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Patent Acquisition Opportunity

Strictly confidential
April 2015

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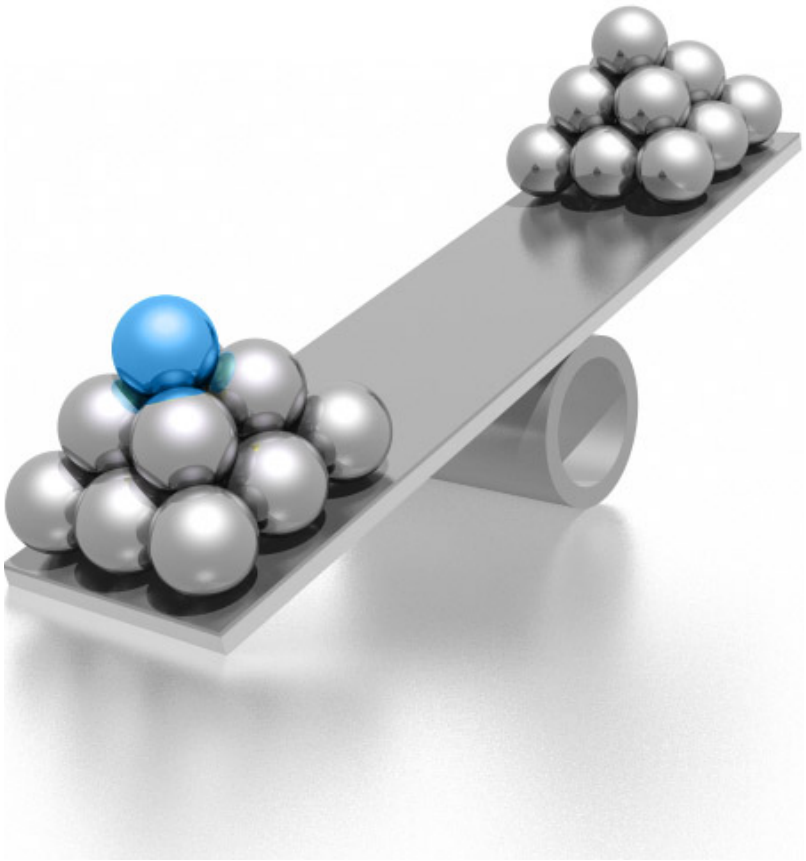

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Executive Summary

Portfolio overview

- The patent offering from HonHai comprises 7 US patents, including foreign filings in China and Taiwan.
- The technology in this portfolio relates to 3D CAD, modelling and verification tools.
- There is 1 key patent in this portfolio.
- Forward citing companies include Honeywell, Siemens, Raytheon.
- The earliest priority date in the portfolio is 28th May 2003.

Transaction Profile

- ICEBERG Role: Sell-side adviser.
- Price expectation:
  US $200k per patent family
- Grantback license required.
- Indication of interest requested to be submitted by: 19th June 2015.

Encumbrances

- No licenses.
- No buyer restrictions.

Appendix

- Evidence of Use analysis suggesting infringement by PTC and Trimble RealWorks.

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Seller Information

Today, Hon Hai / Foxconn Technology Group is the most dependable partner for joint-design, joint-development, manufacturing, assembly and after-sales services to global Computer, Communication and Consumer-electronics ("3C") leaders.

Aided by its legendary green manufacturing execution, uncompromising customer devotion and its award-winning proprietary business model, eCMMS, Hon Hai has been the most trusted name in contract manufacturing services (including CEM, EMS, ODM and CMMS) in the world.

Location: New Taipei City, Taiwan.

Source: http://www.foxconn.com/GroupProfile_En/GroupProfile.html

> "Hon Hai have been ranked first among the Top 1000 Taiwan Enterprises for eight consecutive years according to the evaluation of Common Wealth Magazine, and were recently ranked 30th among Fortune Global 500, and 13th among Forbes Global 2000."

http://www.foxconn.com/GroupProfile_En/CompanyMilestones.html

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Key Patent

US 7683900 – Relates to manipulation of 3D model data in computer software. The patent particularly relates to the processing of a point cloud in a simulated three-dimensional space – allowing the user to manipulate and verify the 3D CAD model.

Leading Market Players – 3D CAD tools

- Trimble Realworks
- Dassault Systèmes SOLIDWORKS
- AutoDesk AutoCad
- CorelDraw
- PTC Creo

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Patent List

Family	US Patent	US	CN	TW	Priority	Title
1	7047151	●		●	28/05/2003	System and method for detecting defects of objects based on a CAD platform
2	7065461	●		●	11/11/2003	Point cloud measuring system and method
3	**7683900***	●	●		**26/05/2004**	**System and method for processing a point cloud in a simulated three-dimensional space**
4	7933749	●	●		29/08/2007	System and method for computing minimum distances between two point clouds
5	7925109	●	●		20/08/2007	System and method for simplifying a point cloud
6	7117116	●		●	26/11/2004	Method and system for cutting point cloud automatically
7	7843450	●	●		28/04/2006	System and method for filtering point clouds

*** Key patent** – See appendix

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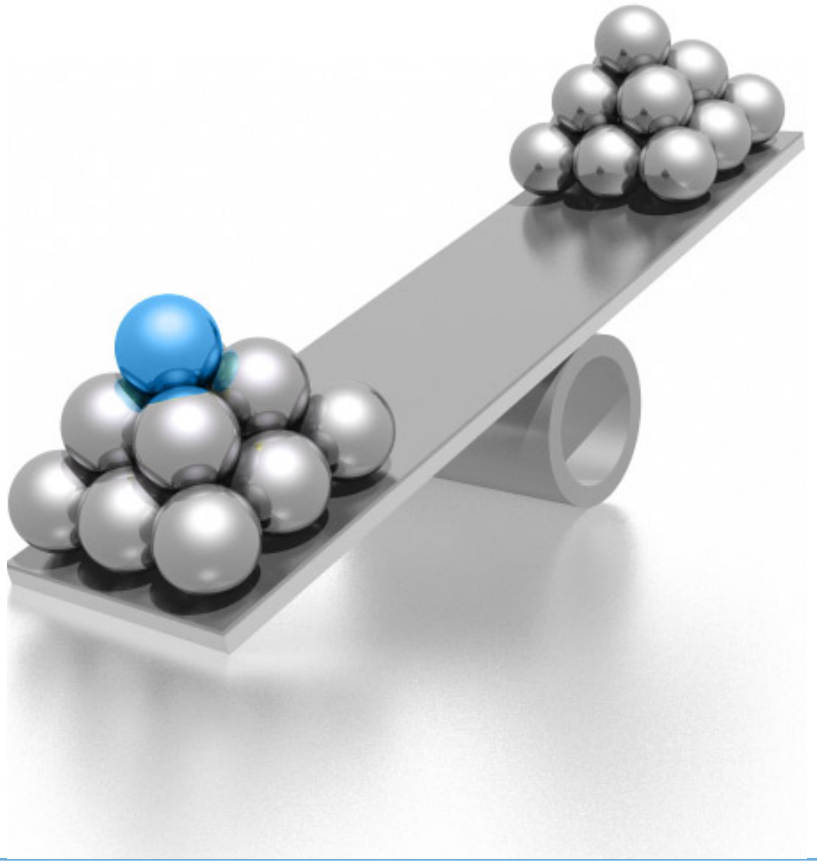
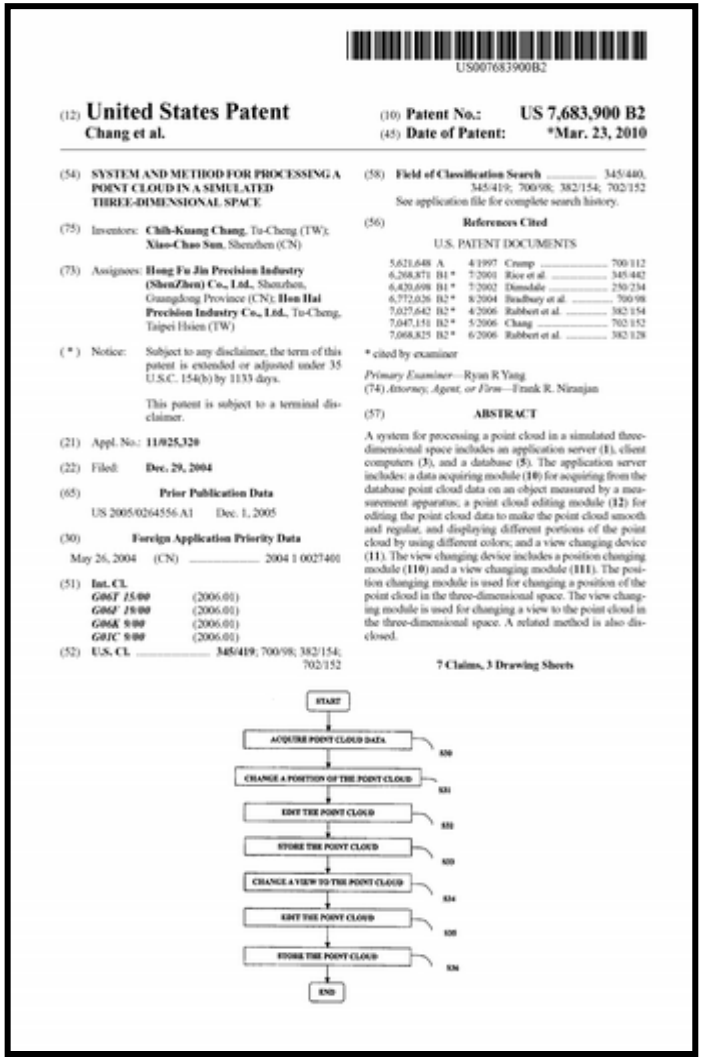
Appendix

Evidence of Use



US 7683900 – Bibliographic information



US007683900B2

(12) **United States Patent**
Chang et al.

