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MULTIPURPOSE CNC MACHINE FOR ADVANCE 3D MANUFACTURING PROCESS

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Abstract:

This paper reviews Multipurpose CNC machine for advance 3D manufacturing process. The basic idea behind our project is to make a CNC machine which will be able to perform multiple machining and industrial work on a single machine. The Multipurpose CNC machine can not only perform Additive manufacturing such as 3D printing, 2D plotting, but also Substractive manufacturing such as Milling, laser engraving, laser cutting, PCB cutting. So in such a way our machine does'nt perform only one or two applications, but a total of six forms of machining works. Our aim to make this machine was to reduce the cost of manufacturing in fields of engineering, medical, architecture. Not only this machine reduces manufacturing cost, but saves time reduces labor, time, does manufacturing on required site. We have tried our best to make this machine as portable, light weight as possible. As of today, for different machining process and different manufacturing work, numorous machines are use. Multipurpose CNC machine has its applications in 3d printing industry, medical industry, engineering industry, arts and craft industry, fashion industry and Food industry.

Keywords:*3DPrinting, Laser engraving, 2D plotting*

Introduction:

In today's world is very competitive & fast changing. Daily new products are launched with additional features. Industries are facing problems such as Fast prototyping, competitive, space availability, cost for every machine, maintenance, size of the machines, because of having different machines for different machining jobs and again all machines are not fully utilized. Normally all the industries require subtracting manufacturing processes like drilling, boring, laser cutting.

At first, we came up with an idea of building a CNC machine which can perform all these above manufacturing processes. After that, we thought of building a machine which can not only perform subtractive manufacturing, but also additive manufacturing such as 3D printing and 2D plotting. So our multipurpose CNC machine can perform 6 different manufacturing processes. Generally industries are using various CNC machines for manufacturing a single product, so with help of our multipurpose CNC machine that one product can be manufactured very easily with different operations.

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WORKING PRINCIPLE:

Multipurpose CNC machine employees all this machining work by uploading g-code file to it. After uploading the appropriate g-code file using software, second thing we need to do is selecting a proper tool head according to the purpose for which the MCM is to be used and then mounting it on the machine. In such a way by simply making some software changes and changing the tool head, the machine can be used for six different machining works.

3D Printer:

When the 3D printer filament extruder is mounted on our multipurpose CNC machine, it can be then used for 3d printing purpose. The 1st step is to design a 3d model which can be prepared in a 3d modelling software. This 3d model is then uploaded to a slicing software and is sliced, that is g-code is created.

Slicing is a process in which a 3d model is converted into a language a 3d printer can understand. Slicing is can be done using various softwares available online by just configuring settings according to the machine settings.

2D plotting:

Tool head for 2d plotting has to be changed from extruder to a pen/marker. For 2d plotting we are using a normal vector image which will be converted into a 3d model of 0.1 mm and then sliced into 2 layers. Here our MCM will be tricked into making a 3d model where as it will be just drawing in 2 dimensions.

Laser engraving:

Tool head for laser engraving is used a 500MW laser which is mounted in place of filament extruder. For laser engraving we need to create a g-code file for vector image. Using lasers with different power cutting and engraving is possible. Laser has to be connected on the ramps board in place of cooling fan, so that PWM signals can be sent to the laser.

Engraving on acrylic sheet:

If a high speed dc motor is fixed in place of extruder then PWM signals can be sent to the motor to control the speed and same technique as 2D plotting can be used to engrave on an acrylic sheet (Milling machine of high power can be used to engrave and mill on to wooden pieces, as the z axis will not be able to lift weight of high power milling machine then a flexible shaft can be used to transmit power to the z axis at place of extruder where the drilling bit will be fixed.)

Main Electronic components:

1) Arduino mega 2560
2) Ramps
3) 128x64 Full graphic LCD
4) A4988 motor drivers

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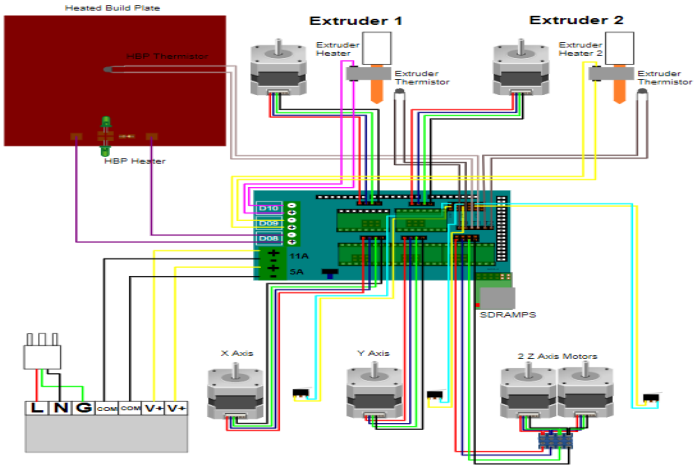
5) Heat bed Thermistor NTC 100k
6) Filament extruder
7) Nema 17 stepper motors (4.2kg)
8) MK2B Heat bed
9) ATX from old CPU
10) Limit switch

