Advanced Manufacturing Technology (TechVision)

3D Printing in the Healthcare Industry

"Impact of 3D Printing on the Healthcare Industry"

D718-TV

February 05, 2016

FROST & SULLIVAN

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Innovations in 3D Printing in the Healthcare Industry

3D-Printed Prosthetic Hands

Open Bionics–Low cost, Lightweight, Ada Prosthetic Hands

Tech. Profile

The three dimensionally printed prosthetic hand consists of advanced electronic systems which convert signals into hand movements. The hand is printed using materials like polylactide (PLA), Acrylonitrile-Butadiene-Styrene (ABS) and ninjaflex. Open Bionics provides options for users to print the prosthetic hand by themselves.

The company is run by Postdoctoral Associates, Graduate students, and PhD students from Universities like Yale (U.S), Cornell (U.S) and NTUA (Greece)

Have an appropriate image from the company

Innovation Attributes

The four major components which are three dimensionally printed are the back cover, palm, and the upper and lower PCB tray of the hand. The other components for the hand can be purchased from Open Bionics' online portal system. The time taken for printing the components is 28 hrs and the user requires to solder the components together according to the accurate and precise information provided by the company.

Technology Readiness Level

1 2 3
4 5 6
7 8 9

Competing Aspects

These three dimensionally printed prosthetic hands are lightweight and weigh less than 300 grams and at the same time they are priced reasonably. The users can order the Ada prosthetic hand kit and can also print the parts directly from the Makerbots Thingverse or from the YouMagine webpage. The electronics components fitted in the hand increase the performance and capabilities of this prosthetic hand when compared to others in the market.

Market Entry Strategies

This affordable prosthetic hand is currently available in the market and can be built within 48hrs.This novel technology is reasonably priced and at the same time offers increased performance and efficiency when compared with other competing products in the market.

Impact & Opportunities

Wide-scale Adoption

The company had commercialised the prosthetic hand and robot hand in 2015.This novel technology is expected to be widely adopted by early 2017.

Market Opportunity

- Military
- Automotive
- Electronics
- Communications
- Aerospace
- Space
- Robotics
- Consumer Electronics

Technology Convergence

This innovation can open a wide range of new application opportunities in the above industries. The convergence between robotics and consumer electronics will increase the wide-scale adoption rate of this technology. This technology can also be anticipated to impact the military and space industries.

3D-Printed Artificial Bones

Tomsk Polytechnic University–Biocompatible and Biodegradable Artificial Bones

Tech. Profile

The 3D printed artificial bone tissue is printed using Fused Deposition Modelling (FDM) and consists of a calcium phosphate compound biomaterial. The 3D printed artificial bone is similar and identical to human bone density and strength and also has a porous structure. These artificial bones can be used to perform bone grafting and bone prosthesis procedures.

Competing Aspects

The 3D printed artificial bone is biocompatible and at the same time biodegradable. It is capable of osseointegration which allows natural bones to regenerate alongside the artificial bone. The three dimensionally printed artificial bone also has the tendency to disintegrate into the patient's body without leaving any traces or causing any side effects and as biomaterial is used to print the bone, the human body system does not reject the implant.

Have an appropriate image from the company

Innovation Attributes

When compared to the traditional method of producing artificial bone prosthetics, by using additive manufacturing technologies, the cost and time of developing and producing the artificial bone is decreased tremendously. Thus making artificial bone prosthetics procedure very affordable and accessible

Market Entry Strategies

At present this novel innovations is still in the development and testing stages. 3D printed artificial bones pose many advantages when compared to the traditional prosthetics and this innovation is expected to impact he healthcare industry with an high intensity.

Technology Readiness Level

Impact & Opportunities

Wide-scale Adoption

At present, scientists from the Siberian State Medical University are researching and conducting non-toxicity tests and have plans to start animal testing by the third quarter of 2016. This novel innovation can be anticipated to enter the medical industry by the end of 2020.

