DESIGN AND ANALYSIS OF PRESSING MECHANISM FOR IMROVING 3D PRINTING PROCESS

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DECLARATION

I declare that this project report entitled “Design and Analysis of Pressing Mechanism For Improving 3D Printing Process” is the result of my own work except as cited in the references

Signature : .....

Name : Muhammad Hafiz Helmi Bin Ibrahim

Date : .....

PENGAKUAN

Saya akui laporan ini yang bertajuk “Reka Bentuk dan Analisis Mekanisme Menekan Untuk Memperbaiki Proses Percetakan 3D” adalah hasil kerja saya sendiri kecuali yang dipetik daripada sumber rujukan.

Tandatangan : .....

Nama : Muhammad Hafiz Helmi Bin Ibrahim

Tarikh : .....

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature : .....

Supervisor's Name : Associate Professor Ir. Dr. Mohd Rizal bin Alkahari

Date : .....

DEDICATION

To Allah S.W.T

For blessing me with a wonderful life

To my beloved mother

A strong and gentle soul who taught me to believe in hard work

To my father

For always supporting me and encouraging me not to give up in life

To my peers

For always cheer me up

ABSTRACT

Three-dimensional printing is a method in which a digital model is transformed into physical object by adding material layer by layer. Despite rapid progress of 3D printing, there are still several area that can still be improve. In 3D printed object, there are many porous areas because of the circular shape of the printed filament. As amount of porous increase, the strength of the printed object decrease. The purpose of this paper is to design new pressing mechanism that act as an attachment to the existing 3D printer and to analyse the effectiveness of the developed system. The selection for the pressing mechanism was made using morphological chart. The prototype for this mechanism was integrated to the existing Fused Deposition Modeling (FDM) 3D printer to apply pressure during printing process. For the pressing mechanism to be tested, a dog bone sample was printed to use for the experiment. Original dog bone samples are compared to the sample with pressure applied on it. Infill density and printing speed are the parameter chosen to be tested. Through the length, width, thickness, surface roughness test, tensile test, and porosity test, the mechanical properties and the dimension of parts fabricated by the new mechanism were obtained. Results show that sample with pressure for infill density parameter were better compared to original sample. As for the speed parameter, sample with pressure applied did improved the porosity percentage of the sample but only at lower printing speed. The pressing mechanism does help improved the strength of the printed object but at the cost of sacrificing the actual dimension of the samples.

ABSTRAK

Pencetakan tiga dimensi adalah satu kaedah di mana model digital diubah menjadi objek fizikal dengan cara menambah bahan lapisan demi lapisan. Walaupun proses pencetakan 3D mengalami kemajuan yang pesat, masih ada yang boleh diperbaiki. Dalam objek cetakan 3D, terdapat banyak liang-liang disebabkan oleh bentuk bulat filament. Apabila kawasan berliang meningkat, kekuatan objek yang dicetak menurun. Kajian ini bertujuan untuk mencipta mekanisme penekan baharu yng bertindak sebagai bahagian tambahan kepada pencetak 3D sedia ada dan bertujuan untuk menganalisis keberkesanan sistem yang dibangunkan. Cara pemilihan reka bentuk untuk mekanisme menekan adalah menggunakan kaedah carta morfologi. Prototaip mekanisme ini dipasang ke pencetak 3D FDM yang sedia ada untuk memberikan tekanan ke atas filamen ketika proses mencetak. Untuk menguji mekanisme menekan, sampel tulang anjing telah dicetak. Sampel asal dibandingkan dengan sampel yang dikenakan tekanan ke atasnya. Ketumpatan dan kelajuan mencetak merupakan parameter yang dipilih untuk diuji. Melalui ukuran dimensi, ujian kekasaran permukaan, ujian tegangan, dan ujian keliangan, sifat mekanik sampel yang dicetak oleh mekanisme diperoleh. Keputusan menunjukkan sampel yang menerima tekanan untuk ketumpatan penuh lebih baik berbanding sampel asal. Untuk parameter kelajuan mencetak, sampel yang menerima tekanan ada menambah baik peratusan keliangan sampel tetapi hanya untuk kelajuan mencetak yang perlahan. Mekanisme menekan memang membantu meningkatkan kualiti objek yang dicetak, tetapi dalam pada masa yang sama memberi kesan kepada ukuran asal sampel tersebut.

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ABBREVIATION

3D	– 3 Dimensional
AM	– Additive Manufacturing
ABS	– Acrylonitrile Butadiene Styrene
CAD	– Computer-Aided Design
DC	– Direct Current
FDM	– Fused Deposition Modeling
PLA	– Polylactic Acid
RP	– Rapid Prototyping
SLA	– Stereo Lithography
SLS	– Selective Laser Sintering
STL	– Standard Tessellation Language
USB	– Universal Serial Bus
UV	– Ultraviolet

CHAPTER 1

INTRODUCTION

1.1 Background

Three-dimensional printing is a process where a digital model is turned into a physical three-dimensional object by adding material layer by layer until it complete at a time (O. Diegel, 2014). This is where the term of additive manufacturing come from. Nowadays, three-dimensional printing is not uncommon as it used to be. Three-dimensional printing is now being used whether in medic, industries and even for personal use. Heavy industries in production usually use three-dimensional printing as a test model before they start their mass production by using injection moulding. This is because based on from (Anonymous,2018) three-dimensional product that are printed can be analyse to review the design to detect any problem in the design. This can save the company a lot of money. Despite 3D printing process having progress rapidly, there are still several area that can still be improve. One is about the strength and the porosity of the printed object. The most interesting idea to tackle this problem is to apply pressure after printing each layer. By doing this, each layer of filament that are printed can be flatten and make it stronger.

