poly Lactic Acid)

PLA is a biodegradable thermoplastic which is derived from renewable resources. This makes of PLA the most environmentally friendly solution in the domain of 3D printing. PLA is tough, but a little brittle, once it has cooled down. Its temperature threshold is lower than the one of ABS, as PLA is normally extruded around 160°C-220°C. PLA is quite slow to cool. Its main drawbacks are that it cannot stand too much heat, as standard PLA becomes soft around 50°C. But PLA is generally considered the easiest material to work with, when you first start printing. It has been becoming more and more readily available.

IV. IMPLEMENTATION OF 3D PRINTER

1. Basic 3D Printer Model

The basic 3D printer model is shown in the figure 4.1 .The three independent axis controls are used for precision positioning of the extruder. The z axis is controlled by two stepper motor in order to enable smooth extruder (printed head) motion in z-direction. The position of extruder is also denoted in figure.

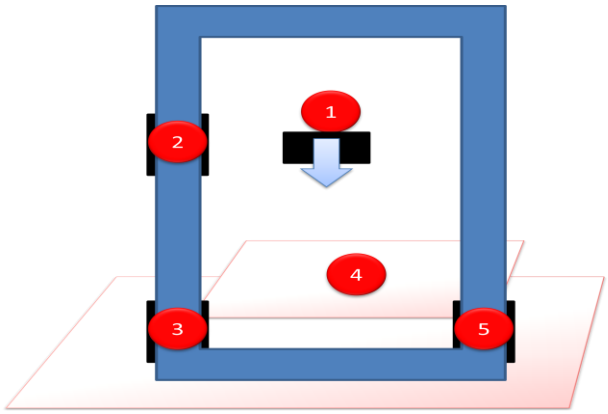

Fig 5. 3D Printer Model

- Here circle indicating the stepper motor for all three axis:
- Total 5 stepper motor are used
- 2 stepper motor are used in Y-axis, 1 stepper motor are used in X-axis, 1 stepper motor is used in Z-axis and 1 stepper motor is used for Extruder.

2. Layout of Stepper Motor for 3D Printer

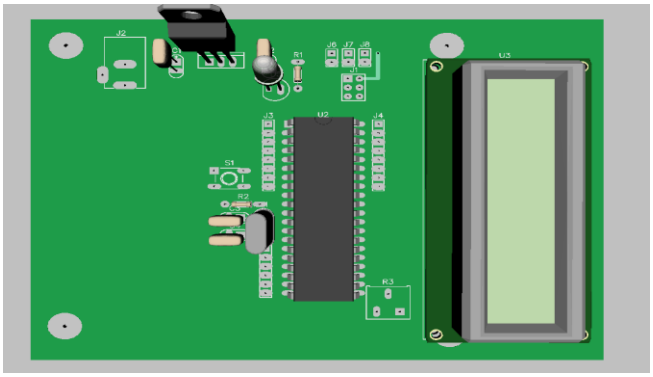

Fig 6. Three Dimensional PCB Layout

V. CONTROL AND SOFTWARE

1. G-Code

G-code is a CNC based tooling language that is used to describe the motions of a tool and the functions of the tool itself in the production of 3D objects. It is a script-based language, where each line usually conveys one type of machine movement [14]. In the grand scheme of 3D printing, G-code is what is created, usually by software, after analyzing a specific part that is to be made. The G-code is generated so as to describe movements that will make a part, including dimensions such as extrusion width, speed, etc.

Some examples of G codes are:

- G00 - Rapid positioning
- G21 - Set programming to millimeters (mm)
- G28 - Return to home

2. Arduino Board Mega 2560

The ATmega2560 on the Arduino Mega comes preburned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. You can also bypass the boot loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header.

3. Programming

The Arduino Mega can be programmed with the Arduino software. For external programmer (e.g. an AVR-ISP, STK500, or parallel programmer), we can burn sketches to the Arduino board without using the boot loader. This allows us to use the full program space (flash) of the chip on the Arduino board. So with an ATmega168, we get 16 KB instead of 14 (on an ATmega8 you'll get 8 KB instead of 7). It also avoids the boot loader delay when you power or reset your board.

4. Marlin

It is the code that Arduino needs to understand all the commands that our computer sends to it. We have to configure most of our 3D printer parameters on it.

VI. CONCLUSION AND FUTURE WORK

This Paper implemented a high-end technology of 3-D printing, which could prove to be a milestone in the field of die making. The final implementation provides a very cost effective and feasible solution to 3-D printing, making it more viable to consumers and opening a wide area of development in this field. The development of this 3D Printer gave a greater insight towards a low cost system which could prove so much useful for preparing a die. Though, this 3D Printer did require overcoming some challenges, like the modeling needed some pretty tough mathematical calculations, and some trial and error methods. After some breaking and some re-assembling, when the mechanical chassis and the structure were ready, the main problem came into picture. The movement of the extruder required up to 5 different stepper motors to be moved simultaneously, which in turn needed 5 motor drivers. Controlling them through g-codes required thorough understanding of Marlin software and the code sequences, this, proved to be quite useful, at the later stages of the development. But, once the whole structure and the program were ready, it was able to print dies successfully, and according to the demanded specifications. Though there are many features that can be added, and this would be a never ending field of research, the objective of the dissertation limits the scope to what was implemented, and proposes it as a low cost solution in manufacturing die and other such jobs/products.

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Link

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