(10) **Patent No.: US 7,683,900 B2**
(45) **Date of Patent: *Mar. 23, 2010**

(54) **SYSTEM AND METHOD FOR PROCESSING A POINT CLOUD IN A SIMULATED THREE-DIMENSIONAL SPACE**

(75) Inventors: **Chih-Kuang Chang**, Tu-Cheng (TW); **Xiao-Chao Sun**, Shenzhen (CN)

(73) Assignees: **Hong Fu Jin Precision Industry (ShenZhen) Co., Ltd.**, Shenzhen, Guangdong Province (CN); **Hon Hai Precision Industry Co., Ltd.**, Tu-Cheng, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1133 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/025,320**

(22) Filed: **Dec. 29, 2004**

(65) **Prior Publication Data**

US 2005/0264556 A1 Dec. 1, 2005

(30) **Foreign Application Priority Data**

May 26, 2004 (CN) 2004 1 0027401

(51) **Int. Cl.**
G06T 15/00 (2006.01)
G06F 19/00 (2006.01)
G06K 9/00 (2006.01)
G01C 9/00 (2006.01)

(52) **U.S. Cl.** **345/419**; 700/98; 382/154; 702/152

(58) **Field of Classification Search** 345/440, 345/419; 700/98; 382/154; 702/152
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,621,648	A	4/1997	Crump	700/112
6,268,871	B1 *	7/2001	Rice et al.	345/442
6,420,698	B1 *	7/2002	Dimsdale	250/234
6,772,026	B2 *	8/2004	Bradbury et al.	700/98
7,027,642	B2 *	4/2006	Rubbert et al.	382/154
7,047,151	B2 *	5/2006	Chang	702/152
7,068,825	B2 *	6/2006	Rubbert et al.	382/128

* cited by examiner

Primary Examiner—Ryan R Yang
(74) *Attorney, Agent, or Firm*—Frank R. Niranjan

(57) **ABSTRACT**

A system for processing a point cloud in a simulated three-dimensional space includes an application server (1), client computers (3), and a database (5). The application server includes: a data acquiring module (10) for acquiring from the database point cloud data on an object measured by a measurement apparatus; a point cloud editing module (12) for editing the point cloud data to make the point cloud smooth and regular, and displaying different portions of the point cloud by using different colors; and a view changing device (11). The view changing device includes a position changing module (110) and a view changing module (111). The position changing module is used for changing a position of the point cloud in the three-dimensional space. The view changing module is used for changing a view to the point cloud in the three-dimensional space. A related method is also disclosed.

7 Claims, 3 Drawing Sheets

Patent of Interest:

US 7683900
(Priority date: May 26, 2004)

System and method for processing a point cloud in a simulated three-dimensional space

Exemplary Market Applications:

The patented technology finds applications in processing of point clouds using reverse engineering. Further, the technology is helpful in enhancing the design of the product.

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US 7683900 – Claim 4

4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of:

    acquiring point cloud data from a database using the at least one processor;

    changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y- axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor;

    editing the point cloud using the at least one processor;

    changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor;

    editing the point cloud again using the at least one processor; and

    displaying different portions of a point cloud by using different colors using the at least one processor.

US 7683900 – EoU Summary

PTC Creo	
Key claim(s)	1,4,6 (independent claims)
Mapped product	Chart has been made with respect to PTC Creo.
Source	Product information available at: http://www.ptc.com/product/creo
Product launch date	1/6/2011 (Creo 1.0)
Details of product / company	Creo is a family or suite of design software supporting product design for discrete manufacturers and is developed by PTC. The suite consists of apps, each delivering a distinct set of capabilities for a user role within product development. Creo provides apps for 2D design, 3D CAD parametric feature solid modelling, 3D direct modelling, Finite Element Analysis and simulation, schematic design, technical illustrations, and viewing and visualization.

US 7683900 – PTC Creo: Overview

Creo provides apps for 2D design, 3D CAD parametric feature solid modelling, 3D direct modelling, Finite Element Analysis and simulation, schematic design, technical illustrations, and viewing and visualization.

PTC Creo provides product design professionals with the most robust, scalable 3D product design toolset in the industry. And PTC Creo 3.0 continues to deliver greater power and more flexibility, to support the acceleration of your product development process. Read the announcement here.

3D CAD software allows users to build three-dimensional virtual prototypes that improve product quality and speed time-to-market by automating the product development process. There are a variety of modeling tools available to create digital prototypes, but only PTC Creo CAD software offers a unified product design and development environment that lets you incorporate a full range of direct and parametric modeling technologies, methodologies and best practices. This fosters greater productivity and innovation by better accommodating the diverse needs of product development professionals across varied disciplines, levels of expertise and degrees of specialization.

Sources: http://www.ptc.com/product/creo/new
http://www.ptc.com/product/creo/3d-cad

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US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** PTC Creo is a software which can process a point cloud in a three-dimensional space. Using PTC Creo Reverse Engineering, point clouds of physical products can be obtained which further can be refined . PTC Creo is a scalable, interoperable suite of product design software that delivers fast time to value. It helps teams create, analyze, view and leverage product designs downstream utilizing 2D CAD, 3D CAD, parametric & direct modeling. PTC Creo Reverse Engineering Extension allows the transformation of existing physical products into digital models. ts suite of automation capabilities and the ability to impose dramatic design changes improve product customization and increase design reuse opportunities. Fast and powerful, PTC Creo Reverse Engineering Extension enables productive reuse of existing intellectual property. • Refine point clouds and quickly fill in gaps, generating precise surfaces automatically from scanned point cloud data **Sources:** http://www.ptc.com/product/creo http://www.ptc.com/product/creo/3d-cad/parametric/extension/reverse-engineering

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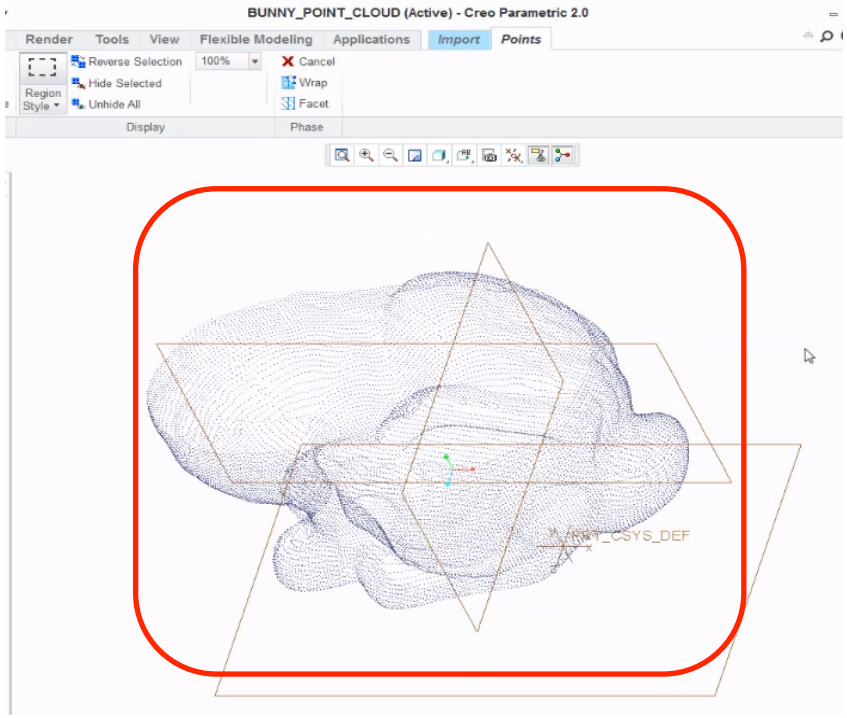
US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, a simulated three dimensional space is displayed by the PTC Creo interface. PTC Creo is the computer readable program code which displays the point cloud in a simulated 3D space.  **Source:** http://learningexchange.ptc.com/tutorial/2271/importing-and-editing-cloud-point-data-in-creo

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US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo

4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor;
changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….

Comment: As shown in the snapshot below, PTC Creo is installed in the computer system environment with specific requirements.. PTC Creo requires a graphics processor with OpenGL specification to operate in the computer system. Thus, the PTC Creo is run by at least one processor (graphics processor and system processor) in a computer system.

System Requirements

	Operating System	Recommended amount
Main Memory (RAM)	Windows Server 2008 R2	4GB or higher
	Windows 8 and 8.1 64-bit	4GB or higher
	Windows 8 and 8.1 32-bit	3GB[a]
	Windows 7 64-bit	4GB or higher
	Windows 7 32-bit	3GB[a]
	Windows XP x64 (64-bit)	3GB or higher
	Windows XP (32-bit)	3GB[b]

Graphics Information

For 3D-hardware acceleration, an OpenGL graphics card must be used that has been tested in a PTC-certified configuration. To ensure the compatibility of a graphics driver with Creo 2.0, a PTC certified or supported hardware configuration is recommended. Graphics cards that support at least OpenGL 3.1 are recommended for Creo 2.0.

PTC recognizes that customers can benefit from using latest graphics driver and performance optimizations and improvements made by PTC's Graphics Hardware Partners. With new workstations being continuously certified by PTC, the most current graphics drivers used in the certification process can now be re-applied to previously certified configurations, as long as the configuration belongs to the same combination of workstation and graphics hardware families.

