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Human Knee Joint Mri Digital To The Fabrication Of 3D Printed Scaffolds

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Abstract — *Now a days FDM (fused deposition modeling)plays a important role In so many sectors, particularly in medical sector it plays a vital role for preparing a surgical guides. The main objective of this project is to develop an artificial knee joint with cost effective and shortest period of time, regarding this work fist collect MRI digital data for the particular patient knee joint, then import in to 3D slicer software Check the dimensions of knee plate which is suitable for patient in 3D slicer software. Print exactly the suitable knee for patient by using 3D printing machine with ABS or PLA are filament. If the 3D printed knee is suitable for replacement, then artificial knee be printed with Ti-6Al-4V filament. By doing this process ordering cost and processing time can be decreased, and also operation time can also be decreased. Because of these reasons total operation cost, Time consuming can be decreased and patient can walk comfortable when compared to trial and error method.*

Keywords-. *MRI digital data,3D slicer,3D printing, DICOM*

I. INTRODUCTION

3D Printing is additive manufacturing process. Every 3D print starts as a digital 3D design file like a blue print for a physical object. Trying to print without a design file is like trying to print a document on a sheet of paper without a text file. This design file is sliced into thin layers which is then sent to the 3D printer.

From here on the printing process varies by technology, starting from desktop printers that melt a plastic material and lay it down onto a print platform to large industrial machines that use a laser to selectively melt metal powder at high temperatures. The printing can take hours to complete depending on the size, and the printed objects are often post-processed to reach the desired finish.

Available materials also vary by printer type, ranging from plastics to rubber, sandstone, metals and alloys - with more and more materials appearing on the market every year

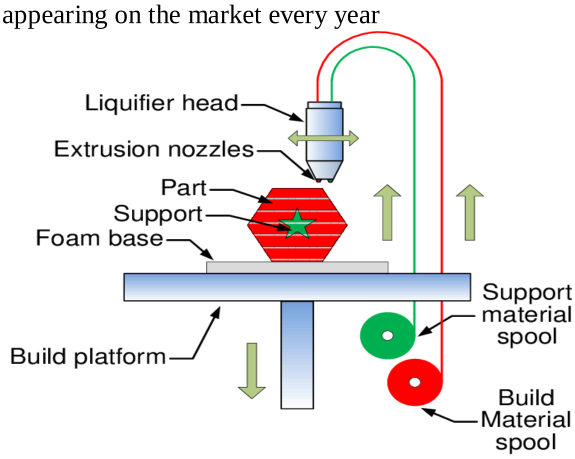


Fig1.1 FDM working principle

The FDM technology works using a plastic filament or metal wire which is unwound from a coil and supplying material to an extrusion nozzle which can turn the flow on and off. The nozzle is heated to melt the material and can be moved in both horizontal and vertical directions by a numerically controlled mechanism, directly controlled by a computer-aided manufacturing (CAM) software package. The object is produced by extruding melted material to form layers as the material hardens immediately

II. ABOUT ARTIFICIAL KNEE

Now a days so many people are facing problems with knee pain, It is because of wear in the knee and decrease the calcium content in the bones, in order Reduce this problem doctors have choose to replace the artificial Knee in the place of Original knee. Doctors adopt trial and error method during the selection of artificial knee, which is almost similar to the original knee. In some cases, it is difficult for the people to walk comfortably as the artificial knee is not exactly similar to the original knee. Doctors prefer 3 sets of artificial knee of different sizes which suits to the patient

.Due to this cost of operation as well as time to perform the operation has increased. Deterioration of your joint and surrounding tissue can make it difficult to perform basic daily activities, even while you sit or lie down.

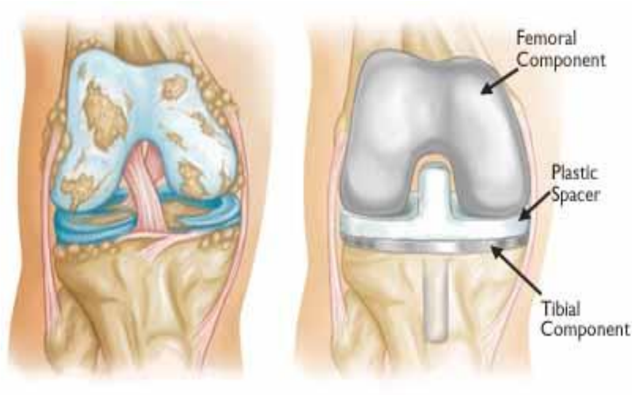


Fig 2.1 Natural and Artificial knee joint

Knee replacement surgery is a common solution that provides dramatic pain relief for more than 90 percent of patients. The vast majority of knee replacement procedures are used to treat osteoarthritis. The procedure introduced in 1968 relies on a mechanical implant to replace severely arthritic or damaged knee joints. According to the Agency for Healthcare Research and Quality, more than 600,000 knee replacements took place in the U.S. last year, and that number is expected to grow into the millions within the next twenty years. Total knee replacement (TKR), also called total knee arthroplasty (TKA), is considered one of the safest and most effective procedures in orthopedics.
Two different types of knee replacement exist:

