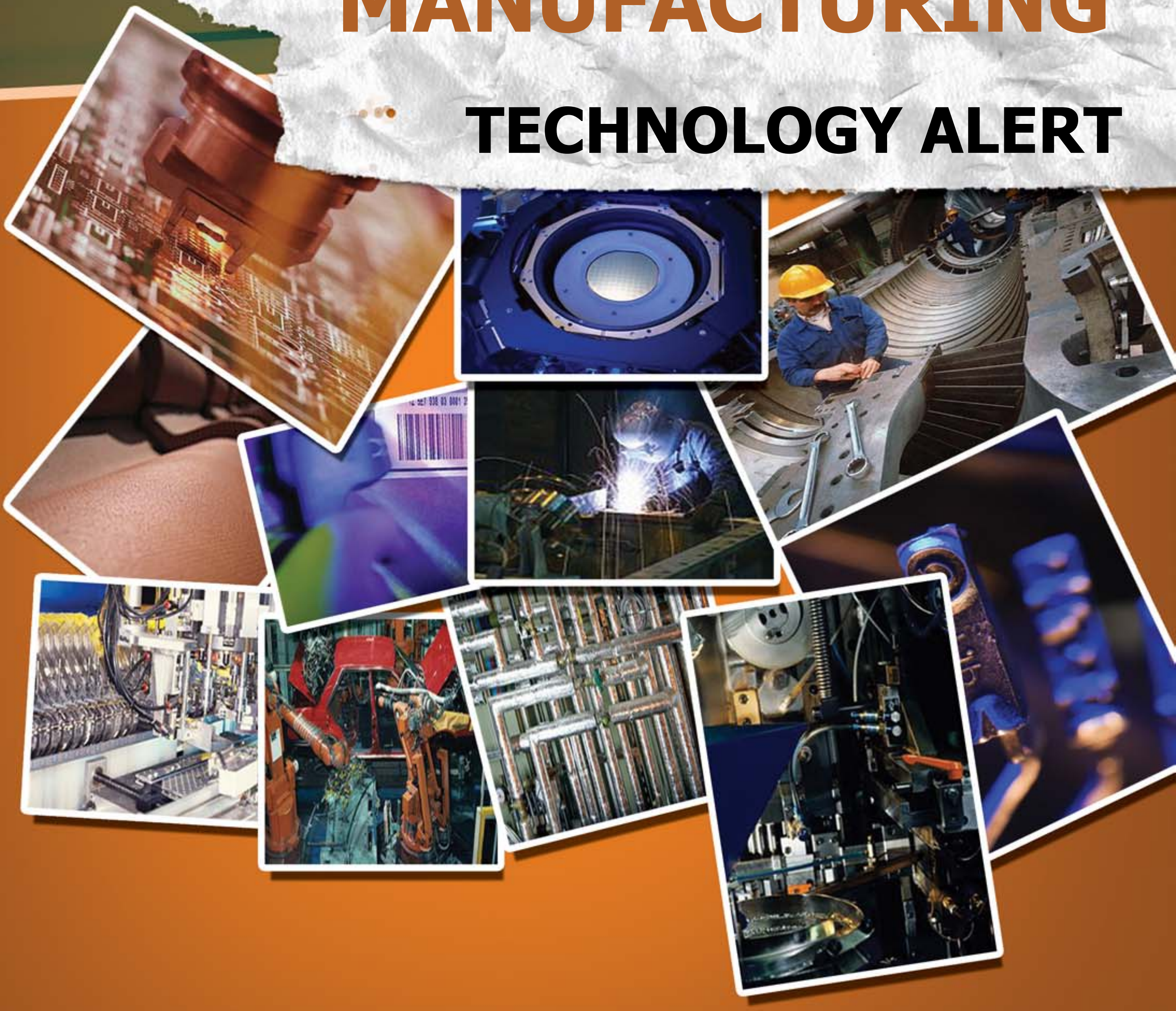
TECHNICAL INSIGHTS

ADVANCED MANUFACTURING

TECHNOLOGY ALERT



22nd August 2014

1. NOVEL MICROBOTS FOR CARRYING OUT A WIDE RANGE OF TASKS

Microrobots or microbots on the order of 1 millimeter to a few centimeters in size have opportunities in a variety of industrial aplications, such as intelligent manufacturing of micro-scale products.Microrobots that work together in a swarm (a large number of simple physical robots) are conducive to tasks demanding miniaturization. The challenges of working with microbots include devising the algorithm used for controlling them and the complexity in designing such robots. Researchers from a university in United States have now developed a novel microrobot that addresses the above-mentioned challenges.