For users of Direct3D on Windows 7, the March 2009 or later release of the DirectX 10.0 End User Run Time libraries must be installed. Additionally, Medium to High-End graphics cards that fully support Direct3D 10.0 are recommended for adequate performance. Visit the Microsoft website for more information about downloading and installing Direct3D.

Source: http://support.ptc.com/WCMS/files/135225/en/creo2_hw_notes.pdf

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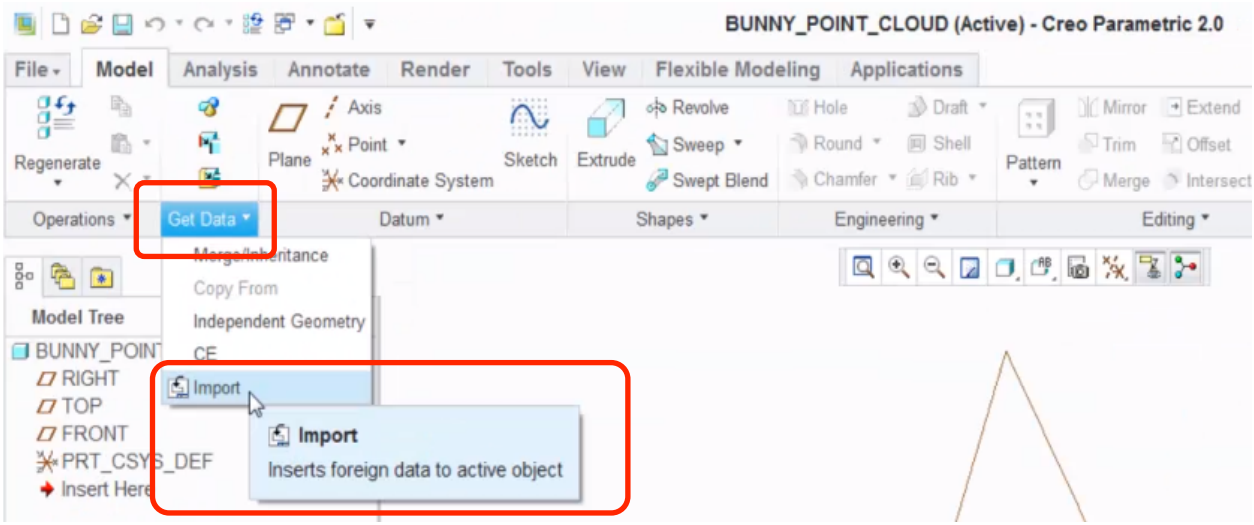
US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: **acquiring point cloud data from a database using the at least one processor;** changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, user can import the point cloud file from the computer memory (database).  **Source:** http://learningexchange.ptc.com/tutorial/2271/importing-and-editing-cloud-point-data-in-creo

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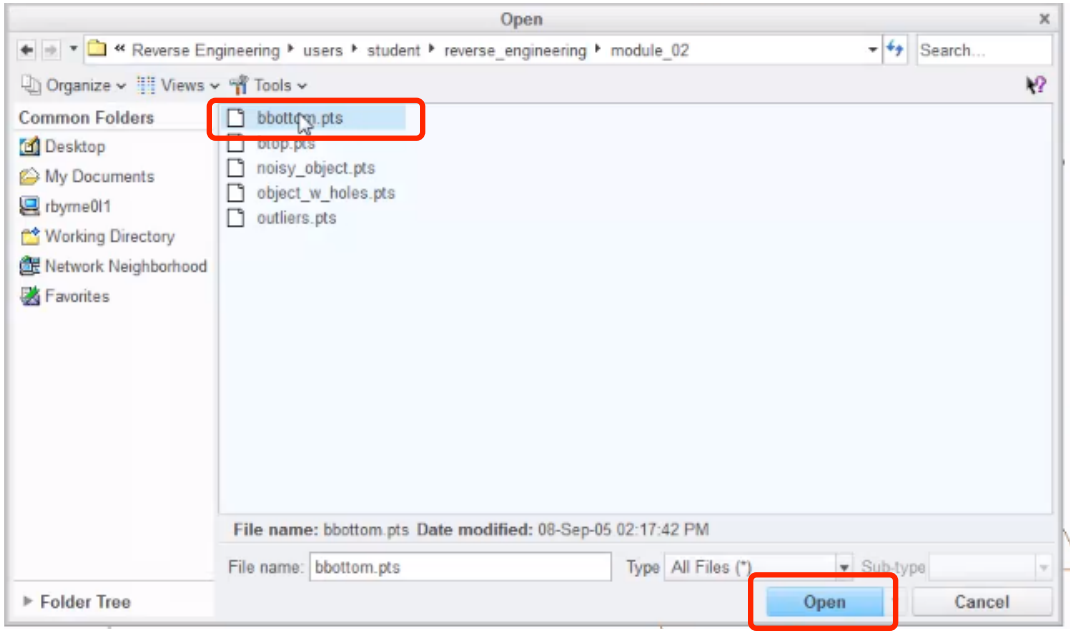
US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: **acquiring point cloud data from a database using the at least one processor;** changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, user can select and open a particular point cloud file.  **Source:** http://learningexchange.ptc.com/tutorial/2271/importing-and-editing-cloud-point-data-in-creo

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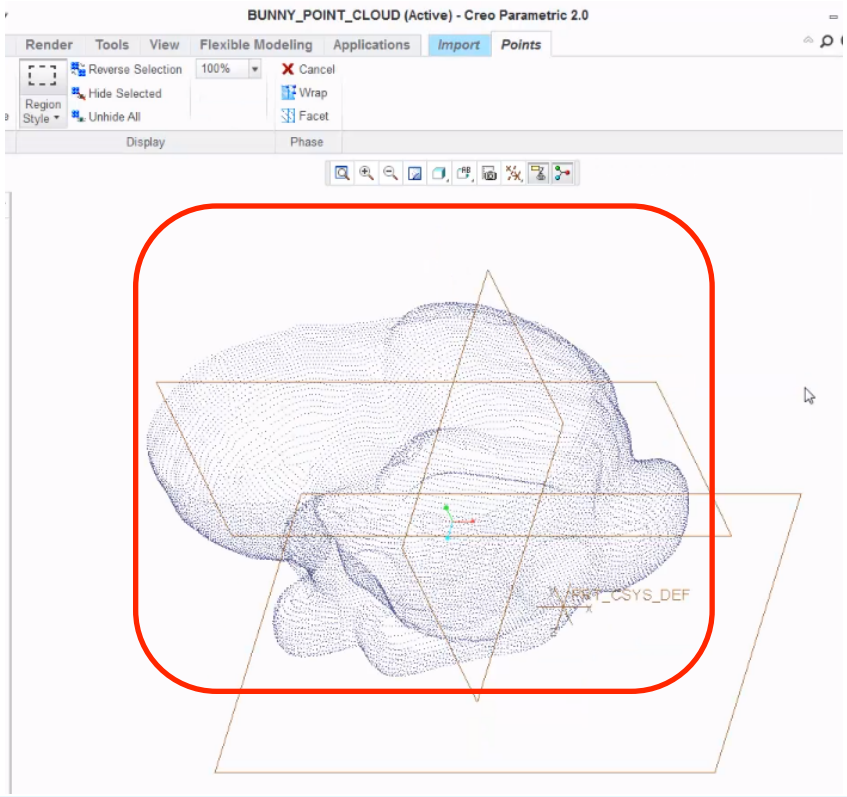
US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: **acquiring point cloud data from a database using the at least one processor;** changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, the point cloud of the particular file is generated in the 3D space.  **Source:** http://learningexchange.ptc.com/tutorial/2271/importing-and-editing-cloud-point-data-in-creo

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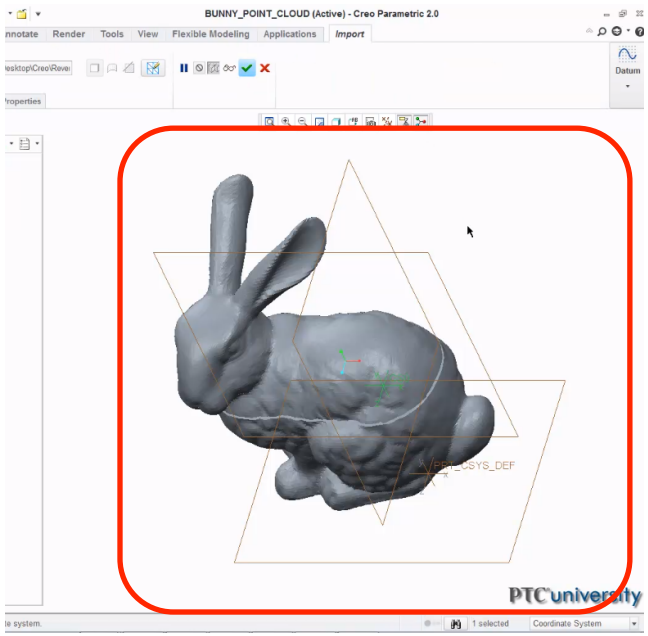
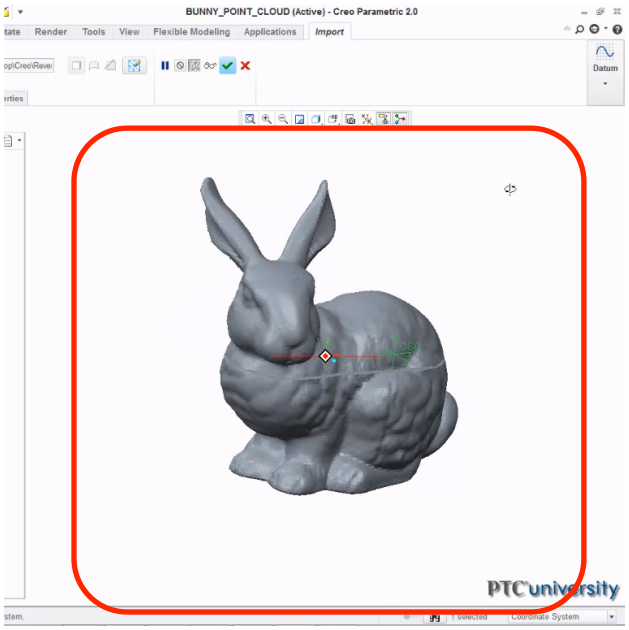
US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; **changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor;** editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, user can rotate the point cloud about X-axis, Y-axis and Z-axis.   **Source:** http://learningexchange.ptc.com/tutorial/2271/importing-and-editing-cloud-point-data-in-creo