Market Opportunity

- Healthcare
- Military
- 3D Printer and Material Providers

Technology Convergence

This innovation can open a wide range of new application opportunities in the above industries. The adoption of additive manufacturing technologies by the medical industry has already resulted in immense advantages and has paved the way for many new innovations and implementation of efficient new methods and techniques for the betterment of the industry.

3D-Printed Vascular Grafts

University of Maryland–3D Bioprinted vascular grafts for congenital heart disease

Tech. Profile

Researchers from the University of Maryland were able to 3D bioprint a patient specific non- cellular vascular draft for coronary heart disease patients using bio-degradable and biocompatible materials like poly propylene fumarate (PPF) and DEF materials.

Wide-scale Adoption

The research group is currently testing the 3D printed vascular drafts on animals. The group is also working on optimizing and improving the design and printing process of these grafts. This novel technology is expected to be commercialized by the end of 2017 and impact the medical industry by the end of 2018..

Market Opportunity

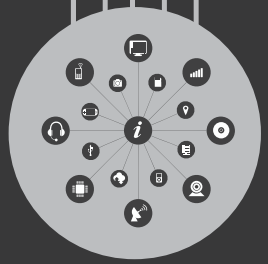
- Medical Industry
- 3D Printer and Material Industry

Competing Aspects

The research group has used a design platform called 'vivo' to customize complex structurers, curves, porosity, bifurcations and surface roughness for the vascular draft. These grafts were tested on the hearts of mice and the obtained results proved that the grafts were able to comply with the cell structure. The grafts also showcased similar mechanical properties to that of native vessels used in traditional grafting procedures.

Innovation Attributes

The research team used the stereolithography technique to 3D print the vascular grafts using EnvisionTEC Perfactory P4 3D printer. MRI and CT scans imaging data were used to design the grafts in SolidWorks CAD designs.



Market Entry Strategies

The research group is planning on collaborating with government and medical bodies to obtain approval for this novel technology. As 3D printing vascular grafts provide a solution for coronary heart disease, this technology is expected to impact the medical industry in the near future.

Technology Convergence

The medical industry after adopting additive manufacturing technologies has been immensely innovating and implementing new techniques and methods for efficiently treating various diseases. Technology convergence will pave the way for new application opportunities in the medical industry.

Technology Readiness Level 1 2 3 4 5 6 7 8 9

3D-Printed Bone Implants

Nottingham Trent University–Bone implants for accident and cancer patients

Tech. Profile

A research group from Nottingham Trent University has researched and implemented a method to improve the strength of the bone implant and at the same time increase the strength, porosity, structure and toughness of the bone scaffold. The team was able to manipulate and freeze the growth crystals for the material which is used to print the bone implant.

Wide-scale Adoption

The research group is currently working on improving and optimizing the 3D printing method and the process of freezing and manipulating the crystal cells. Wide-scale adoption of this novel technique can be expected by the end of 2018.

Market Opportunity

- Medical Industry
- 3D Printer and Material Industry

Competing Aspects

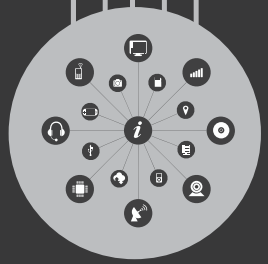
Though there has been a lot of research and implementation procedures involving 3D printing of bones, vertebra and sternum implants, this technology requires more research to maintain the strength and retain the porosity levels of structures similar to that of the bones in the patient's body. But this novel method developed by the research team increases the overall strength and structure of the bone scaffold.

Technology Convergence

With the development of 3D printers which are compatible with more traditionally used materials, new innovations and applications in relation to the medical industry can be expected in the near future. The adoption rate of 3D printing in this industry is guaranteed to revolutionize the medical industry.