A group of researchers from the Harvard School of Engineering and Applied Sciences (SEAS) and the Wyss Institute for Biologically Inspired Engineering at Harvard University have developed a swarm of self-assembling robots named Kilobots. The robots are extremely simple with each of them only a few centimeters long. The researchers believe that the small robots could be used as a swarm instead of highly complex robots, thereby providing a simple platform for the enhancement of complex behaviors. In one of the demonstrations at Harvard University, the researchers assembled 1024 of these microrobots using infrared signals. The algorithm used in the robots is capable of controlling a larger swarm of robots than conventional algorithms that could control only a few hundred microrobots. The Kilobots require no micromanagement or intervention once an initial set of instructions has been delivered. For instance, four robots mark the origin of a coordinate system and all the other robots receive a two-dimensional (2D) image that they should follow. Then, by using very basic behaviors, such as, following the edge of a group, tracking a distance from the origin, and maintaining a sense of relative location, the robots take turns moving toward an acceptable position. Kilobots are also capable of correcting their own mistakes; for instance, in the case of a traffic jam or when a robot moves away from the prescribed route resulting in an error, the nearby robots sense the problem and cooperate to overcome the problem. The researchers have built the Kilobots by using two vibrating motors that allow each robot to slide across a surface on its rigid legs. An infrared transmitter and receiver have also been used to help the Kilobots communicate with a few of their neighbors and measure their proximity. All the above-mentioned design features have helped the researchers to significantly reduce the manufacturing cost of the Kilobots and also have made the robots much simpler in terms of working and design compared to conventional robots. The design and software used in the Kilobots developed by the researchers at Harvard is said to be available on an open source platform for non-commercial use. The Kilobots have also been licensed by Harvard's Office of Technology Development to K-Team Corporation, a manufacturer of small mobile robots. Some of the potential applications for the Kilobots are industrial tasks, and disaster management and response.

Some of the advantages of the innovative Kilobots developed by the researchers are that the design and operation are simple. Also, the cost associated with manufacturing can be significantly less compared to conventional robots. Due to the above-mentioned advantages, the Kilobots and their technology can have potential to be adopted for developing other microbots in the future.

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2. DESIGN SOFTWARE FOR HEALTHCARE SECTOR PRODUCTS

Computer-aided Design (CAD) and computer-aided manufacturing (CAM) software can increase design or manufacturping productivity and product quality. Companies across market sectors look for innovative design software to help in the development of their products. Delcam, a UK-based computer-aided design (CAD) and computer-aided management (CAM) software company, has developed an innovative version of its OrthoMODEL software for the healthcare industry.

This software is used for designing and manufacturing of custom orthotic insoles. The new version of OrthoMODEL can display multiple two dimensional (2D) and three dimensional (3D) models simultaneously. This version also has a wide range of improvements in the user interface for simplifying the workflow and reducing design time. The company believes that, with this new version of the OrthoMODEL, it would be able bring together 2D image and 3D scan data. Representation of both the image and the data would help the user to decide which features are required in the orthotic. This new software also enables multiple 2D images to be imported and overlaid onto the 3D scan data, enabling the user to interpret the information represented by the 2D images in correlation with the 3D model. This extra dimension offered by OrthoMODEL allows display of multiple images at the same time. For instance, the user would be able to overlay the photographic image of the plantar surface and an image from a pressure system, and also would be able to see the data from both overlaid on the 3D scan. The ability to vary the scanner, image, and orthotics transparency allows the user to get detailed information about the various elements that work together for influencing the overall design. By getting detailed information about the various elements, users would be able to take informed decisions about the design changes needed on the basis of their requirements. Another feature of this new version is the significantly updated user interface that enables making decisions on the orthotic design faster and more accurate. The software has also been updated to allow users of Delcam's iQube scanner to send orders containing either the scan data or the finished design to the online laboratories that can carry out the manufacturing. This benefits the user in utilizing the digital designs without having to invest in a computer numeric control (CNC) mill or router.