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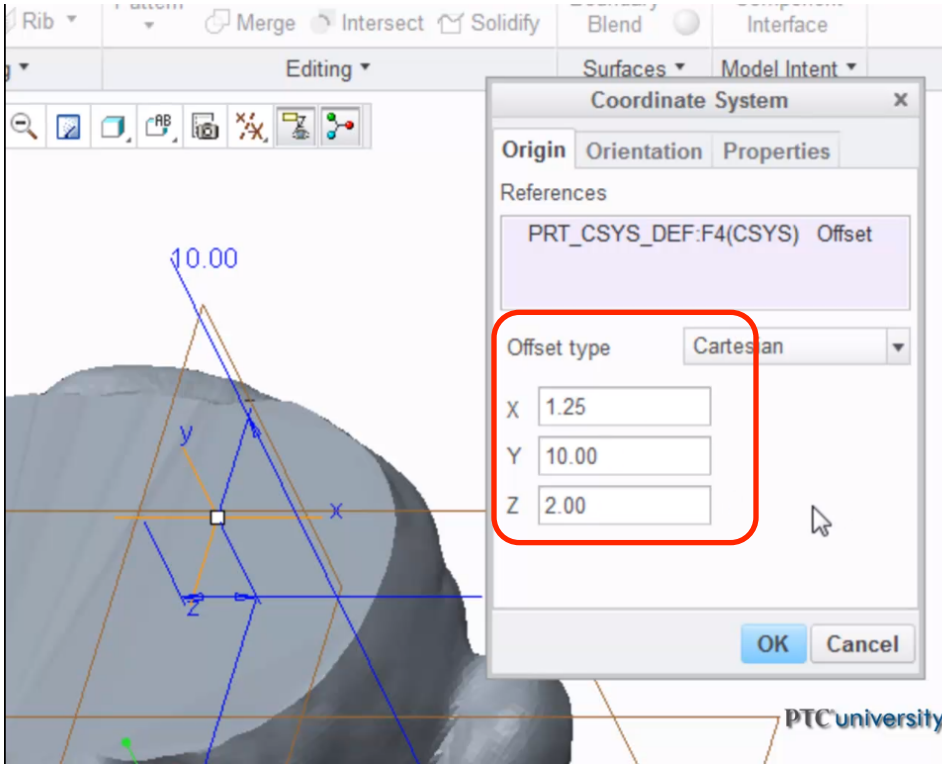
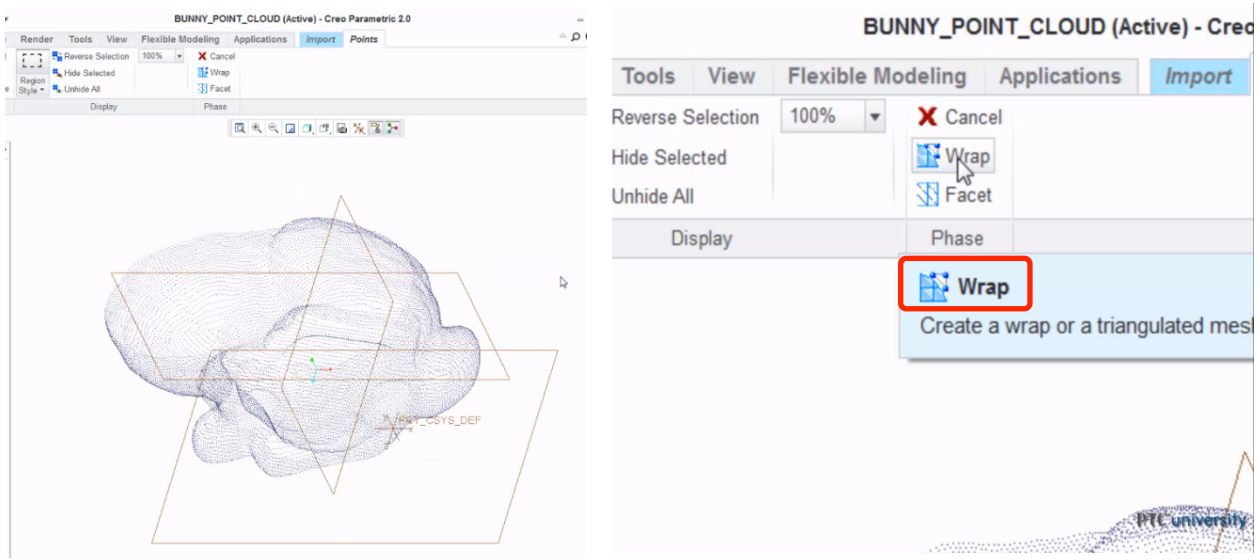
US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; **changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor;** editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, user can move the point cloud parallel to the X-axis, Y-axis and Z-axis by giving offset values.  **Source:** http://learningexchange.ptc.com/tutorial/2271/importing-and-editing-cloud-point-data-in-creo

US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; **editing the point cloud using the at least one processor;** changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, a point cloud can be smoothed out using the wrap command.  **Source:** http://learningexchange.ptc.com/tutorial/2271/importing-and-editing-cloud-point-data-in-creo

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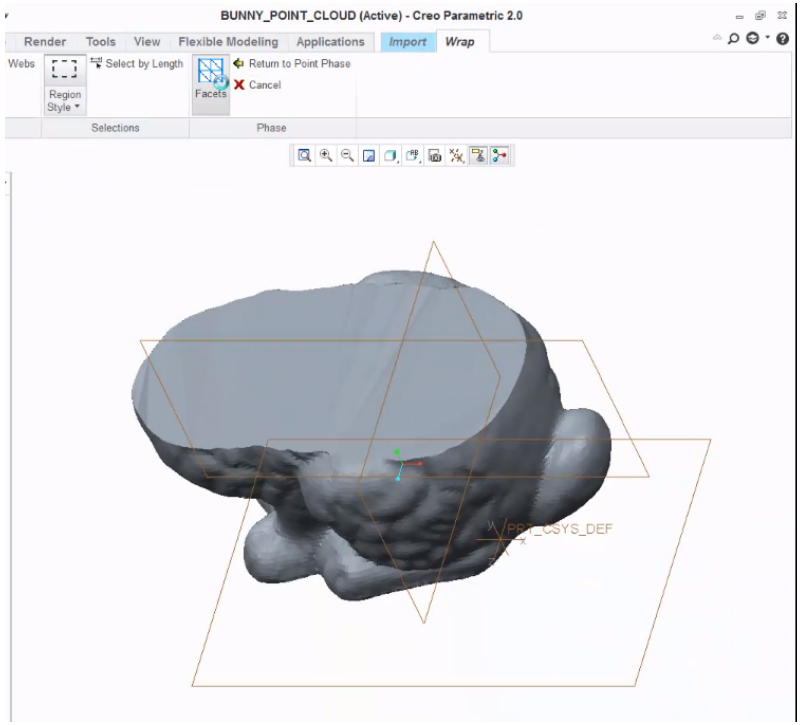
US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; **editing the point cloud using the at least one processor;** changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, the point cloud appears as solid model after the wrap command is executed.  **Source:** http://learningexchange.ptc.com/tutorial/2271/importing-and-editing-cloud-point-data-in-creo