Hardware requirements:

1) Smooth rod (6mm Diameter)
2) T8 threaded rod
3) T8 nuts
4) Lm6uu bearings
5) L brackets
6) Aluminium profile

Wiring diagram:



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APPLICATIONS:

1) **Engineering Industry**
2) **Electronic industry**
3) **Plastic Surgery Industry**
4) **Dentistry**
5) **Orthopedic**
6) **Fashion Industry**
7) **Prototyping and product development Industry**
8) **Food Industry**
9) **Refurbishment Industry**
10) **Arts and crafts Industry**
11) **Architecture**
12) **Education Industry (School projects)**
13) **Casting / Foundry industry**

Applicationsof 3d printing are infinite, they range from 3d printing art work to constructing a real size house to food and chocolate 3d printing. Currently 3d printers are used in engineering field for creating complex structures and hollow objects. China recently even produced 3d printed houses using large size 3d printers. With 3d printing technology manufacturing cost of products has been drastically reduced which is a push forward for additive manufacturing industry. In engineering industry it has not only save time, labour but also raw material required for production which was being wasted in current subtractive manufacturing technology.

Doctors are using 3d printers for producing prosthetics, artificial bones, jaws etc. Recently in USA a woman whose jaws were completely damaged in a car crash resulting in face damage and losing speaking abilities undergone a surgery where her jaws were replaced with 3D printed jaws. Also metallic 3d printed bones are being used in medical surgeries. Dentists will be able to 3d print teeth within no time in ceramic material in near future.

Fashion designers from France are using 3d printing technology to manufacture clothes. Using flexible filaments like nylon they were successful in creating 3d printed wearables.

Food industry is no behind in the race of using 3d printers. One of the largest chocolate manufacturers from USA, Hershey is currently trying and exhibiting their unique and custom 3d printed chocolates. The company promises to launch their chocolate printing 3d printers soon.

Refurbishment industry is using 3d printers to print broken parts of old machines which have no service centers available in market. The basic idea is to either scan the broken part or make a 3d model in computer using 3d modelling services and software and then 3d printing the model in required material. (PLA, ABS, Carbon Fiber or any other) Architectures are using this technology to create small size replica of actual building which will be built using traditional methods and might take time.

Soon in coming years this machine can become in every house just as computers are in every household.

Results: Actual Machine manufacturing:

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First size of machine was finalized which can manufacture part of size 150 mm X 150 mm X 150 mm. Prepared drawings for the the same. Electrical circuit diagram was prepared.

List of components prepared. Specifications for components finalized. Soureces for components were sreach and finalized. Components were procured. Those component not available directly. Drawings prepared of it. Raw material procured and compoenents manufactured from it. Components were tested for the performance such as motors, power supply, heat bed, Arduino, etc.

At first we surveyed all kinds of stepper motors available in market. We selected Nema 17 stepper motor for our multipurpose CNC machine which can give up to 4.2 kg of torque which was enough to do normal machining works like 3d printing, 2d plotting, laser engraving etc. Then we selected smooth rods of appropriate length for X axis, Y axis and Z axis. T8 threaded ACME rod was selected for Z axis as it is multi start and can produce faster motions. Also we did the selection of couplers for coupling the two stepper motors of Z axis with the threaded rods. To start off with the 3d printer we used wooden ply as base and started mounting our parts on to it. The frame of 3d printer was made using an aluminium profile which was bent at 2 places in 90 degrees. Motor holders and mounts were printed in PLA using another 3D printer.

