Development of a 3D printer for multi-material applications: Design of the prosthetic hand

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INTRODUCTION

SLS, or Selective Laser Sintering, is considered to be one of the most accurate techniques. It is a 3D printing process known as powder bed fusion, which utilizes laser to sinter powdered material. PCL(Polycaprolactone) and polyamide powder are typical polymer materials for SLS. New design of the SLS printer for composite materials allows wider range of materials to construct.

AIM

create a system for multi-material feeding chamber and its technology

OBJECTIVES

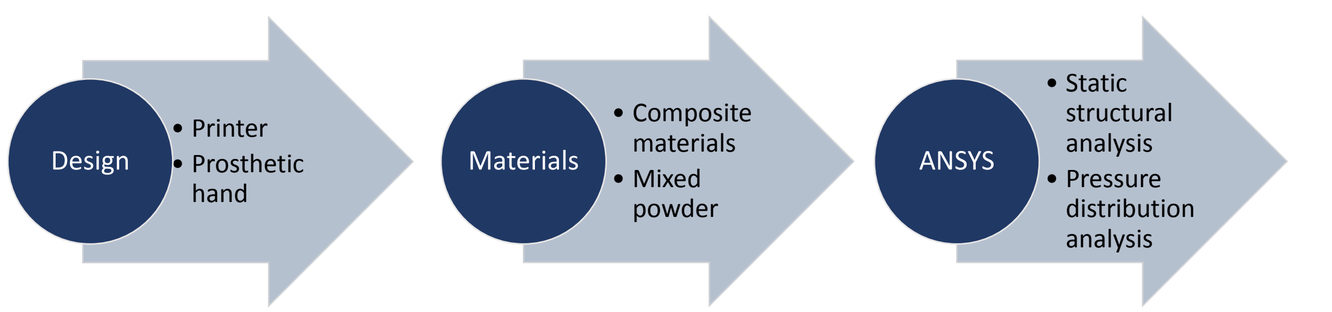
To develop a cost-efficient 3D printer for multi-materials application

To design special design of the prosthesis for SLS multi-material printing

Simulate the materials in the software

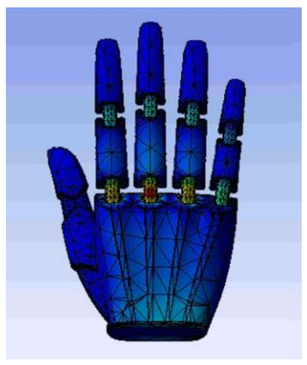
METHODOLOGY

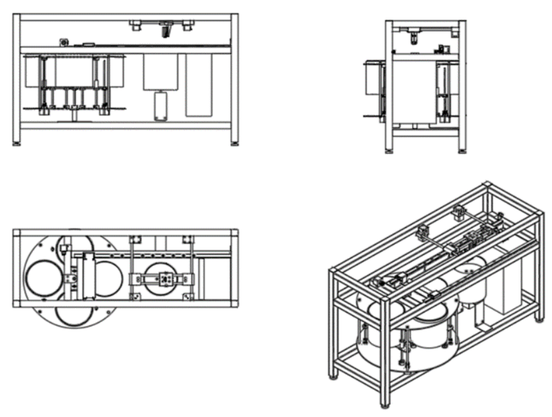
	Min	Max	Average
Total deformation	0mm	0.00018515mm	0.000092575mm
Directional deformation	-1.2497e-005mm	3.3096e-005mm	1.02965e-005mm
Equivalent Elastic Strain	0mm	4.4942e-007	1.4985e-007
Maximum Principal Stress	-6.3457e-010MPa	4.415e-007MPa	-0.96535e-008MPa
Shear Stress	7.5174e-MPa	9.1914e-004MPa	8.6855e-004MPa
Minimum Principal Elastic Strain	3.7412e-015mm/mm	5.6416e-015mm/mm	4.6908e-015mm/mm
Minimum Principal Stress	-8.8911e-002 MPa	2.6852e-002MPa	-3.1029e-002MPa
Normal Stress	8.5427e-004MPa	9.8862e-004MPa	9.2144e-004MPa
Elastic strain	- 2.8661e-017 mm/mm	5.9478e-007 mm/mm.	-0.0713e-012mm/mm



Especially for this project the design of prosthetic hand was made in order to compare materials performance of the multi-material printing. Three steps for design investigation are conducted. Design for printing in entire object with full range of joints. Next stage, materials selection for both electronics/mechanical parts and consumables. Last was to check the design for deformations in ANSYS.

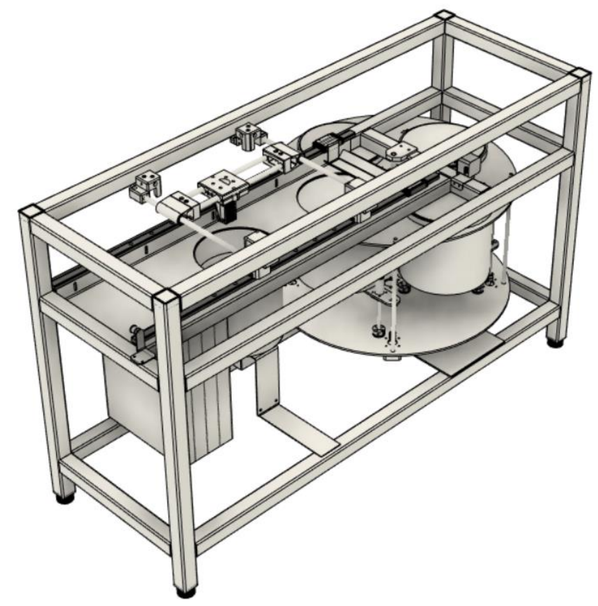
RESULTS





Drawing of the SLS printer for multi-materials

The novelty of this design is the four chambers of feeding platforms which capable of printing up to four materials by rotating the main chamber. The main chamber consists of four cylindrical containers where the powders are placed. The platform for excess materials is also considered in the design which is separated into four sections. The design utilizes CO_2 laser for sintering process which based on two axis movement in contrast to conventional mirror system with galvanometer. Laser is controlled by stepper motors, the electronics such as controller (Raspberry Pi) are not considered in the design but are in the list of consumables. Therefore, the CNC mechanism was selected because the prior mechanism was too sophisticated to be installed in a SLS printer as it involved the complex control movement of the mirrors and was not commercially viable. The fabrication platform (in the middle) has the press to move downwards, it should be 0.5mm distance between each layer to be dispersed by the roller. The roller repeats the same process of spreading powder to the fabrication platform, whereas the rest of materials shift to the compartment for excess materials.



Design of the printer

CONSLUSIONS & RECOMMENDATIONS

1) Minimization methods for multi-material structures; from polymer materials with the desired mechanical properties.
2) Development of the concept of SLS 3D printer for multi-materials.
3) Material optimization of the new multi-material structures. The analysis of material reduction was performed in ANSYS software considering the composite material characteristics.
4) Considered limitations of the new concept of the SLS-based 3D printing;
5) Explored the multi-material design for the novel technology and applying simulation techniques.

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