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The Electronic Aspects of 3d Printer

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***Abstract*: -- This research paper is regarding the various electronics used in this project- 3D Printer, which has become a prominent topic of today's discussion. The actuator used in this printer is a stepper motor which is an electrical actuator. It is used to move the various axis of the printer (Cartesian Printer) and to position extruder at its exact location with accuracy. The control for proper positioning is achieved by the use of various electronic components which is being described sequentially in this paper. The accuracy of the 3D printer can be attained by achieving control on various parameters of these electrical components individually.**
Keywords: 3d printing, stepper motor, stereo-lithography, rapid prototyping, additive manufacturing.

I. INTRODUCTION

3D printing technology is an emerging aspect having variety of applications in various fields. The fields of applications are growing day by day. 3D printer is a typical example of mechatronic system, where in the Cartesian printer mechanism is mechanical engineering and the use of stepper motor and circuits is electronic engineering. This paper attempts to discuss the electronic aspects of 3d printer along with their use and utility. The accuracy of 3D printer can be achieved by attaining control over various parameter of these electrical components individually.

The 3D printers generally are designed in three most common styles namely Cartesian, delta and polar. Cartesian 3D printer are named after the dimensional co-ordinate system, the X, Y, and Z axis which is used to determine where and how to move in three dimensions. Another style that is growing in popularity is the Delta 3D printer. These were designed for speed, but they have distinction of a print bed that never moves. The extruder is Suspended above the print bed by three arms in triangular configuration. The last one is Polar 3D printer, it can function with only two stepper motors. It is similar to the Cartesian except that the co-ordinates described parts on a circular grid rather than a square. 3D Printing also known as additive manufacturing, stereo-lithography or desktop manufacturing is a rapid prototyping process whereby a real object can be created from a 3D CAD model for rapid prototyping process. This 3D CAD model is sliced into number of layers in anyone of the slicing software available, it is being done by depending upon the fed layer dimensions and the G-code is generated which is being used to generate signals for stepper motors and is being fed through motherboard and motor drivers to the motors. The accuracy and precision in control can be achieved by proper calibration among these motors. The flow of material used is controlled by use of stepper motors and melted with the help of heating coil at certain temperature as required by passing current from the supply.

Functions of a 3D printer electronics board:

1. Processes G-code instructions.
2. Controls and regulates the four stepper motor controllers where both Z-axis motors are essentially connected to same stepper motor controller.
3. Monitors the end-stops.
4. Controls the temperature of the hot end and heat bed.

II. ELECTRONIC COMPONENTS OF 3D PRINTER

The various electronic components used in our 3D printer are:

A. Arduino

Arduino is a open source hardware. Most of the arduino boards consists of Atmel 8-bit AVR microcontroller (Atmega8, Atmega168, Atmega328, Atmega1280, Atmega2560) with varying amounts of flash memory, pins and features. The MEGA 2560 is designed for more complex projects with 54 digital input output pins, 16 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, a reset button and a large space for sketch, so it is recommended board for 3D printers and robotics projects. It consists of everything needed to support 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.

B. RepRap Arduino Mega Polulu Shield

The MEGA 2560 is compatible with most of the shields. Shields are the boards that can be plugged on the top of the arduino PCB extending its capabilities. Shields can provide motor controls for 3D printing and other applications such as liquid crystal display, ethernets or Global Positioning System.

The RepRap Arduino Mega Polulu Shield, or RAMPS for short is designed to fit the entire electronics needed for a RepRap in one small package for low cost. RAMPS interfaces on Arduino MEGA with powerful arduino MEGA platform and has plenty of room for expansion. The shield design facilitates plug in stepper drivers and extruder control electronics on an Arduino MEGA shield for easy service, part replacement and expansion.

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RAMPS was developed to run 12V system, but it is possible to run 24V with various precautions. Most of the RAMPS boards can run at 13.8V or slightly higher with no modification.

C. Motor Driver (A4988)

A stepper motor of a 3D printer need to be precisely controlled to produce a good quality print. One of the components responsible for this function is the stepper motor driver. A motor driver is a little current amplifier, the function of motor driver is to take a low current control signal and then turn it into a higher current signal that can drive a motor. Typically, the microcontroller does not supply the power to the motor directly, since the microcontroller cannot provide enough power to drive the stepper motor. Using a driver the microcontroller can control the speed and position of the stepper motors while powering the motors directly from the power supply.

The breakout board Allegro's A4988 micro-stepping bi-polar stepper motor driver features adjustable current limiting, over current and over temperature protection and five different micro-step resolutions. It operates from 8V to 35V and can deliver upto approximately 1A per phase without a heat sink or forced air flow.

D. Stepper Motor

A stepper motor, step motor or stepping motor is a brushless Dc electric motor that divides a full rotation into number of equql steps. The motor's position can then be commanded to move and hold at one of these steps without any position sensors for feedback, as long as the motor is carefully sized to the application in respect to torque and speed. The stepper motor is a electromagnetic device that converts digital pulses into mechanical shaft rotation.