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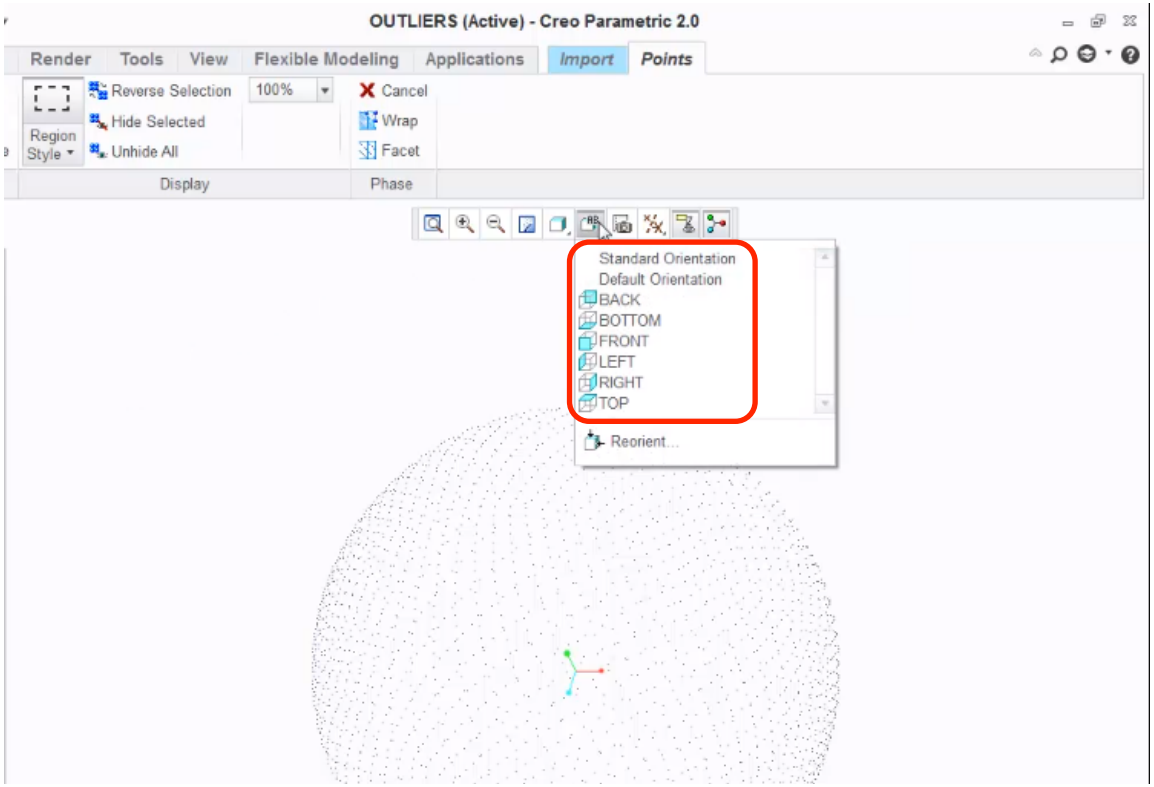
US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; **changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor;** ….	**Comment:** As shown in the snapshot below, user can switch between different views.  **Source:** http://learningexchange.ptc.com/tutorial/2272/selection-and-deletion-of-cloud-point-data-in-creo

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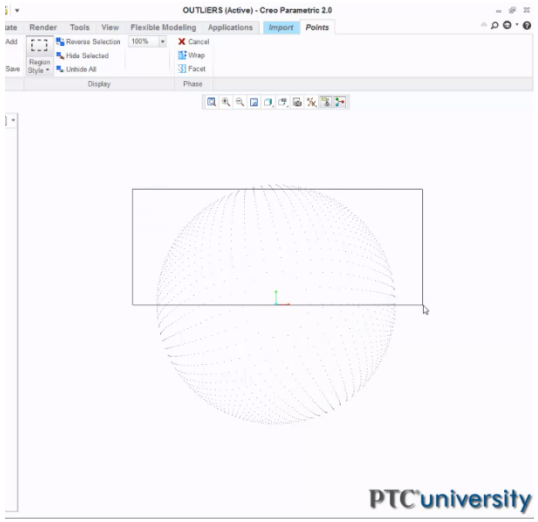
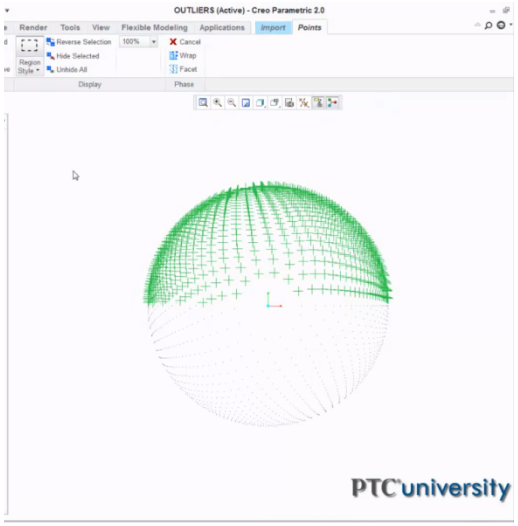
US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
….**editing the point cloud again using the at least one processor;** and displaying different portions of a point cloud by using different colors using the at least one processor.	**Comment:** As shown in the snapshot below, portion of the point cloud can be selected and deleted, thus editing the point cloud after changing the view of the point cloud.





Source: http://learningexchange.ptc.com/tutorial/2272/selection-and-deletion-of-cloud-point-data-in-creo

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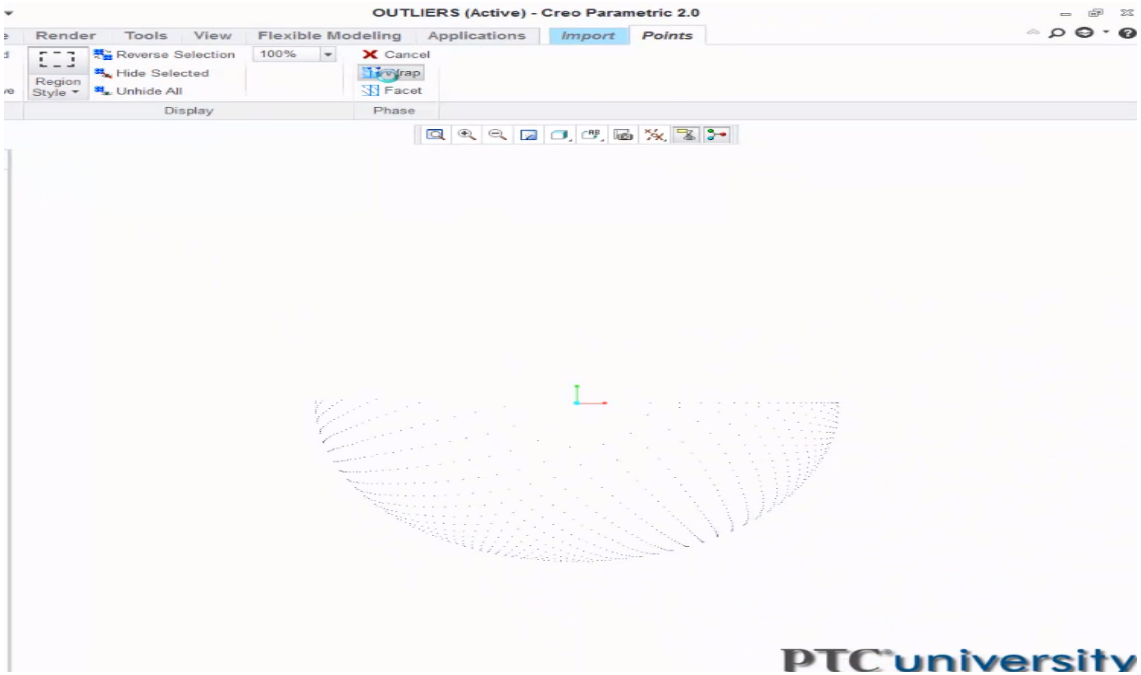
US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
….**editing the point cloud again using the at least one processor;** and displaying different portions of a point cloud by using different colors using the at least one processor.	**Comment:** The snapshot below shows the edited point cloud.  **Source:** http://learningexchange.ptc.com/tutorial/2272/selection-and-deletion-of-cloud-point-data-in-creo

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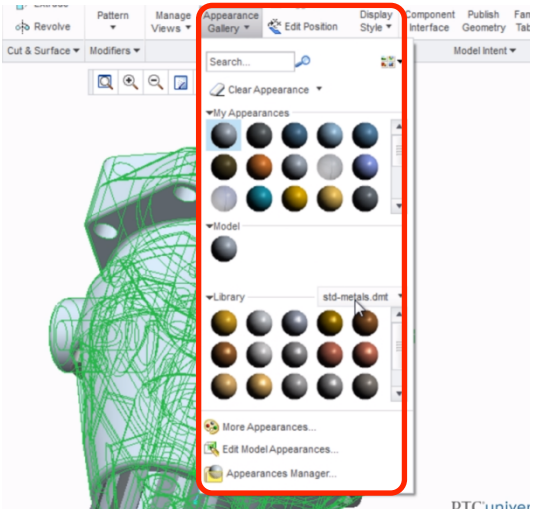
US 7683900 – Claim 4 vs. PTC Creo

Claim	PTC Creo
….editing the point cloud again using the at least one processor; and **displaying different portions of a point cloud by using different colors using the at least one processor.**	**Comment:** As shown in the snapshot below, the portion of the point cloud can be colored by selecting a color from the displayed palette. The color palette is included in the appearance gallery option in the PTC Creo. Thus, it can be construed that the different portions of the point cloud are displayed by using different colors.

