Patient Specific Implant Design

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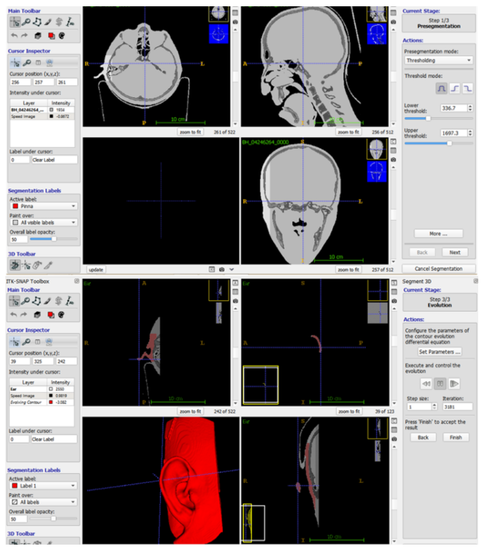
ABSTRACT

The uniqueness of the human body poses a huge problem for replacing any damaged part of the body. This can be countered using implants designed specifically for a given case. The implants can be designed using software however, the cells are incapable of growth on such implants. In this project, a structure is designed such that it provides cells the ability to grow within the implant allowing full acceptance into the body

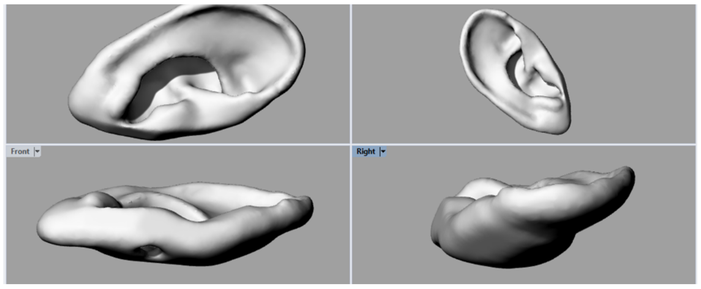
OBJECTIVE

This project aims at making structurally biocompatible implants which are specific to the patient.

PROCEDURE



Most parts of the human body have mirror images due to which designing an implant is possible. The design is created using the CT or MRI scans of the patient. This image is taken and mirrored. For the example in this project, a ear is being designed for a patient born with only one ear. The process requires the scans of the patient in question. These scans are isolated and the ear is separated from the skull. This is the first step and is called segmentation and this step is performed using ITK-Snap software.



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Following segmentation, the excess parts of the skull need to be removed and the design needs to be checked for smoothness and quality. At this point the structure is also mirrored. This is done using Autodesk Meshmixer. The product is the required structure. This is yet not fit for implantation. For this, the ear is converted into a mesh using the software Rhinoceros and the mesh is used as a template for small cylindrical structures that make it possible for the cells to grow on the implant.

The following are the steps for the completion of the above process.

1. ITK-Snap: Segmentation. The three steps in segmentation are Pre-segmentation, initialization and evolution. The segment containing the ear is now separated.
2. Autodesk Meshmixer: This software is mirror and remove unnecessary portions of the ear
3. Rhinoceros: This software is used to convert the ear into a mesh like structure for the cells to be able to grow on. The following is the pseudocode:

Dim base, height, width, minCoordinate, maxCoordinate

Base = constant

getCoordinates of mesh

For y = Height = min_yCoordinate of ear to max_yCoordinate of ear

For x = min_xCoordinate of ear to max_xCoordinate of ear

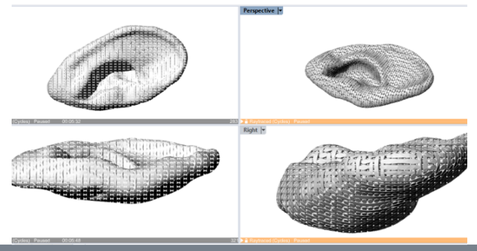
Addcylinder (base, height)

Loop

Loop

CONCLUSION

The design as shown above is a mesh framework. It is effective and can be used as an implant. The cells have a stable and effective scaffold to grow upon. The implantation is carried out by first allowing a few cells to grow on the implant and then by using skin from another part of the body and covering the implant with it. This helps in growth of the cells which are similar in composition to the individual. The cells are of the same type and hence reduces the possibility of rejection. The issues that arise are the selection of a biodegradable material that can be used and the types of cells to be grown on the implant. Ideally the implant should be biodegradable in a given amount of time. This is so once the cells have grown around it, it can degrade and the entire structure would be primarily composed of the cells. There is another subject for future research. The cell culture using a bioprinter is only possible for one type of cell at a time. The ear itself consist of many nervous cells, blood vessels, cartilage cells and hence it would be difficult to grow a completely natural ear. The ear grown using this method would only be made of one type of cell. If the printer is made capable of growing many cells and their interactive phases, the ear can be grown as its natural form. This would also make it possible to print organs which are much more complex because each cell in an organ has an interactive function and play an important role in the well being of an individual



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