Innovation Attributes

By freezing and manipulating the growth crystals of the material at a microstructural level, the researchers were also able to immensely reduce fabrication time, cost of developing a bone implant and at the same time improve its overall properties.



Market Entry Strategies

As this method provides many advantages in relation to bone implants, the research team is planning on collaborating with government bodies and hospitals to improve and implement this technology at a higher intensity.

Technology Readiness Level 1 2 3 4 5 6 7 8 9

Analyst Perspectives

3D Printing in the Healthcare Industry

Innovation Ecosystem Strength

At present,3D printing technology has made a tremendous impact on the medical industry. Many research groups, universities, government bodies and OEMs have collaborated to innovate and implement new applications in relation to the medical industry. Due to high-intensity wide-scale adoption of this technology in the medical industry, an increase in innovations can be anticipated in the near future.

Target Markets–Near-, Medium- & Long- Term

- 3D bio- printing is expected to impact electronics design and fabrication in the near term.
- This technology will also impact design devices with electronics in such industries as aerospace, consumer electronics, healthcare, automotive in the medium term.
- This novel method of 3D printing electronics can be expected to be adopted by the aforementioned industries for designing, developing, rapid prototyping, and relatively limited-volume production of components and devices.

Driving Forces

- By adopting additive manufacturing technologies, the medical industry is able to design, rapid prototype and develop functional implants, prosthetics, organ structures and so on.
- When compared to the conventional methods of development, using additive manufacturing technology has reduced the time and cost and has also paved the way for new techniques to perform tasks in a range of applications which were not possible using traditional methods.

Entry Barriers

- The present 3D printers are not compatible with the traditional used materials in the medical industry. The use of multi-materials for printing is challenging and still requires more research.
- Since human lives are involved, proper designing and immense testing is required before implementation.
- Many rules, regulations and FDA approvals are also associated in using additive manufacturing technology in the medical industry. This also poses as a challenge for the wide scale adoption of this novel technology in the medical industry.

Competitive Landscape

- The highest number of patents filed in relation to 3D printing in the medical industry is from Japan and China followed by the US.
- The North American region has very high intensity in 3D printing technology development and also in wide-scale adoption.
- The European region is also constantly researching and implementing new applications for the medical industry using 3D printing. Technology development and wide-scale adoption intensity is high even in this region.
- Though the APAC region has filed a large number of patents, due to the lack of participation from countries like North Korea and India, the technology development and adoption rate has been low in this area.

Key Patents

No.	Patent No.	Publication Date	Title	Assignee
1	WO2016012583	January 28, 2016	Printable Morphogenetic Phase-specific Chitosan-calcium-polyphosphate Scaffold For Bone Repair	MÜLLER, Werner Ernst Ludwig Georg
	This invention concerns a formula for the synthesis of a printable hybrid material, formed of carboxymethyl chitosan (CMC) and polyphosphate (polyP). Both polymers are linked together by calcium ions. The inventive CMC-polyP material, in combination with alginate, is biocompatible, biodegradable and useful for three-dimensional (3D) printing and 3D cell printing (bioprinting). The CMC-polyP scaffold, hardened by exposure to calcium ions, is morphogenetically active and can be used in bone tissue engineering, as a bio mimetic 3 -phase scaffold that mimics and induces essential phases in bone repair, including blood clot formation and platelet degranulation (release of growth factors and cytokines) (Phase 1: initiation phase), calcium carbonate bioseed formation (Phase 2: nucleation) and expression / activation of bone alkaline phosphatase (Phase 3: hydroxyapatite - biomineral formation).			
2	US20150343708	December 03, 2015	Medical 3d Printing Conex	OSIRIS BIOMED 3D, LLC
	The present disclosure provides devices and methods for obtaining images of body parts, implants, instruments and models to provide for a mobile hospital, operating room, and/or facility to print desired tools or prostheses. A Conex of the present disclosure includes a computer, image scanning device, printer, and raw materials, and optionally an autoclave and second, product verification scanner. All of these components will be co-located within the Conex. The operator of the Conex will also have access to a database with stored data relating to the large number of objects needed in surgical applications (such as tools and anatomical norms of bone and tissue), allowing the ability to field a mobile hospital at a greatly reduced weight, cost and time.			