Key Benefits

- Reduce costs and shorten development time by automating the process of reverse engineering a physical prototype
- Simplify the workflow, and minimize the learning curve, by using the same CAD program you use to design your products to also reverse engineer a product
- Reduce noise in point cloud data for more accurate product designs
- Maintain design integrity by accurately capturing the design intent of the original product



Sources:
http://www.ptc.com/File%20Library/Product%20Families/Creo/Model/Creo_Reverse_Enginering_Extension.pdf
http://learningexchange.ptc.com/tutorial/476/managing-and-editing-appearances

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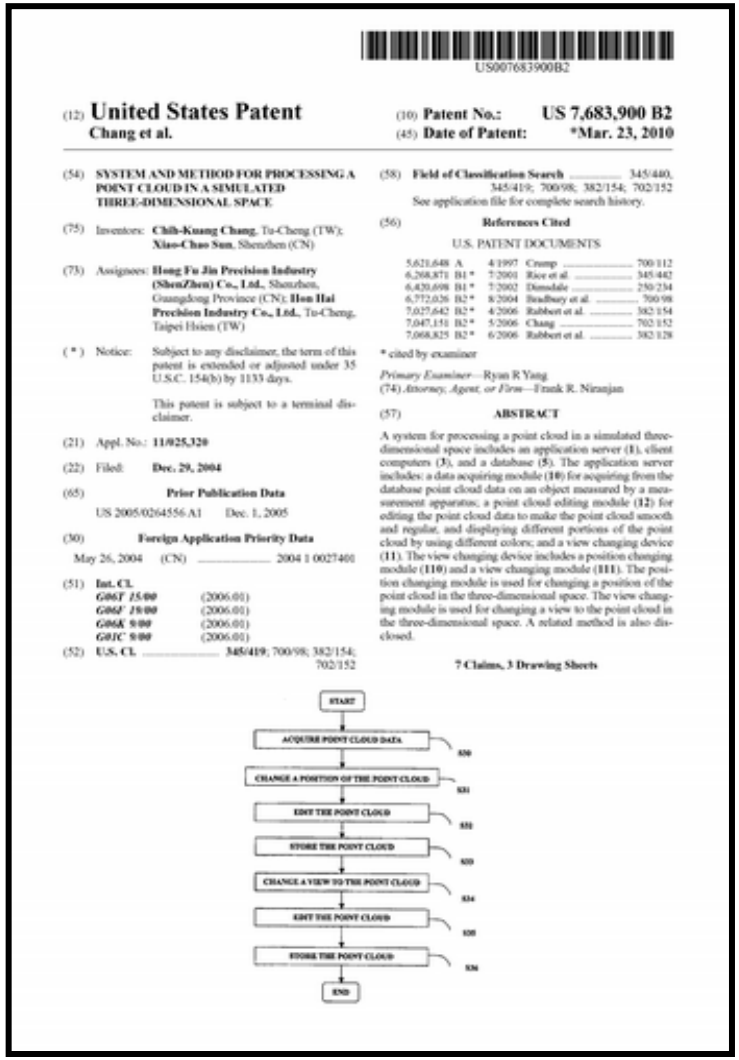
US 7683900 – Bibliographic information



US007683900B2

(12) **United States Patent**
Chang et al.

(10) **Patent No.: US 7,683,900 B2**
(45) **Date of Patent: *Mar. 23, 2010**

(54) **SYSTEM AND METHOD FOR PROCESSING A POINT CLOUD IN A SIMULATED THREE-DIMENSIONAL SPACE**

(75) Inventors: **Chih-Kuang Chang**, Tu-Cheng (TW); **Xiao-Chao Sun**, Shenzhen (CN)

(73) Assignees: **Hong Fu Jin Precision Industry (ShenZhen) Co., Ltd.**, Shenzhen, Guangdong Province (CN); **Hon Hai Precision Industry Co., Ltd.**, Tu-Cheng, Taipei Hsien (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1133 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **11/025,320**

(22) Filed: **Dec. 29, 2004**

(65) **Prior Publication Data**

US 2005/0264556 A1 Dec. 1, 2005

(30) **Foreign Application Priority Data**

May 26, 2004 (CN) 2004 1 0027401

(51) **Int. Cl.**
G06T 15/00 (2006.01)
G06F 19/00 (2006.01)
G06K 9/00 (2006.01)
G01C 9/00 (2006.01)

(52) **U.S. Cl.** **345/419**; 700/98; 382/154; 702/152

(58) **Field of Classification Search** 345/440, 345/419; 700/98; 382/154; 702/152
See application file for complete search history.

(56) **References Cited**

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7,047,151	B2 *	5/2006	Chang	702/152
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Primary Examiner—Ryan R Yang
(74) *Attorney, Agent, or Firm*—Frank R. Niranjan

(57) **ABSTRACT**

A system for processing a point cloud in a simulated three-dimensional space includes an application server (1), client computers (3), and a database (5). The application server includes: a data acquiring module (10) for acquiring from the database point cloud data on an object measured by a measurement apparatus; a point cloud editing module (12) for editing the point cloud data to make the point cloud smooth and regular, and displaying different portions of the point cloud by using different colors; and a view changing device (11). The view changing device includes a position changing module (110) and a view changing module (111). The position changing module is used for changing a position of the point cloud in the three-dimensional space. The view changing module is used for changing a view to the point cloud in the three-dimensional space. A related method is also disclosed.

7 Claims, 3 Drawing Sheets

Patent of Interest:

US 7683900
(Priority date: May 26, 2004)

System and method for processing a point cloud in a simulated three-dimensional space

Exemplary Market Applications:

The patented technology finds applications in processing of point clouds and enhancing the design of the product.

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US 7683900 – Claim 4

4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of:

    acquiring point cloud data from a database using the at least one processor;

    changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y- axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor;

    editing the point cloud using the at least one processor;

    changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor;

    editing the point cloud again using the at least one processor; and

    displaying different portions of a point cloud by using different colors using the at least one processor.

US 7683900 – EoU Summary

Trimble RealWorks	
Key claim(s)	1,4,6 (independent claims)
Mapped product	Chart has been made with respect to Trimble RealWorks.
Source	Product information available at: http://www.trimble.com/3d-laser-scanning/realworks.aspx http://trl.trimble.com/docushare/dsweb/Get/Document-603879/TrimbleRealWorks_EN.pdf http://trl.trimble.com/docushare/dsweb/Get/Document-231132/022543-123I_TrimRealWorks_TN_1114_LR.pdf
Product launch date	December,2009
Details of product / company	Trimble RealWorks is a powerful office software that imports rich data from your 3D laser scanning instrument and transforms it into compelling 3D deliverables. As the desktop component of Trimble's suite of 3D scanning solutions, Trimble Realworks provides you with the capability to efficiently manage, process, and analyze large data sets with confidence.

US 7683900 – Trimble RealWorks: Overview

Trimble 3D scanning software allows you to integrate 3D point and survey data to Extract measurements, Generate deliverables and Utilize inside 3D CAD software.

Highights of Trimble RealWorks are:

- Effectively manage, process and analyze large datasets
- Visualize 3D data
- Streamlined workflow via the Easy Guided Step™
- Combine 3D scanning, imaging and position data
- Extract 3D point clouds, CAD models, video simulations
- EasyPipe™ tool allows automatic modeling of pipes
- Seamless transfer to Trimble LASERGen

Source: http://www.trimble.com/3d-laser-scanning/realworks.aspx

US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, Trimble RealWorks is a software which can process a point cloud in a three-dimensional space. Further, Trimble RealWorks analyses and refines point clouds. **WHAT'S INSIDE TRIMBLE REALWORKS** Trimble® RealWorks® software enables you to register, visualize, explore and manipulate as-built or scene point cloud data collected with virtually any laser scanner. Advanced, but very easy to use, Trimble RealWorks allows you to: • Manage, process and analyze large datasets • Perform smart measurement – semi-auto clearance, projected vertical and horizontal **Source:** http://trl.trimble.com/docushare/dsweb/Get/Document-231132/022543-123I_TrimRealWorks_TN_1114_LR.pdf

US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, a simulated three dimensional space is displayed by the Trimble RealWorks interface. Trimble RealWorks is the computer readable program code which displays the point cloud in a simulated 3D space.  **Source:** https://www.youtube.com/watch?v=hzIVE20DtBs

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US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, Trimble RealWorks is installed in the computer system environment with specific requirements. Trimble RealWorks requires a processor of minimum specification to operate in the computer system. Thus, the Trimble RealWorks is run by at least one processor in a computer system. **SYSTEM REQUIREMENTS** **OPERATING SYSTEM** • Microsoft® Windows® 7 or 8 – 64-bit • Processor: minimum 2.8 Ghz (Quad-Core) or higher, (additional cores with Hyper-Threading support strongly recommended) • RAM: minimum 8GB (16 GB and higher recommended)* • VGA card: OpenGL 3.2 compatible with minimum 1GB VRAM (3GB or higher recommended) • 3-button mouse **OTHER REQUIREMENTS:** • Solid State Drive (SSD) for maximum performance (pref. 256 GB) – strongly recommended. **Source:** http://trl.trimble.com/docushare/dsweb/Get/Document-231132/022543-123I_TrimRealWorks_TN_1114_LR.pdf

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US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: **acquiring point cloud data from a database using the at least one processor;** changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, user can import the point cloud file from the computer memory (database). **Import a Project File** A project file can be imported into an existing project by using the Open dialog. To Import a Project File: 1. From the File menu, select Open. The Open dialog opens with the Add to Project option dimmed*. 2. Select a type of file from the File of Type field. 3. Navigate to the drive/folder where the file is located. 4. Click on the file to select it. Its name appears in the File Name field. 5. Keep the Add to Project option checked. 6. If there are several projects, click on the pull-down arrow. 7. Choose a project from the drop-down list. 8. Click Open. The Open dialog closes. **Tip:** You can use the shortcut key Ctrl + O (or click Open in the Main toolbar) to pop-up the Open dialog. **Source:** http://trl.trimble.com/docushare/dsweb/Get/Document-603879/TrimbleRealWorks_EN.pdf