3D printed parts for our machine

Frame of 3d printer using aluminum profile

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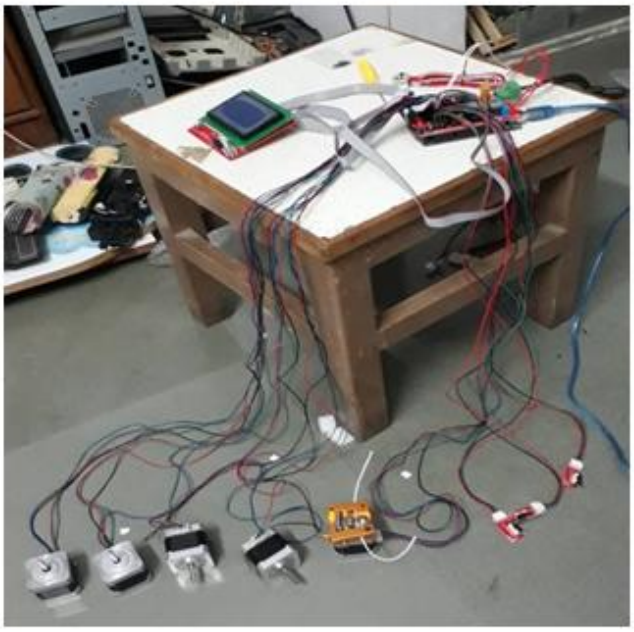
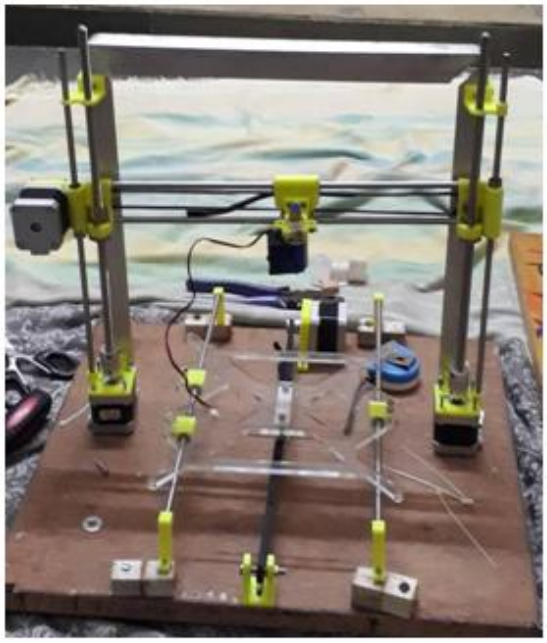


Testing of motors, drivers, limit switches, extruder and thermistor



Mechanical assembly of machine

Assembling the mechanical parts (a)

Assembling the mechanical parts (b)

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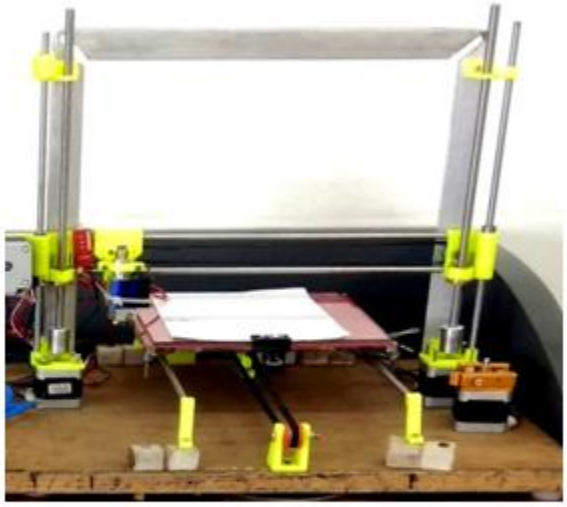

Final working machine

3D models printed on 3D printer

Once mounting of all parts was done and mechanical assembly was completed. All parts alignment checked for parallelism and perpendicularity. Movement ball screw. Movement of bed. Levelling of bed. Calibration machine regarding bed level. Tool movement over all part of bed. Adjustment of home position of Tool and Bed. we started wiring the electronic components. After completing wiring we uploaded the firmware to Arduino Mega by making specific changes in the configuration page of firmware obtained from marlinfw.org website which is open source and easily available. Synchronization of Bed movement, tool movement and extrusion of plastic was done.

Future area of research:

We want to increase the productivity and efficiency of our MCM so we are currently working on finding solutions for the heating issues related to motors and drivers. Currently we are providing our machine with air cooling but want to provide water cooling just like type of liquid cooling provided in gaming computers.

Also today we need to prepare a 3d model in computer before printing it, so for refurbishment purposes we are working on photogrammetry technology which will be able to scan temporarily joined objects and prepare a 3d model itself in computer. This will reduce the skills and time required to design a 3d model. Fully developed machine will be able to scan a object and print it in required material and colour by automatic selection process by sending couple of commands like a Xerox machine.IOT..digitization.

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