Widening the Scope of 3D Printers

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Situation

3D printers were founded by Charles Hull in 1986 and were made available to the public through his company 3D systems [1]. 3D Printers are currently being used in many industries including the Aviation, Automotive and Medical industries. As a result of the use of 3D printers in these large industries, the 3D printing market has been steadily growing as shown in figure 1 below. This creates a need to improve 3D printers and widen their scope of use to make them a more valuable commodity in several industries.

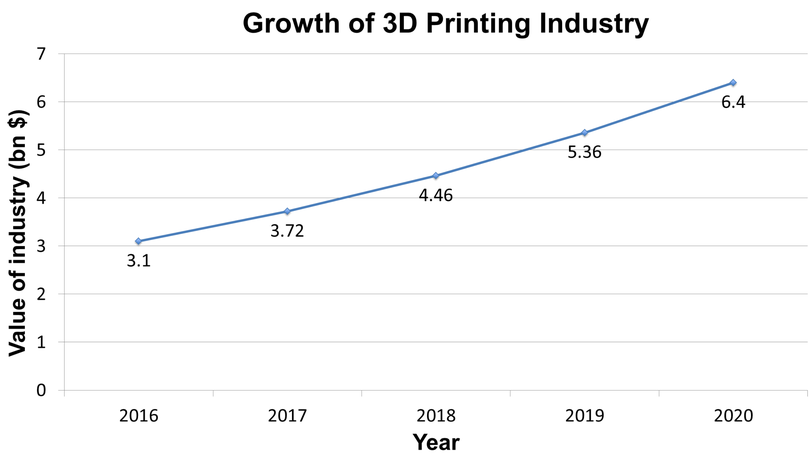

Figure 1: Yearly growth of 3D printing industry [2]

Problems

- Lack of speed in 3D printers leads to lower production output levels which is impractical for industries that require mass production. This factor depends on the mechanics of the printing process such as the motors and the axes of movement.
- The application scope of the printer is limited due to the extrusion materials and support limitations. An extruder is the part of a printer out of which the printing material flows, and existing models make use of one or two extruders that print limited materials. Also, objects with irregular shapes and extended parts are impractical when printing using the existing printers due to the lack of support and cooling provided for the extruded material.
- Materials such as wood or steel are not durable. For example, steel is corrosion susceptible and hence, when used for the body of the printer, this decreases the durability and the printer requires maintenance more frequently
- Maintenance is costly and time-consuming because entire parts of the 3D printer, such as the wiring system or the extruder head, need to be replaced when faulty.

Solutions

In this project, we propose implementing a step motor (1), a rotating bed (2), a four-extruder system (3), a movable platform (4), and a cooling system (5).

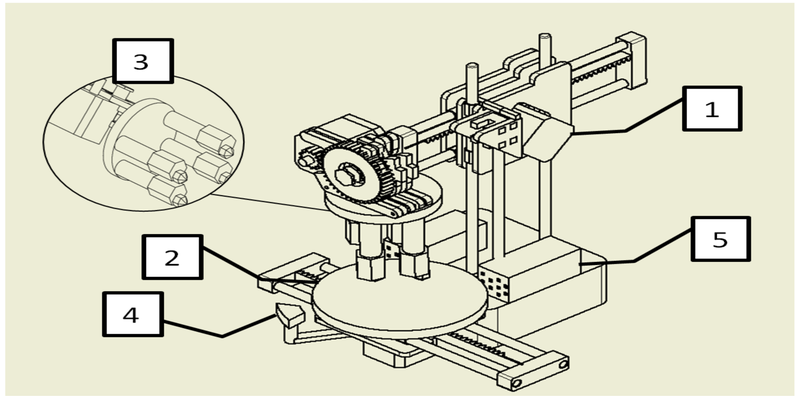

Figure 2: Model of 3D printer with labeled parts

Increasing speed

As shown in figure 3, the rotor shaft of a step motor is teethed and hence, it converts a digital input of power to a step-wise rotation of the shaft. In a step motor, the number of input steps and output steps always match and hence, the speed of printing can be increased and will not be affected by fluctuations in the input power [3].

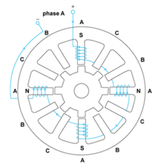

Figure 3: Rotor shaft [3]

The rotating bed moves based on polar coordinates as well as Cartesian axes and therefore, this also increases the speed of printing.

Widening the application scope

Extrusion depends on the type of material being used for printing, as well as the temperature [4]. Therefore, a four-extruder system which allows the inter-changeable use of metals, ceramics, biomaterials, and composite materials, will enable the use of different materials at different conditions within the same printer. Also, the movable platform and cooling system provide support for the object being printed and increase the speed of cooling, and this allows for a wider range of product shapes.

Increasing durability

Figure 4 below shows aluminum 6061 honeycomb structure embedded between steel plates, which is a light-weight, cheap, durable material for the body of the printer. Paint coating will also serve as a solution for the corrosion problem.

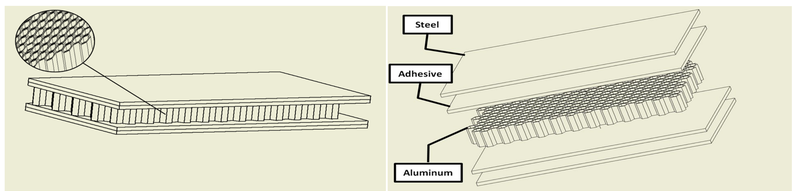

Figure 4: Honey-comb aluminum 6061 structure

Easing maintenance

Using silver wires in the proposed model of the 3D printer will make the wiring system more durable. The properties of silver make it more favorable than copper, as shown in table 1.

Also, organizing the wiring system with the use of electrical connector plugs will ease the maintenance process. Parts of the 3D printer such as the extruder head can be replaced in a shorter amount of time and at a lower cost with this proposed wiring system.

Table 1: Comparison between silver and copper electric wires [5]

Copper wires	Silver wires
*Good conductivity	*Higher conductivity
*Used in most applications	*Used in audio electronics
*Average Durability	*More durable

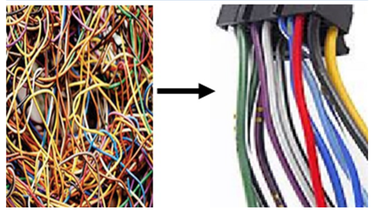

Figure 5: Organizing wires to ease maintenance

Evaluation

Improving the 3D printer will make it a valuable commodity for applications such as prosthetic limbs in the Biomedical Engineering industry, as well as engine parts in the Automotive and Aviation industries. Practicality and low-cost are also criteria that support the solutions proposed in this project as seen in table 2 below.

Table 2: Comparison between existing and proposed models of 3D printers [6,7,8]

	Price	Size	Weight	Extrusion materials	Speed	Body material	# of extruders
Existing model of 3D printer	$6500	19.4" x 22.2" x 33.6"	52 kg	PLA	Very fast	PC-ABS	1
Proposed model of 3D printer	• Step motor = $25 • Body = $334 • Extruders = $704 *Total* = $1063	6.0" x 6.0" x 6.0"	4.8 kg	• Metals • Ceramics • Biomaterials • Composite materials	Faster than existing	Aluminum 6061 alloy embedded between thin sheets of steel	4

References

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