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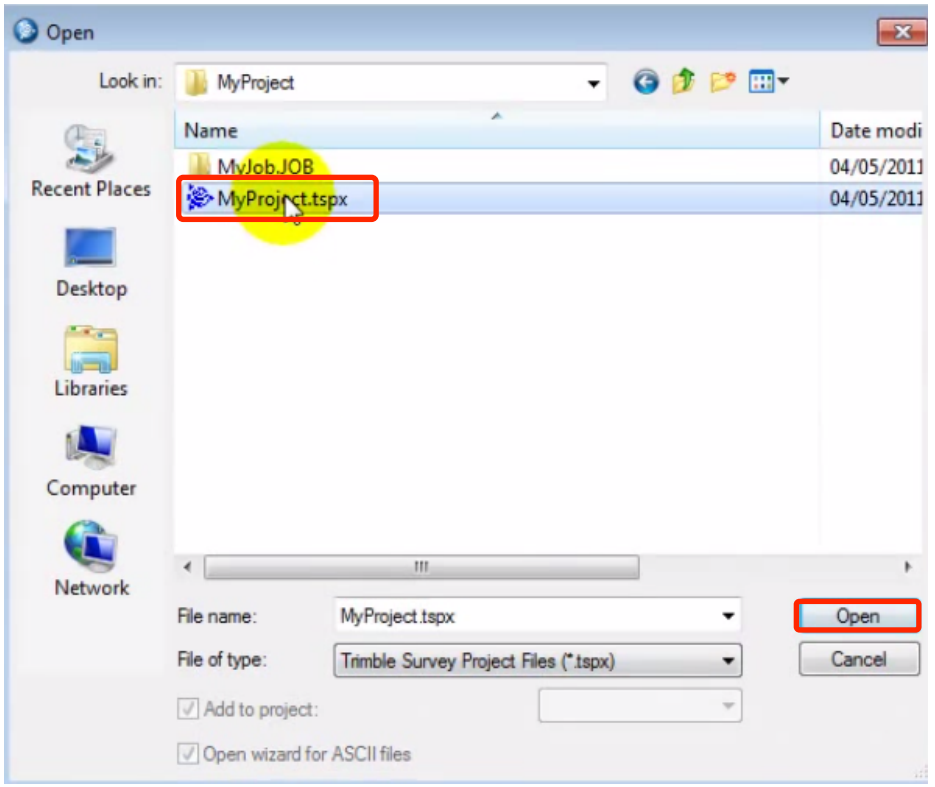
US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: **acquiring point cloud data from a database using the at least one processor;** changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, user can select and open a particular point cloud file.  **Source:** https://www.youtube.com/watch?v=0EtrwHqejGM

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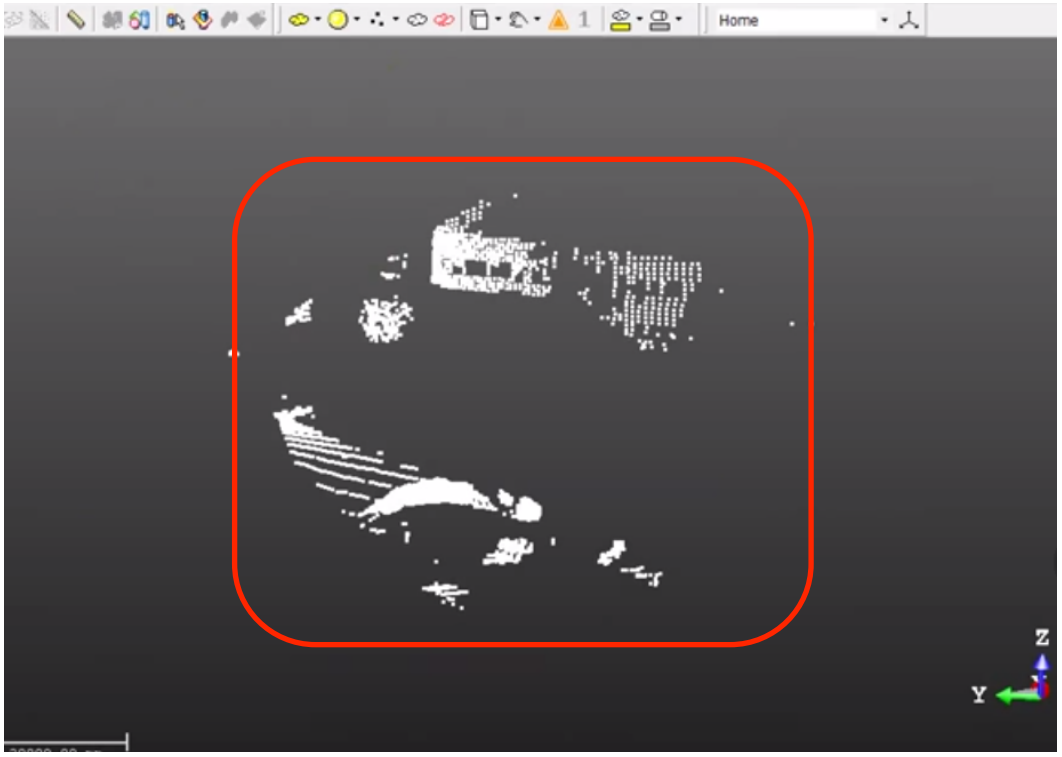
US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: **acquiring point cloud data from a database using the at least one processor;** changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, the point cloud of the particular file is generated in the 3D space.  **Source:** https://www.youtube.com/watch?v=0EtrwHqejGM

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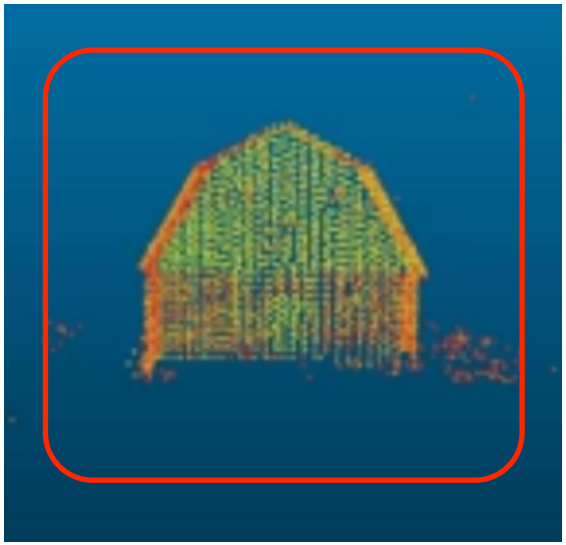
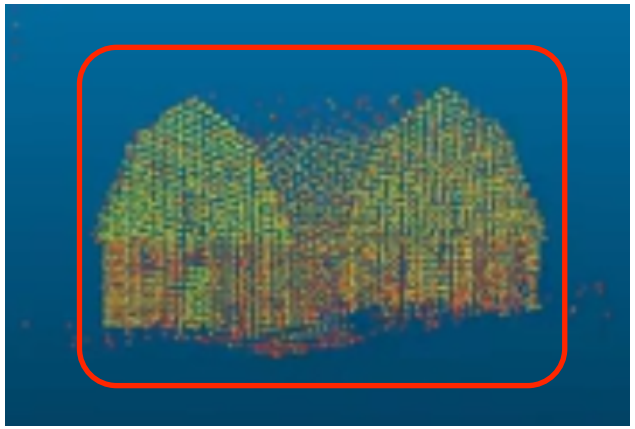
US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; **changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor;** editing the point cloud using the at least one processor; changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, user can rotate the point cloud about X-axis, Y-axis and Z-axis.   **Source:** https://www.youtube.com/watch?v=hzIVE20DtBs

US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
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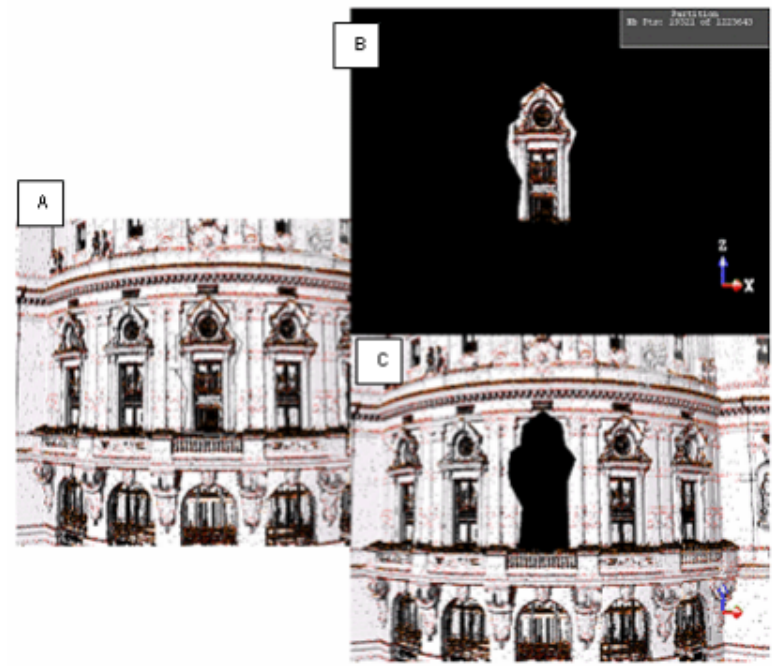
US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; **editing the point cloud using the at least one processor;** changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, a point cloud can be divided into many point sub-clouds using the Segmentation Tool. Thus, points clouds can be edited in Trimble RealWorks. **Segmentation Tool** This tool allows you to segment a point cloud object into several point sub-clouds. By using this tool, you can structure a complex scene into its logical component parts, and work subsequently on each part. It is important to note that an object containing both the point cloud and geometry representations cannot be segmented. In order to do this, you have to use the Sampling Tool to create a new point cloud without geometry and then perform the segmentation on the newly created point cloud. In order to enable this tool, you should select one or several point cloud objects. **Note:** The Segmentation Tool, as a standalone version, is only available in OfficeSurvey and Modeling. When using it as a sub-tool, it is available anywhere. **Source:** http://trl.trimble.com/docushare/dsweb/Get/Document-603879/TrimbleRealWorks_EN.pdf

US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; **editing the point cloud using the at least one processor;** changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor; ….	**Comment:** As shown in the snapshot below, the point cloud is segmented after the Segmentation Tool is used.  **Source:** http://trl.trimble.com/docushare/dsweb/Get/Document-603879/TrimbleRealWorks_EN.pdf

US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
4. A method for processing a point cloud in a simulated three-dimensional space, the method being performed by execution of computer readable program code by at least one processor of at least one computer system, the method comprising the steps of: acquiring point cloud data from a database using the at least one processor; changing a position of the point cloud in the three-dimensional space by rotating the point cloud about an X-axis, a Y-axis, and/or Z-axis, and/or moving the point cloud parallel to the X-axis, the Y-axis, and/or the Z-axis using the at least one processor; editing the point cloud using the at least one processor; **changing a view to the point cloud in the three-dimensional space, the view being changed to any one of a top view, a bottom view, a right side view, a left side view, a front view, and a rear view using the at least one processor;** ….	**Comment:** As shown in the snapshot below, user can switch between different views.

