ABSTRACT

Knee braces is a tool used to avoid knee injuries. Traditional knee braces not suitable for many types of movement, such as running, jumping, pivoting, and kneeling. Traditional knee braces don’t have custom size. It just have few select sizes such as small, medium, and large. This knee braces are created to enable consumer to wear and use knee braces that suitable with their knee sizes and also to create low budget knee braces that suitable for any movement. Knee braces will be created by using software that called Blender and Cubify Sense. The main equipment that will be use is 3D Scanner and 3D Printer. The prototype will be print using 3D Printer. After do the final step, this prototype is ready to use by person.

Keywords: braces, knee support, computer-aided

INTRODUCTION

Fabrication is a manufacturing process in which an item is made from raw or semi-finished materials instead of being assembled from ready-made components or parts. Computer-aided design (CAD) is the use of computer technology to design and create documentation. Nowadays, CAD have replace the manual drafting with an automated process. This software have more advantages than manual drafting. Knee braces is a tool that you wear for a painful or injured knee. Some people use knee braces to avoid knee injuries during sports. Braces are made from vairety materials such as metal, foam, plastic, elastic materials and straps. Braces have many sizes, colors, and designs. Computer-aided knee braces fabrication can be defined as a computer method that used to design and create custom size of braces thats can be wear by all person that have leg injury and athlete. Currently, manufacturing have created knee braces that only for few select sizes such as small, medium, and large. Traditional knee braces require extensive machining and strap components. By using CAD program, we created a custom-made knee brace that can be wear for all consumer.

PROBLEM STATEMENT

Current method to develop the knee braces is complicated because the manufacturer produce knee braces that not have custom size. It just have few select sizes such as small, medium, and large. Traditional knee braces are not subtable with patient’s knee size. Traditional knee braces also not suitable for running, jumping, pivoting, and kneeling. Patient that wear traditional braces can cause skin irritation, joint swelling, and discomfort. Knee braces that have in market right now also quite expensive.
Traditional knee braces are not user friendly because quite difficult to put on and remove when wear it.

To collect details about resizing knee braces, it requires patient 5 to 7 hospital visits for customization. It can caused air pollution due to frequency visits hospital for customization process. It can also increasing cost for patient. Traditional process took about 2-3 weeks to complete the knee braces. In average, there are 20 tons of CO2 are released into atmosphere in produce traditional knee braces due to used of aluminium as a material. Traditional knee braces have are solid structure. While in this research, knee braces come out will honeycomb structure in the design allowed reduction of material’s weight.

RESEARCH OBJECTIVES

The main objectives of doing this research is to study a new effective method to develop a customized knee braces. Therefore, the objectives of this research are;

i. To scan the knee area.
ii. To design knee braces using CAD method
iii. To fabricate knee braces that suitable with patient knee sizes.
iv. To test the knee braces.

METHODOLOGY

Method to develop the custom-made knee braces can be categorized into several stages.

Data acquisition
This section discussed the method to transform 3D data from knee.

Equipment preparation
First step to delevop custom-made knee braces is scanning. Scanning is process transfer physical knee into digital data of knee model. The scanner that used is Cubify Sense 3D scanner. The 3D scanner shown in Figure 1.

![3D Scanner](image)

Figure 1
3D Scanner

Scanning process
At this stage, knee has been scan and transform it to digital data. A Cubify Sense 3D scanner are used to scan size of knee in this research. The subject will be scanned and be analysed into the digital data. To perform the digital data, 3D system Sense software was selected. To get a good data, the scanning process should be done carefully to avoid
the problem such as lost tracking and blur data model. The scanning process is shown in Figure 2.

Figure 2
Scanning process

Knee braces model development
This section discussed about methods to develop the knee support.

Insert to software
In this research, Blender software was used to construct the knee braces due to friendly user. This software can be downloaded easily for a website without any payment or trial version. Blender software was built for creating and modifying the 3D model. This software allows 3D models printed using 3D printer. Figure 3 shown 3D knee in Blender.

Figure 3
3D knee in blender

Design the knee braces
In this stage, design process of knee braces were shown in details. Firstly, the previous 3D scanning subject need to import to software. The 3D model is imported to the Blender for modifying. After that, a cylinder object was created. The cylinder insert around the 3D model. Then, cylinder object need to subtract. Subtract process can be done using boolean method. Process design of knee braces is shown in Figure 4.
3D printing of knee braces model

In this section, the process of 3D printing for knee braces model discussed. 

3D printer preparation

3D printer is the most important tool in this project. The knee braces model can be print with 3D printer. The 3D printer that been used is Flashforge Creator Pro Dual Head 3D Printer. Makerbot software is needed for additional setting before the model can be printed. Material used for created physical knee braces is Polylactid Acid (PLA). Figure 5 shown the 3D printer.

3D printing process of knee braces model

The design of the 3D knee braces model was exported to StereoLithography (stl) format and import to the Makerbot software. 3D printer can be setting according to the user preference by using Makerbot software. For example, the temperature of the printer nozzle and platform can be set at Makerbot software. Knee braces model need some rafting and support part to avoid model from collapse and these created at Makerbot. After setting, the print file was exported and save in X3G format. This format can be read by the 3D printer. The printing process of knee braces took about 3 hours and 47 minutes. After finished print, the raft and support materials removed from knee braces. The printing process is shown in Figure 6.
Process to testing knee braces
Knee braces has been printed using 3D printer. After printed, knee braces has been assembled part by part. The assembled process took about 15 minutes. Then, the knee braces will attached to the patient's knee. Testing process include identify either the size of knee braces matching with size of patient’s knee.

RESULT

Result shows the new method that can develop custom-made knee braces. The result discussed in this stage.

Scanning process result
After finished scanning the physical subject to digital data, the data transferred into Sense software that called 3D Builder. The result of scanning process show in Figure 7.

Knee braces design result
The knee braces has designed in Blender software. They are several step to made completed design of knee braces such as subtract and boolean methods. The final design of knee braces show in Figure 8.
3D printing result
Design of knee braces has printed with 3D printer. The 3D model of knee braces has been modified in Makerbot. Rafting and support part has added to avoid knee braces from collapse. The 3D printing process took about 3 hours 47 minutes. The 3D printing result shown in Figure 9.

Knee braces testing result
After all component of knee braces been assembled, knee braces attached to the patient’s knee. The patient has to wear the knee braces. Then, after checking the knee braces and patient knee, the size of knee braces and patient knee was matching each others. The patient is comfortable wearing this knee brace without any side effects. The testing result shown in Figure 10.
CONCLUSION

This project has nicely done identified a new method of develop knee braces would enable a patient to wear a custom-made knee brace. The method has been explained and discussed in the paper. This method providing benefit because it can reduce assembly time dan costs. Besides that, it is green technology. In future research, researchers are suggestes to develop more features for knee braces.

REFERENCES