The advantages of this innovative version of the OrthoMODEL are the significantly enhanced user experience and advanced capabilities for improving the design of orthotics. The new version of the OrthoMODEL has potential to be adopted on a significant scale in the manufacturing of products for the healthcare sector.

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3. UNMANNED GROUND VEHICLE FOR CUSTOMIZED APPLICATIONS

Unmanned vehicles can offer various opportunities to replace human operations in high risk, strenuous tasks. These vehicles belong to a field of robotics in which sensory feedback allows the vehicles to operate autonomously or by using a remote human controller. Unmanned vehicles have been the focus of various research projects, however, there have been a relatively limited number of ready-to-use platforms for advanced research targeting specific applications. This leads to increased cost in the projects that are attributed to either development of the platform or customizing components as per requirements. Moreover vehicles intended to traverse difficult terrain are not readily available. Developing such robot vehicles from scratch can be highly complicated or outside the area of expertise of researchers.

To address these challenges, US-based Clearpath Robotics has developed a line of unmanned vehicles that can be used by researchers to address specific needs. The company's largest unmanned ground vehicle (UGV), Grizzly, is able to carry a maximum payload of 600 kg and has a maximum speed of 12 miles per hour. The robot has been built in a bottom-up approach, with the basic goal of making it autonomous. This principle is applicable to Clearpath Robotics' entire offerings, which include other land, air, and water surface unmanned vehicle platforms. The robots use the robot operating system (ROS), an emerging open source development framework. This helps users customize the vehicle platform according to their needs. Application developers, software developers, and product developers can therefore test or build their offerings.

Apart from traditional controlling methods, the robot can be controlled using remote gesture control technologies. Clearpath has worked with companies such as Thalmic Labs and Vicon to enable gesture-based control of unmanned vehicles.

The unmanned robot has a very sturdy build with a high ground clearance of 8 inches, which allows it to traverse difficult terrain with ease. It has a running time of 12 hours with a towing time of up to 3 hours. When not carrying loads, the robot measures 1750 mm (length) by 1282 mm (breadth) by 811 mm (height).

The major applications of Grizzly are in the military field in applications such as land mine detection, traversing difficult terrain, working in toxic environments, and so on. The product can also be used for mapping various geographies; used to assist in agriculture, mining; and to carry heavy equipment. By replacing human beings in high-risk jobs such as land-mine scanning, human safety is enhanced. The robot has a flat-bed top, which allows a vast range of equipment to be installed on the vehicle. The robot is primarily targeted to be used by researchers or developers of specific applications.

It is expected that the adoption of unmanned vehicles is going to increase in the near to long term with major interest coming from military and agriculture.

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4. PATENT ANALYSIS OF THE STEREOLITHOGRAPHY PROCESS

The stereolithography (SLA) process is one among several technologies used to create three dimensional (3D) printed objects. It is the process by which the liquid plastic is converted into solid 3D objects. The printers used for the SLA process consist of a tank, an ultraviolet (UV) laser, and a computer for controlling the platform and the laser. In this process, a thin photopolymer layer ranging between 0.05 mm and 0.15 mm is exposed above the perforated platform. The UV laser is then projected on the perforated platform to paint the pattern of the object being manufactured. The first layer of the 3D printed object is formed as the curable liquid hardens instantly when the UV laser is made to fall on it. After the first layer of the object to be manufactured is hardened, the perforated platform is lowered, thereby exposing a new surface layer of the liquid polymer. The laser is again made to trace the cross section of the object that is being printed, allowing the new surface to bond with the hardened surface that is found beneath the new surface. This process is repeated until the entire object is completely formed and made to fully submerge in the tank. The platform is now raised to expose a 3D object; and it is then rinsed with a liquid solvent to remove the excess resin found on the surface of the printed product. The product being manufactured is then heated in an ultraviolet oven, which helps in curing the plastic.