Align to a Standard View

There are twelve pre-programmed standard viewing positions. Six of them (Top, Back, Right, Left, Front and Back) are defined as shown below where X, Y, Z represent the three axes of the Active Frame.

View	View Direction
Top	Looking parallel to - Z-axis, + Y-axis bottom to top, + X-axis left to right
Bottom	Looking parallel to + Z-axis, + Y-axis top to bottom, + X-axis left to right
Front	Looking parallel to + Y-axis, + Z-axis bottom to top, + X-axis left to right
Back	Looking parallel to - Y-axis, + Z-axis bottom to top, + X-axis right to left
Left	Looking parallel to + X-axis, + Z-axis bottom to top, + Y-axis right to left
Right	Looking parallel to - X-axis, + Z-axis bottom to top, + Y-axis left to right

Source: http://trl.trimble.com/docushare/dsweb/Get/Document-603879/TrimbleRealWorks_EN.pdf

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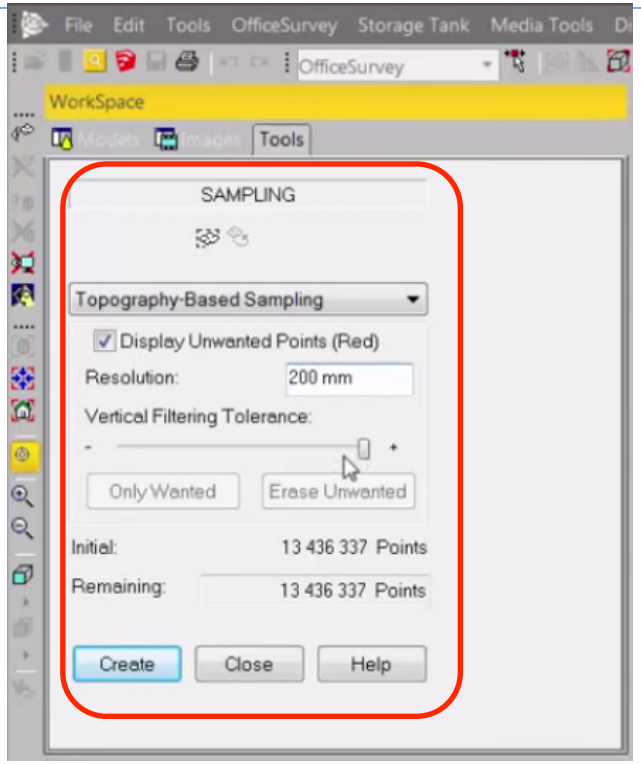
US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
….**editing the point cloud again using the at least one processor;** and displaying different portions of a point cloud by using different colors using the at least one processor.	**Comment:** As shown in the snapshot below, user can use the Sampling Tool to remove points from the point cloud, thus editing the point cloud after changing the view of the point cloud.  **Source:** https://www.youtube.com/watch?v=C6-kxdEE1tQ

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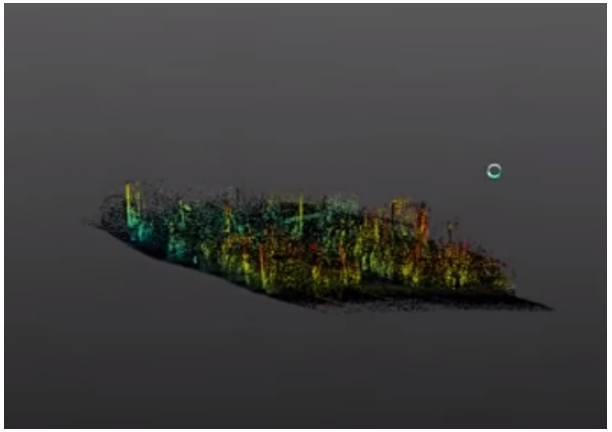
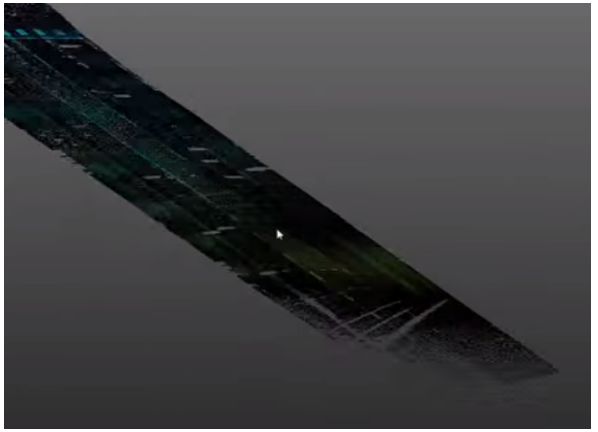
US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
….**editing the point cloud again using the at least one processor;** and displaying different portions of a point cloud by using different colors using the at least one processor.	**Comment:** The snapshots below show the initial point cloud and the edited point cloud.   **Source:** https://www.youtube.com/watch?v=C6-kxdEE1tQ

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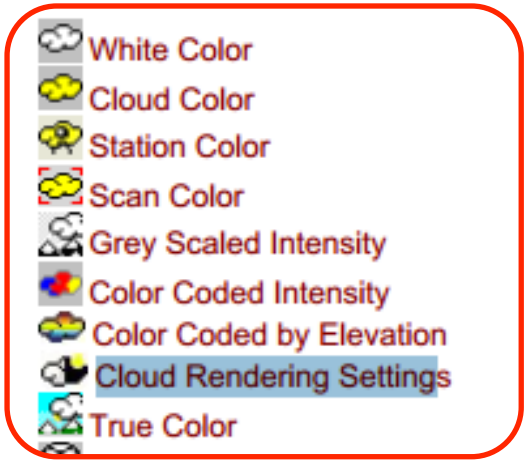
US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
….editing the point cloud again using the at least one processor; and **displaying different portions of a point cloud by using different colors using the at least one processor.**	**Comment:** As shown in the snapshot below, there are several rendering options that can be applied to a displayed point cloud.

3D View

Under the 3D View toolbar, you can find the following list of icons:



Source: http://trl.trimble.com/docushare/dsweb/Get/Document-603879/TrimbleRealWorks_EN.pdf

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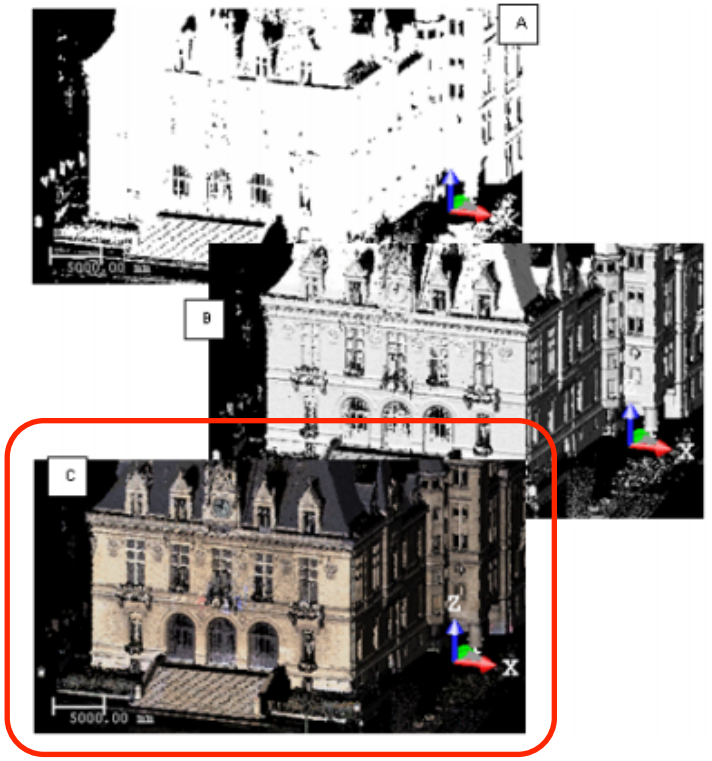
US 7683900 – Claim 4 vs. Trimble RealWorks

Claim	Trimble RealWorks
….editing the point cloud again using the at least one processor; **and displaying different portions of a point cloud by using different colors using the at least one processor.**	**Comment:** As shown in the snapshot below, the different portions of the point cloud can be displayed using different colors.  **Source:** http://trl.trimble.com/docushare/dsweb/Get/Document-603879/TrimbleRealWorks_EN.pdf

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