Key Patents

No.	Patent No.	Publication Date	Title	Assignee
2	CN104123752	October 29, 2015	Human organ three dimensional (3D) modeling method capable of performing 3D printing	WEI CHENG
	Disclosed is a human organ three dimensional (3D) modeling method capable of performing 3D printing. The human organ 3D modeling method capable of performing the 3D printing includes: obtaining a tissue and organ medical image; simultaneously generating axial two dimensional (2D) images, sagittal 2D images and coronal 2D images of three same organs in the axial direction, the sagittal direction and the coronal direction of the tissue and organ medical image; respectively and correspondingly performing axial surface image separation, sagittal axial surface image separation and coronal axial surface image separation on the above images; performing 3D fusion of the 2D images against an image separation result; judging whether the 3D fusion takes effect or not; extracting surface features of a 3D image in medical image processing software, adding an individual file which is generated into a model, and saving the individual file as an STL formatted file; performing smoothing and polishing processing on the surface of the model; generating a file which can be printed in 3D mode and performing the 3D printing; judging whether a model which is printed out is real or not. The model which is printed out by using the human organ 3D modeling method capable of performing the 3D printing is not only realistic in surface feature, but also has an internal structure completely consistent with the structure of a human body.			
2	CN103520771	January 22, 2014	Polyether-ether-ketone biomimetic artificial bone 3D printing manufacturing method	Beijing Jiyuan United Biological Technology Co., Ltd.
	Disclosed is a human organ three dimensional (3D) modeling method capable of performing 3D printing. The human organ 3D modeling method capable of performing the 3D printing includes: obtaining a tissue and organ medical image; simultaneously generating axial two dimensional (2D) images, sagittal 2D images and coronal 2D images of three same organs in the axial direction, the sagittal direction and the coronal direction of the tissue and organ medical image; respectively and correspondingly performing axial surface image separation, sagittal axial surface image separation and coronal axial surface image separation on the above images; performing 3D fusion of the 2D images against an image separation result; judging whether the 3D fusion takes effect or not; extracting surface features of a 3D image in medical image processing software, adding an individual file which is generated into a model, and saving the individual file as an STL formatted file; performing smoothing and polishing processing on the surface of the model; generating a file which can be printed in 3D mode and performing the 3D printing; judging whether a model which is printed out is real or not. The model which is printed out by using the human organ 3D modeling method capable of performing the 3D printing is not only realistic in surface feature, but also has an internal structure completely consistent with the structure of a human body.			

Industry Interactions

Minas Liarokapis

Postdoctoral Associate (Yale University),
Open Bionics,
19 Nash St, Apt 2, New Haven, 06511, CT.
Phone: +1-203-535-7207
E-mail: aaron.dollar@yale.edu, hello@openbionicscom
URL: www.openbionics.org

Nikita E. Toropkov

Graduate Student,
Tomsk Polytechnic University,
pr. Lenina, 30, Tomsk, Tomsk Oblast, Russia.
Phone: +7-38-22-56-42-61.
E-mail: zerogooff@gmail.com
URL: www.tpu.ru/en/

Anthony Melchiorri

PhD Student, Fischell Department of Bioengineering,
University of Maryland,
College Park, MD 20742.
Phone: 301-405-8782
E-mail: anthony.melchiorri@gmail.com
URL: www.umd.edu/

Emmanouil Papastavrou

PhD Student,
Nottingham Trent University,
Burton Street, Nottingham, NG1 4BU.
Phone:+44-0-115-848-3256
E-mail: emmanouil.papastavrou@ntu.ac.uk
URL: www.ntu.ac.uk/