Some of the advantages of using the stereolithography process are the speed of the process and the ability to make parts with smooth surface finish and that are sufficiently strong to be machined. However, the stereolithography process can be expensive and supporting structures are required to attach the part to the elevator platform, prevent deflection due to gravity, and hold cross sections in place so that can resist lateral pressure from the re-coater blade.

From the patents exhibited, it can be seen that research is being carried out to, for example, employ complex metal alloys for stereolithography and to develop improved stereolithography systems and processes for reducing differential shrinkage in processed objects,

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Use of a complex metal alloy containing aluminum for stereolithography	May 2, 2013/ WO 2013167448 A1	Universite De Lorraine, Centre National De La Recherche Scientifique (Cnrs)	Samuel Kenzari, Adnene SAKLY, David Bonina, Serge Corbel, Vincent Fournee	The invention relates to the use of a mixture of a photopolymerisable resin and a complex metal alloy containing aluminum in a method for stereolithography by photopolymerisation or three-dimensional printing by photopolymerisation. The invention also relates to a method for producing a three-dimensional part by stereolithography by photopolymerisation, said method comprising a step of solidifying said three-dimensional part, layer by layer, in a liquid medium comprising a mixture of a photopolymerisable resin and a complex metal alloy containing aluminum, by exposing said liquid medium to ultraviolet radiation. The invention further relates to a three-dimensional part produced by said method.
Method for producing a three-dimensional object and stereolithography machine employing said method	January 18, 2012/ US 20130249146 A1	Dws S.R.L.	Sergio Zenere, Roberto Fortunato	Method for producing a three-dimensional object in layers by way of a stereolithography machine (**1**) including a container (**2**) suited to contain a liquid substance (3), structure (**5**) suited to emit predefined radiation (**4**) suited to selectively solidify a layer (**6**) of the liquid substance (3) adjacent to the bottom (**2** *a*) of the container (**2**), and an actuator (**8**) suited to move the solidified layer (**6** *a*) with respect to the bottom (**2** *a*). The method includes selectively solidifying the liquid layer (**6**); separating the solidified layer (**6** *a*) from the bottom (**2** *a*) through a movement (**11**) suited to move them away from each other, including a plurality of shifts (**12, 12** *a*, **12** *b*, **12** *c*) for corresponding predefined lengths, spaced by corresponding intermediate stops (**14, 14** *a*, **14** *b*) for corresponding predefined time intervals (**15, 15** *a*, **15** *b*). The intermediate stops are carried out before the solidified layer has become completely detached from the bottom.
Stereolithography systems and methods using internal laser modulation	November 29, 2011/ WO 2012074986 A1	3D Systems, Inc.	Guthrie Cooper	Stereolithography systems (10) and methods using internal laser modulation are disclosed. The system includes an internally modulated diode-pumped frequency-multiplied solid-state (DPFMSS) laser 40. There is no external modulation system (EMS) within an external optical path (OPE) between the laser and a scanning system (80). The scanning system directs a laser beam (72) with laser pulses (72P) to a focus position (FP) on surface (23) of a build material (22) to form bullets (25) therein to define a build layer (30) based on build instructions for forming a three-dimensional object (32).
Method for reducing differential shrinkage in stereolithography	September 27, 2011/ EP 2433778 A2	Materialise NV	Sam Coeck	The present invention relates to a new and improved stereolithography method and system for generating a three-dimensional object by forming successive, adjacent, cross-sectional laminae of that object, thereby providing an object being specially processed to reduce differential shrinkage.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Modelling Plate for a Stereolithography Machine, Stereolithography Machine Using Said Modelling Plate and Tool for Cleaning Said Modelling Plate	January 11, 2011/ US 20120328726 A1	Dws S.R.L.	Sergio Zenere	The invention is a modelling plate (**6; 6'; 6"**) for a stereolithography machine (**1**) suited to produce three-dimensional objects (A) through superimposition of a plurality of layers (E) with predefined thickness of a liquid substance (**3**) that solidifies when subjected to a selective stimulation (**4**). The plate (**6; 6'; 6"**) comprises a work surface (**7**) that supports the object (A) and grooves (**8**) made in the work surface (**7**) along a development trajectory (X).
Three-dimensional stereolithography apparatus, three-dimensional stereolithography method, and three-dimensional object	October 28, 2010/ US 8540501 B2	Sony Corporation	Hiroyuki Yasukochi	A three-dimensional stereolithography apparatus includes a stage, a support mechanism to support a film so that the film is opposed to the stage, a pressing mechanism, a supply mechanism, an irradiation unit, a movement mechanism, and a control mechanism. The pressing mechanism presses at least a linear area of the film so that the linear area closest to the stage is formed in the film. The supply mechanism supplies a light-curing material into a slit area formed between the stage and the linear area. The irradiation unit irradiates the light-curing material supplied into the slit area with laser light through the pressing mechanism and the film. The movement mechanism moves the stage and the pressing mechanism relatively to the film, to form one cured layer of the light-curing material. The control mechanism controls a distance between the stage and the linear area of the film, to stack the cured layer.
Improved stereolithography machine	August 3, 2010/ EP 2461963 A2	Dws S.R.L.	Sergio Zenere	The invention is a stereolithography machine (1) comprising the following: a container (3) suited to contain a fluid substance and comprising a transparent bottom (3a); a support plate (2) provided with a hole (2a) and designed to house the container (3) so that the transparent bottom (3a) faces the hole (2a); a radiation source (4) arranged below the support plate (2) and suited to convey a radiation beam towards the transparent bottom (3a) through the hole (2a); a temperature control unit (5) suited to maintain the support plate (2) at a predetermined temperature.

