A Review on 3D Printed Bionic Ears

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Abstract : This is a review on 3D printed bionic ears which has become a notable topic in today's technological discussion. This study introduces the 3D printed bionic ears concept, design and working that target to revolutionize cyborg organs by 3D printing.3D printed bionic ear integrates biologic and nano-electric functionalities using 3D printing. The bionic ear is fully functional organ that not only replicates the real one, but extends it using embedded electronics. The objective of this paper is to gather, analyze, categorize and summarize information about 3D printed bionic ears.

Keywords: Additive manufacturing, tissue engineering, bionics and cybernetics, bioelectronics, cyborg organs.

I. INTRODUCTION

Additive manufacturing technology came about as a result of developments in a variety of different technology sectors. Like with many manufacturing technologies, improvements in computing power and reduction in mass storage costs paved the way for processing the large amount of data typical of modern 3D computer-aided Design (CAD) models within reasonable time frames.3D printing also known as additive manufacturing is any of various processes used to make a three-dimensional object [1].

Tissue engineering is interdisciplinary field which applies the principles and method of engineering and life sciences towards the fundamental understanding of structural and functional relationship in normal and pathological substitutes.(Langer and Vacanti 1999). In other words tissue engineering is using a person's cells to create a new artificial fully alive tissue or organ that can replace or improve/heal the old one in the body.

Bionics and cybernetics are very similar as they both study to gain knowledge on behavior and structure of living organics in order to better the quality of life. Bionics design and creates artificial machines that mimic a variety of nature's ways of doing things. Cybernetics seeks more to explain living beings, then design and creates artificial attachments that mimic the missing parts behavior. The main advantage of both bionics and cybernetics is eyes, artificial hearts, limbs and many other vital organs can be replacing by mechanical devices [2].

Bioelectronics is the application of electronics to problems in biology, medicine. This includes electronics for both detection and characterization of biological materials, such as on the cellular and subcellular level. Bioelectronics also focuses on physically interfacing electronics devices with biological systems [3].

Cyborg is a theoretical or fictional being with both organic and biomechanical parts. A cyborg is essentially a man-machine system in which the control mechanisms of the human portion are modified externally by drugs or regulatory devices so that the being can live in an environmental different from the normal one. Cyborgs tissues structured with carbon nanotubes and plant or fungal cells have been used in artificial tissue engineering to produce new material for mechanical and electrical uses.

II. LITERATURE SURVEY

A number of papers and articles related to 3D printed organs have been published over the past few years. Recently, Princeton university, New jersey is generally regarded to have printed first 3D printed bionic ears having the ability of detecting frequencies a million times higher than ordinary human biology capabilities provides [1]. The credit for the 3D printed bionic ear generally goes to Manu S.Manoor, Ziwen jang, Teena James, Yong Lin Kong, Karen A.Malatesta, Winston O. Soboyejo, Naveen Verma,David H. Gravid H.gracias and Michael C.McAlpine[2].

III. STEPS FOLLOWED WHILE MAKING THE EAR

CAD drawing of human ear is used by research team as a blueprint for the printing as shown in figure 1.

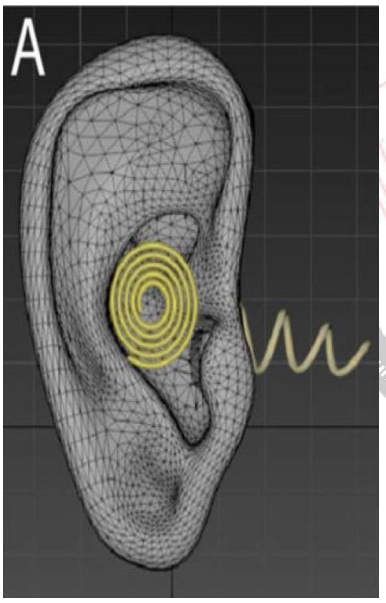

Fig: 1 drawing of human ear

The researcher used three materials as a printer inks. Structural silicon, cartilage cells in a hydrogel matrix, and silicone infused with silver nanoparticles. The component (ear) was built layer by layer using syringe extrusion based fab@Home 3Dprinter with the silver-infused ink forming an inductive coil acting as a receiving antenna as shown in fig 2.