A. Total and partial.

B. Total Knee Replacement

A.TOTAL KNEE REPLACEMENT

Total Knee Replacement makes up about 90 percent of all knee replacement procedures. During TKR, a surgeon repairs your knee joint by covering the thighbone with a metal covering and encasing the shinbone with plastic. The prosthesis replaces the rough and irregular surfaces of the worn bone with smooth surfaces. In many cases, the surgeon also replaces the undersurface of your kneecap with a plastic surface, in order to further reduce pain and provide a smoother functioning joint. The procedure involves some removal of bone and cartilage.

B.PARTIAL KNEE REPLACEMENT

If you receive a partial knee replacement, your surgeon will replace only the part of your knee that's damaged or arthritic. The advantage to this approach is that it requires a smaller incision, involves less bone and blood loss and consequently, produces less pain. Patients undergoing partial knee replacement tend to experience a faster recovery time than those who have TKR. However, there are disadvantages, including the possibility that you will have to eventually undergo further surgery if arthritis develops in the parts of the knee that are not replaced.

III. ABOUT MACHINE

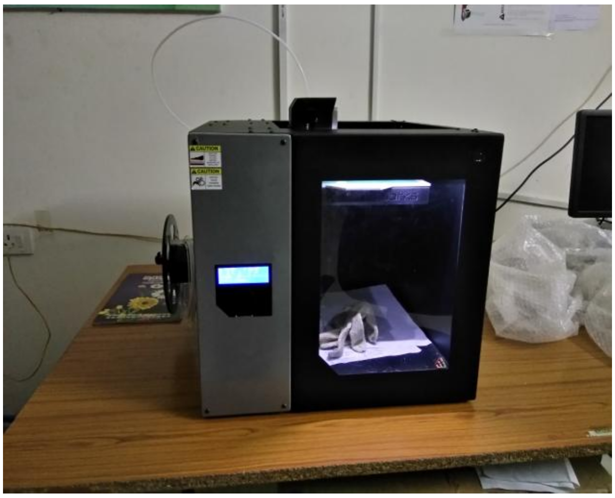


Fig 3.1 facktal works Julia+3D printer

TABLE-1

SPECIFICATIONS	LIMIT
Build volume	210×250×260mm^3
Filament diameter	1.75mm
Nozzle diameter	0.4mm
Filaments supported	ABS, PLA, Nylon, Wood, Bronze
File types	.stl, .obj
Nozzle movement	X, Y directions
Bed movement	Z direction

Software factory based application development addresses the problem of traditional application development where applications are developed and delivered without taking advantage of the knowledge gained and the assets produced from developing similar applications. Many approaches, such as training, documentation, and frameworks, are used to address this problem; however, using these approaches to consistently apply the valuable knowledge previously gained during development of multiple applications can be an inefficient and error-prone process.

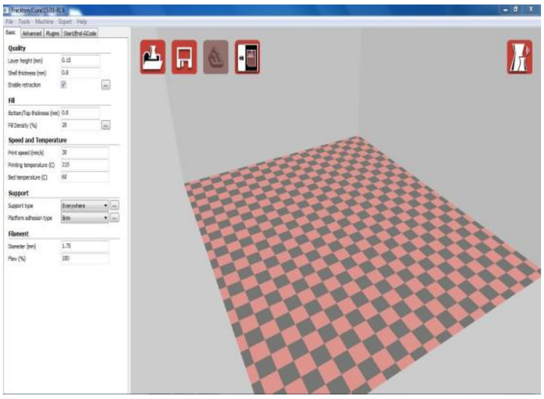
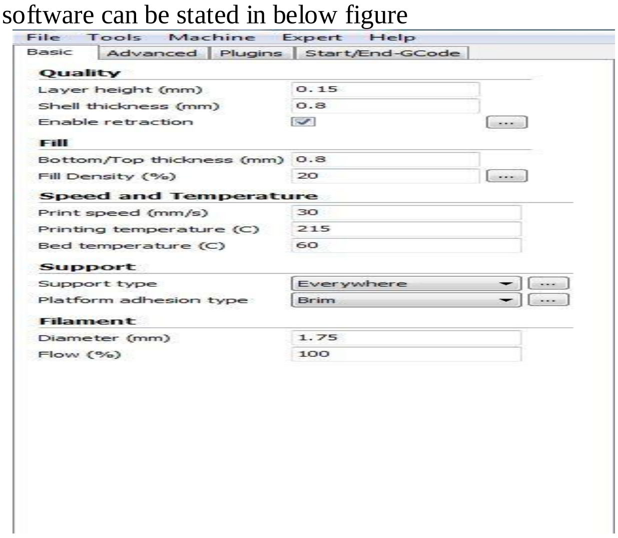


