Scientific Journals
Maritime University of Szczecin

Zeszyty Naukowe
Akademia Morska w Szczecinie

2012, 30(102) pp. 66–69

2012, 30(102) s. 66–69

Integration of Cloud Computing and Reverse Engineering 3D Scanning for marine applications

Integracja Chmury Obliczeniowej i Inżynierii Wstecznej Skanowania 3D do zastosowań morskich

Jakub Jawor, Mirosław Luft, Zbigniew Łukasik, Elżbieta Szychta

Technical University of Radom, Faculty of Transport and Electrical Engineering
Uniwersytet Technologiczno-Humanistyczny im. Kazimierza Pułaskiego w Radomiu
Wydział Transportu i Elektrotechniki
26-600 Radom; ul. J. Malczewskiego 29, e-mail: {jakub.jawor; m.luft; z.lukasik; e.szychta}@pr.radom.pl

Key words: reverse engineering, 3D laser scanners

Abstract
Reverse Engineering (RE), in particular Coordinate Measuring Machine (CMM), is increasingly used in construction, maintenance and refurbishment of vessels. Over the last few years, it can observe increasing interest in the small size scanning instruments which operational characteristics will be similar to those station ones. In this way, hand-held scanning devices based on laser were developed. In this article, authors would like to present what role non-contact 3D laser scanners in quality control, project design and creation of new technical documentation in the form of CAD drawings. Authors would also like to propose a solution that would simplify the whole process of scanning and spared time and money. The solution is to move the entire infrastructure and software in the cloud computing and connecting to it using a thin client which then would be connected to the scanning device.

Słowa kluczowe: inżynieria odwrotna, skanery laserowe 3D

Abstrakt
Inżynierię Odwrotną (ang. *Reverse Engineering*), a w szczególności maszyny współrzędnościowe, coraz częściej stosuje się w budowie, utrzymaniu i w renowacji jednostek pływających. Przez ostatnie lata możemy zauważyć duże zainteresowanie urządzeniami skanującymi małych rozmiarów, których właściwości robocze będą zbliżone do tych stacjonarnych. Tym sposobem powstały ręczne urządzenia skanujące na bazie lasera. W artykule przedstawiono rolę, jaką odgrywają bezdotykowe skanery laserowe 3D w kontroli jakości elementów, projektowaniu czy tworzeniu nowych danych technicznych w formie rysunków typu CAD. Zaproponowano rozwiązanie, które uprościłoby cały proces skanowania, jak i oszczędziło czasu i pieniędzy. Rozwiązaniem tym jest przeniesienie całej infrastruktury i oprogramowania w chmurę obliczeniową i łączenie się z nią za pomocą cienkiego klienta, który następnie byłby połączony z urządzeniem skanującym.

Introduction

Reverse engineering (RE) is widely known and used method in all fields of industry, its main purpose is to gain knowledge about the object (equipment, electronic component, computer program, etc.). RE is also used when you wish to update blueprints for the device or create them from scratch. For this purpose it is necessary to measure the object and draw in a suitable CAD software its graphical representation. In some cases, we only need to validate that the element was made according to CAD models in other words it has to check the quality of newly made object. In both cases, it can aid with the latest achievements of technology namely a graphical object representation using Coordinate Measuring Machines (CMM). Due to rapid development of new ways of measurements and graphical representation of three-dimensional objects, 3D scanners based on Laser Detection and

Ranging (LADAR) were invented. Unfortunately, first scanners did not have high accuracy and range, therefore only some branches of industry used them. But for a few years now it can see new wave of three-dimensional laser scanning. Today's scanners have what is needed to scan large objects like vessels, piping, engines, hulls, mechanical equipment and many more. Newest scanners can work in any time of a day which is great advantage that can save lots of time. Also due to high quality data and accuracy more and more branches of industry implement this way of measurement and CAD model building [1].

Unfortunately, in marine application it is still innovative approach which can aid marine engineers and architects in their work of building, repairing, repurposing or restoring marine vessels. Some marine objects have lack of digital documentation, which can cause many problems in long time period especially when off-shore object must be repaired [2, 3]. That is why 3D laser scanning technology is a solutions that can ensure that all marine objects (vessels, platforms, engines, system, platforms, etc.) can be safely build, restore or repaired, without loss of time and money.

Integrating laser scanning technology with Cloud Computing can bring even more advantage to marine applications. Engineers and architects would no longer wait for data from scanning as all scanned points would be available in the cloud with necessary specialized software in which our point cloud would be processed to desired CAD model [4]. Also no more heavy PC's or laptops would be needed as due to fully virtualization of our system. Engineers would apply the required corrections to CAD models on work site and all subcontractors would have always newest data to be able to fit all parts according to corrected plans, without time loss and money saved. In this article authors would like to present why we should start implementing Cloud Computing with 3D scanning to marine applications.

3D scanning

Currently scanning three-dimensional objects has become one of the core elements of reverse engineering, and over the past few years we have seen it growth, in particular when it comes to laser scanning. Laser Detection and Ranging (LADAR) is a rapidly developing application for measuring the shape of objects. In principle nothing more is done than sending out a laser beam, and measure the reflection that is coming back from the object. This can be done in two different ways. One way is to send out a laser pulse and measure the time until a reflected signal is received. And the other way is to use a continuous beam and measure the difference in the phase of the reflected beam when it reaches the sensor in the scanner. The second one is the fastest one and can easily capture 120,000 points in (x,y,z)-coordinates [5].