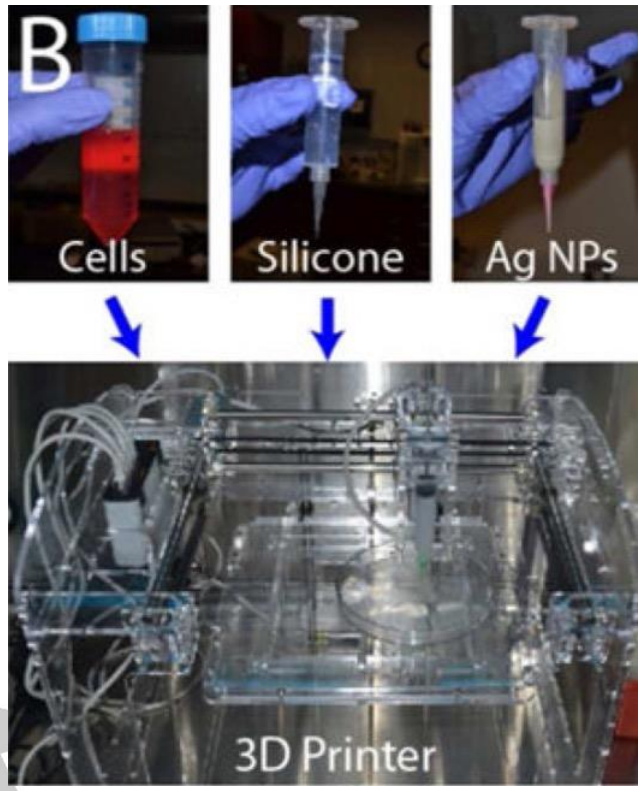

Fig: 2 3Dprinter

Human ear auricle is in the form of STL format along with an integrated circular coil antenna connected to cochlea shaped electrodes. STL file format has been opted as the standard file format by rapid prototyping industry [1]. STL file format represents a three dimensional surface as an assembly of planner triangles, like the facets of a cut jewel. The more number of triangles have to be used for highly curved surfaces[2].

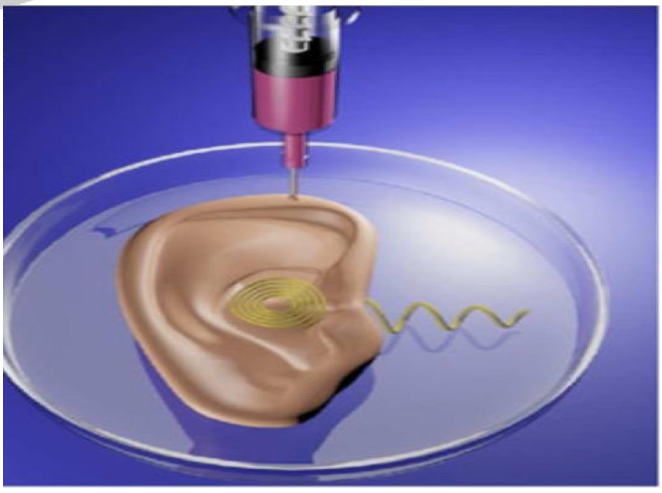

Fig: 3 3D printed bionic ear

The following figure 3 shows the 3D printed bionic ear immediately after printing.

Fig: 4 printed ear

The printed ear was immersed in chondrocyte culture media containing 10% or 20% fetal bovine serum (FBS) which was refreshed every 1-2 days. Over a 10 week period in culture conditions, the hydrogel component of printed ear was reabsorbed and the cells developed an extracellular matrix turning the ear opaque the above fig 4 shows [3].

IV. WORKING

The final 3D printed bionic ear consists of a coiled antenna inside a cartilage structure. Two wires lead from the base of the 3D printed bionic ear and wind about a helical "cochlea". Electrodes connected to the part of bionic ear that senses sound the below fig 5 shows.

Fig: 5 final 3D printed bionic ear

The researchers exposed the cyborg ears to antenna signals of left and right stereophonic audio, collected the signals received by bionic ear, fed them into a digital oscilloscope and played the resulting audio signals through loud speakers the below fig 5 are shows signals through speakers [1].

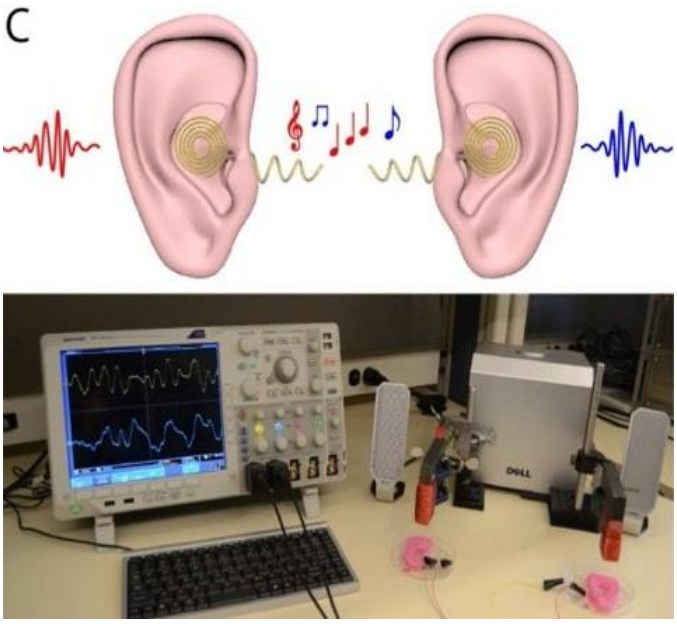

Fig: 6 signals through speakers

V. CONCLUSION

3D printed bionic ear project shows that electronics and tissues can be combined to form hybrid bionic organs. The 3D printed bionic ear was intended less as an exploration of potential health implications, but rather to examine the possibilities of using technology to extend the normal human abilities.

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