The advantages of stepper motor are its low cost, high reliability, high torque at low speed and simple rugged construction that operates in almost any environment. The main disadvantage in using a stepper motor is the resonance effect often exhibit at low speeds and decreasing torque with increasing speed.

E. Hot End (E3D)

Material extrusion uses a nozzle to extrude semiliquid material to create successive object layers. Today, material extrusion is the most common 3D printing process. This technology was invented by Scott Crump in 1988. The material used for creating object is melted with the help of hot end. The hot end consists of.

a. Nozzle- This is the part where the filament comes out.

b. Heater block- It is usually made from aluminium, the heater block joins the nozzle to the heat break and holds the heater cartridge and thermistor.

c. Heater cartridge- This component as the name suggests responsible for heating up the hot end uses a ceramic heater cartridge, though some older design use power resistor or nichrome wire.

d. Thermistor- This part senses the temperature of the heat block. It is usually a small glass bead with two wires attached for high temperature printing a thermocouple may be used instead.

F. End-stops

Mechanical end-stops are popular choice in 3D printer because they are very inexpensive and simple to use. Mechanical end-stops connects to the 3D printer mother board with just two wires. Therefore in terms of setup, one mechanical end-stop is mounted to each axis and wired to the motherboard. In electrical engineering a end-stop is a switch operated by the motion if the machine par as the presence of an object.

They are used for controlling machinery as part of a control system as a safety interlocks, or to count object passing through a point. A mechanical end-stop is a electromechanical device of an actuator mechanically linked to a set of contacts. When an object comes in contact with the actuator the device operates the contacts to make or break an electrical connection.

III. APPLICATION ANDS SCOPE OF 3D PRINTING

There is more in the future as this field advances at a staggering rate and futurists are calling it the revolution of 3D printing like never before. Some of the fields where 3D printing application has highest scope in future are:

A. Developing Complex Engine Parts

Some engines, let's say Jet engines have quite a few complex designs to manufacture. Fuel Nozzle of jet engines for example, can be developed at a much faster pace using 3D printing with more accuracy and enhanced design. Now that the American designers are working on 3-D printed cars they will find it easier to improvise the design for the advancement in performance.

Dr. David Sheffler's class built a 3D-printed jet engine replica that was able to spin at 2,000 RPM.

B. Fashion

3D printing is conquering the fashion world. Although the pioneering new technology still has limitations, more designers are today experimenting with it and creating entirely new looks with more distinguished and more qualitative output.

Daniel Widrig 3d printed jewellery

C. Medical applications

One of the most impact-full area of growth will be in the medical field. Where creation of artificial bones and limbs has made way from experimental to practical life and on the other hand there are investigations on the possibility of printing organic materials to replace defective human body parts. There are few cases of successful facial transplants and prosthetic jaw transplant, and 3D printing-based medical techniques have already saved countless lives and opened new doors in medicines which were not imagined before.

D. Space Explorations

When something goes wrong with the machine parts in space, it is normal procedure to send replacements from earth, which is no easy job and costs millions of dollars. But with a 3D printer in space the required parts can directly printed in space saving up on vital time, cost and reduces potential risks.

IV. CONCLUSION

3D printer are combination of mechanical components along with electrical devices and circuits, electrical motors and computing devices. The selection and use of specific electrical devices decide the functioning and accuracy of 3D printer. Depending on the type and requirement the various electrical components can be selected. This paper can help researcher in development and design of 3D printer.

REFERENCES

[1] Priyanka Takalkar, A. S. Patel, "A Result Paper on 3D Printing And Technologies used for Developing 3D Models", Dr. B. A. M. U. University, Aurangabad, Maharashtra, India.

[2] D. P. S. Pranav, D. Anil Kumar, I. Abhishek, "Development of Arduino Controlled CNC/3D Printer", Mahatma Gandhi Institute of Technology, Hyderabad, Telengana, India.

[3] "Electronic Devices and Circuits by A. P. Gadse", U. A. Bakshi.

[4] "Computer-Aided Design and Manufacturing" M. Groover, E. Zimmers.

[5] Jacobs, Paul Francis (1992-01-01). "Rapid Prototyping and Manufacturing Engineers".

[6] Jagdish, Dr. R. Jayapal, "Design and Development of Universal Switch Mode Power Supply", R V College of Engineering, Bengaluru, Karnataka, India.

[7] Mary B. Halli, Narayana Swamy R, "DESIGN AND IMPLEMENTATION OF ARDUINO BASED 3D PRINTING USING FDM TECHNIQUE", John Institute of Technology, Karnataka, India.

[8] Shailesh J. Parmar, Mital S. Zala, Ishita S. Thaker, Ketan M. Solanki, "Design and Development of Stepper Motor Position Control using Arduino Mega 2560", Dr. Subhas Technical Campus, Junagadh, Gujarat, India.

[9] https://www.arduino.cc/en/main/ArduinoBoardMega2560

[10] https://www.reprap.org /wiki /Arduino_Mega_Polulu_ Shield

[11] http://www.thethirdindustrialrevolution.com