Title	Publication Date/Publication Number	Assignee	Inventor	Abstract
Stereo-lithography device with detachable groove	March 31, 2009/ CN 101850617 B	Technology Research Corporation	Xi Guo-yuan, Dong Yaqing	The invention discloses a stereo-lithography device with detachable groove, which is used for the stereo-lithography of a stereo article and at least comprises a detachable groove and a lifting apparatus. The detachable groove includes a groove body and a bottom plate, and the lifting apparatus is arranged below the detachable groove and used for bearing the detachable groove thereon and controlling the lifting displacement of the bottom plate in the process of the stereo-lithography of the stereo article. The detachable groove is detached from the lifting apparatus upon the stereo-lithography of the stereo article in order to achieve powder removal and article withdrawal.
Hydrogel constructs using stereolithography	April 24, 2006/ WO 2006116180 A8	Board Of Regents	Ryan Wicker, Francisco Medina, Karina Arcaute, Luis Ochoa, Christopher Elkins, Brenda Mann	The present invention includes a method and system for building cost-efficient biocompatible hydrogel constructs using stereolithography. Hydrogel constructs may be used in, for example, multi-lumen nerve regeneration conduits and other tissue engineering scaffolds with embedded channel architecture that facilitate tissue regeneration through possible incorporation of precisely located bioactive agents, cells, and other desired inert and/or active chemical agents and devices. Another preferred embodiment of the present invention provides a method of fabricating a hydrogel construct comprising: solidifying a first solution into a first construct layer with a first energy dosage using stereolithography, the first solution comprising: a first polymer; and a first photoinitiator, wherein the first polymer and first photoinitiator are of a first concentration.
Stereolithography resins and methods	April 3, 2006/ WO 2006107759 A3	Birds Inc 3, Alma L Coats, James P Harrison, James Scott Hay, Manuel Jacinto Ramos	Alma L Coats, James P Harrison, James Scott Hay, Manuel Jacinto Ramos	Radiation curable resin compositions are provided that is most useful in stereolithography. A radiation curable resin includes a base oligomer, a cross-linking agent, a reactive solvent, and an anti-nucleation agent. The resin after curing provides a solid product that has improved physical properties.

Exhibit 1 depicts patents related to stereolithography process.

Picture Credit: Frost & Sullivan

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