Fig 3.2 : Fractory work bench

IV. THE MAIN SPECIFICATION OF FACTORY SOFTWARE

The main features of fractory software can be stated in below figure



In this software layer thickness can be changed to 0.06mm to 0.25mmLayer height 0.06mm for smooth finishing .it can take more time when compared to 0.25mm.FRACTOL WORKS JULIA +3D printer type of machine layer height can Starts from0.06mm Layer height 0.25mm for rough finished surface .this process is very faster when compared to 0.06mm but accuracy is poor when compared to 0.06mm layer height

A.SHELL THICKNESS

By increasing the shell thickness of the part we can increases the strength of the part .in this type of 3D printing machine shell thickness can be increase in multiples of two

B.TOP AND BOTTOM THICKNESS

Top side and bottom side portion of the body is called top thickness and bottom thickness. This can decides the strength of the body. By increasing this property the printed object can be have more strength

C.FILL DENCITY

The filling percentage of inside portion of a body is called fill density. Generally for maximum strength 100 percent and for weak sections, halo sections 0 percent fill density can be selected. Moderate strengthen 3D parts can have the 20 percentage of fill density.

V. RELATED WORK

First taken the MRI (Magnetic Resonance Imaging) scanning data from MRI scanning center .it is available in DICOM format. Then I can install the 3D slicer software. Opening the slicer window then load in to the DICOM data in to the soft ware

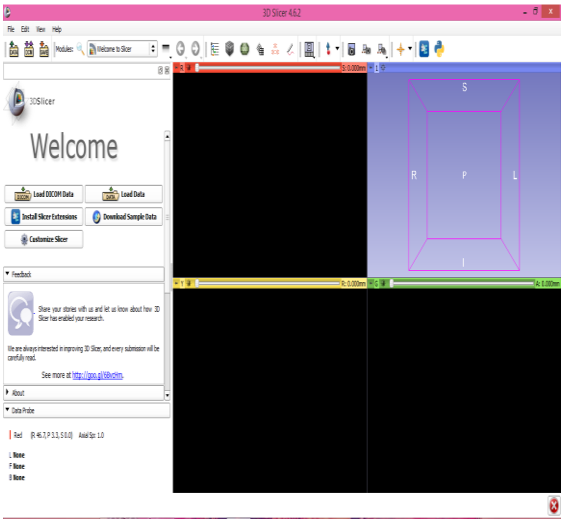


Fig 5.1:3D slicer workbench

After the entering in to the DICOM file in to the slicer the window can be show like these below stated way

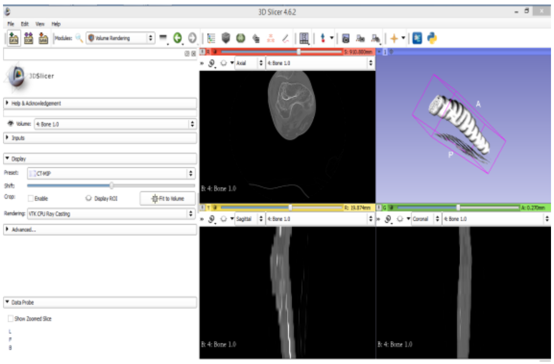


Fig 5.2:dicom loading condition in 3D slicer

The 3D imaging data can be visible in write side top window on 3D Slicer workbench. After separate the bone on the particular DICOM file, Collect gap between the two bones and save it ,then opening the by using mesh mixer software I can extend the Tibia and femur component and extend it till the empty space and save the data in .stl format. The selected file can be enter into the fractory work bench and adjusted the temperature and fill density for PLA material in these below stated form.