1.2 Problem Statement

In 3D printed object, the mechanical properties of it is lack in strength. This lack of strength is because the filament that are arrange layer by layer is circular in shape. This as a result can produce many porous areas for the printed object. As the amount of porous increase, the strength of the printed object decrease.

1.3 Objectives

The objectives of this project are as follows:

- To design new pressing mechanism during 3D printing.
- To fabricate additional mechanism as attachment to the existing 3D printer.
- To analyse the effectiveness of the developed system.

1.4 Scope of Project

The scope of this project are as follows:

- Using low cost 3D printer (open source system / entry level printer)
- Using FDM process parameter such as layer thickness and infill density
- Using thermoplastic material such as ABS and PLA.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter focus more on the project development that is base from the previous studies. Any study that were related to the project were referred to help better understanding about this project such as the quality of the object printed by FDM. 3D printer that are integrated with pressing mechanism to enhance the structure of the object printed were never find before because this project are the first of its kind. This pressing mechanism also help to improve the quality of the product. The mechanism of the 3D printer integrated with pressing mechanism were explained in this chapter. Additive manufacturing also were explained briefly in this chapter.

2.2 History

3D printing uses computer technology to create solid objects of three dimensions. 3D printing combines thin horizontal cross sections of the additive process or layering of the material with a computer program for printing solid objects. You can create almost anything from 3D printing, including toys, weapons or parts of the machine. The history of 3D printing is important in order to understand the future of production.

Japanese inventor Hideo Kodama in 1981 was the first person recorded attempting 3D printing in the additive process. He created a product using UV lights to harden polymers and create solid objects. Charles Hull invented stereolithography, a 3D printing process that uses technology to create prototype version before manufacture the actual product. This way, more money and time can be save because the company can test it on the prototype rather test it on the actual product. The object is layer by layer printed, solvent rinsed, and ultraviolet light hardened. Computer Aided Design (CAD) are used to create 3D models.

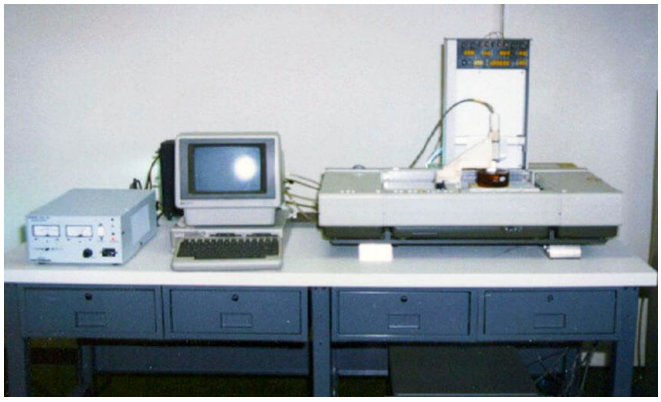

Figure 2.1: SLA-1 invented by Charles Hull in 1987 (H. Bensoussan, 2016).

Figure 2.1 shows the first-ever 3D printer that are invented by Charles Hull. This 3D printer transform manufacturing process and enabled designs with complexity.

Selective Laser Sintering (SLS) is another more advanced 3D printing/additive manufacturing form. It uses additive production and a polymer–usually nylon–powder to create objects. SLS uses a laser to combine the powder, layer by layer, in more complex forms than SLA can create. Fused Deposition Modeling (FDM) by Scott Crump is the most common form of 3D printing nowadays. It is known as the "3D desktop printers" because it is the most widely used technology form. The printer heats a thermoplastic cable into a liquid form in order to form an object and extrudes it layer by layer (Brooke Hahn, 2018).

2.3 Rapid Prototyping

Rapid Prototyping (RP) is a technology used to construct a physical model or prototype directly from three-dimensional Computer-Aided-Design (3D CAD) data in a very short time (Harun et al., 2016). The 3D printer enable designers to quickly create tangible prototypes rather than two-dimensional images of their designs. Such models have many uses. They provide excellent visual aids to communicate ideas within colleagues or customers in addition to design testing (Mahindru & Mahendru, 2013).

2.3.1 General Principles of 3D Printing

This is the general process of 3D printing:

1. Designing 3D model. Any type of CAD Software that can design 3D model can be use.
2. Generation of STL files. As there are many CAD software, hence to standardized and bring uniformity all files are saved in .STL format. Where STL is stand for Standard Tessellation Language.
3. Support are generate for overhang parts.
4. STL files are check for any defect.
5. STL file is transmit to slicing software.
6. The STL model is slice into thin cross sectional layer (Slic3r)
7. Part building layer by layer
8. Finishing prototype

Firstly, it begins with 3D product modelling. There are many type of software for 3D designing in the market nowadays. All of design software have their own pros and cons, so user have to decide which software suit best. After the designing process is finish, the design have to be convert to the CAD drawing to a STL file. Different surfaces of a CAD model are approximate in a piece by a series of triangles and the vertices of triangles and their surface norms are listed in tessellation. After the STL file are generate, overhang part in the drawing need to have support generate for it. Usually, slicing software can auto generate support for this overhang parts. Then, these STL files are check for any defects and are repaired if found to be