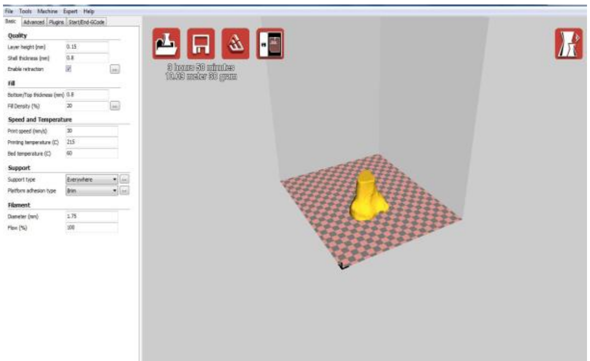


Fig 5.3: Tibia bone

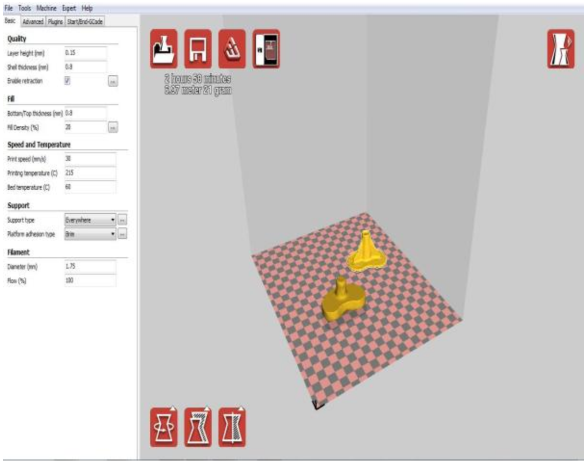


Fig 5.4: Tibia knee joint

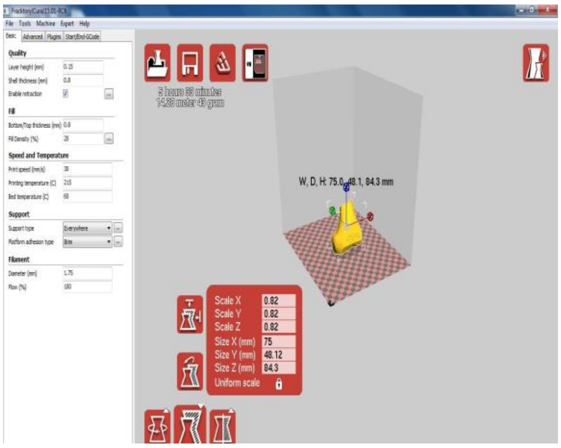


Fig 5.5: femur bone

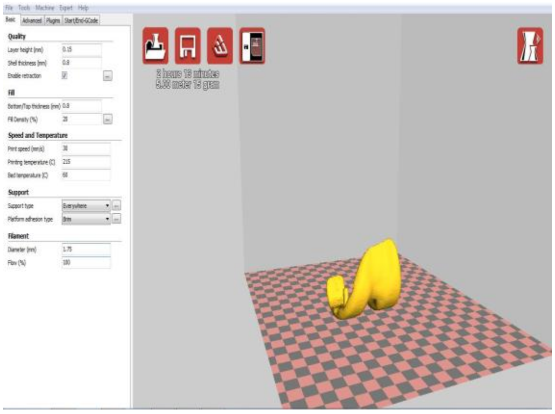


Fig 5.6: femur joint

Fig 5.1 to 5.6 shows the tibia and femur joints and their supported bones on loading fractory software

TABLE -2

PROPERTY	VALUE
Layer height	0.1mm
Top/bottom thickness	1.2mm
Shell thickness	1.2mm
Nozzle temperature	210◦C
Bed temperature	60◦C
Fill density	60%
Filament flow	100%

Table 2 shows the printing conditions for PLA filaments

Fig 5.7:final 3D printed knee joint

TABLE -3

factors	Trial and error method	3D printing process
Time for preparing artificial knee joints	More than10 days	Max 7 days
Cost for artificial knee plates	45,000/-	18,000/-
Total operation cost	1,40,000	1,15,000/-

Table3 shows the comparison between 3Dprinting process with trial and error method.

VI. CONCLUSION

The time taken for preparing an artificial knee joints using trial and error method is more than 10 days and cost is 45,000/- but in this work ,by using FDM technology the time is reduced to less than 7 days and cost was reduced to 18,000/- Therefore, FDM Technology is the most effective method compared to trial and error method

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