3D scanning for marine applications is a ground base to create digital models of complex entities such as hull models, seagoing vessels, shipyards, engine rooms and other bug structures and marine locations. By using very accurate data obtained from 3D scanning engineers are able to create and simulate the actual objects through modeling gathered point cloud in specialized CAD software. Also there is no size limit on the measured object when using laser scanning technology, therefore we are no longer bound to scanning pole arms or to directional travel of CMM (Coordinate Measuring Machine) machines.

LADAR technology as a part of RE is a tool than can accurately and efficiently scan any part of marine vessels from whole ship, engine rooms to entire systems. It can combine laser scanning technology with special software applications that can recognize components such as wiring, valves and piping. Such advance technology can greatly improve scanning process and shorten modeling time.

Basic elements that are performed during 3D scanning are:

– scanning;
– registration (combining point clouds);
– modeling (generating surfaces out of points).

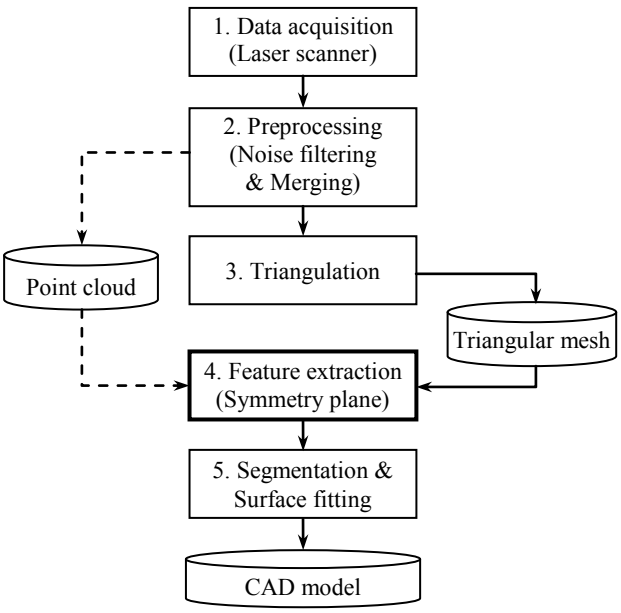

Fig. 1. Typical flow of reverse engineering [6]
Rys. 1. Typowy tok procesu inżynierii odwrotnej [6]

The next steps are dependent on our project. If this is a quality check of the element, we will do a comparison of scanned object with the original CAD model. But if we want to create a model to calculate Computational Fluid Dynamics (CFD) we will first perform simulations and then compare the results obtained from the older model in CAD.

Marine applications

When the vessel is build, its structure not always is the same as plan drawings, which can cause problems when components like windows, cabin, engine parts and other systems are fitted. To resolve this issue 3D laser scan can be performed outside and inside of the hull skeleton. Acquiring this data and transforming it to CAD model on every stage of ship building can be very useful to monitor that all ship's parts will fit correctly at the first time which can save time and money[7, 8].

Most vessels have incorrect CAD models due to not keeping them up-to date or do not have any CAD models made because they where built before even CAD models where implemented. The issue arises when we have to make repairs or update some part of vessel. Without such accurate data shipbuilders work with the blindfold as they do not have precise dimensional data at hand. In such cases using LADAR technology would shorten a time even to half, without wondering if replacement of faulty part or hull update will fit correctly.

3D laser scanning technology provides high resolution data which can be used to make 3D virtual simulations on an in-service vessel. This is very important stage when the vessel is to be repurpose to different type, for example Seismic Research Unit converted to ship support for underwater work or cargo carrier converting to a passenger ship. Simulation data can provide us with very important information how newly converted ship will behave on open waters, will it be safe during storm, what will be its manoeuvreability, what maximum weight can it carry, etc. This way money and time can be saved and dangerous situations can be avoided.

Cloud computing SaaS/DaaS

Cloud computing is no longer a technological novelty, it is used widely in various fields of industries and is slowly becoming the standard for various IT industries. Cloud Computing is not just Internet and several connected devices. Originally, the term meant sharing computing resources such as CPU time, storage and services that can be purchased in the same way as the everyday media [9]. Therefore, moving the entire infrastructure (except the physical measuring machines) into the cloud could be a huge benefit. We would use only what we currently require to perform a specific task. There will be no need to buy a license for specialized programs for multiple stations, and most importantly, expensive computer equipment that until now has been necessary for the proper and smooth operation of the whole system.

Fig. 2. Relationship pyramid of Cloud Computing models [9]
Rys. 2. Piramida zależności pomiędzy modelami chmury obliczeniowej [9]

To realize these assumptions the most suitable models for cloud computing are SaaS (Software as a Service) and DaaS (Desktop as a Service) embedded in a private cloud. The two recommended models have the advantage for the client not to be concerned about the hardware infrastructure or operating system, as well as programs updates and data security. The only difference is how user will access the work environment. With the use of SaaS, we are still at the mercy of the operating system and hardware that we use. DaaS gives us greater scope option providing a total of virtualized operating system and PC components. With DaaS the only thing we will be using is thin client or a tablet computer with access to the Internet. Everything that normally would be situated within our central unit together with our operating system would be transferred in the cloud. By enabling our thin client we would get access automatically through the cloud to our full virtualized desktop, not realizing that we operate on a virtual software.

Application of CC and 3D laser scanning in marine applications would be great benefit for engineers working off-shore and on the land. Using CC would ease when necessary off-shore repair is needed and vessel do not has accurate CAD documentation. Therefore, integrating LADAR technology and CC would help. At the same time of scanning our data point cloud would be available in the private cloud where on shore engineers can immediately make necessary CAD model and send it to fit or produce new replacement part.

It is very important that different companies which are taking part in the same project are using

same CAD models, especially when new hull skeleton is being build. In such cases using same CAD model and same tools would be essential in order to keep clear communication between two parties. Using private cloud and thin client or tablet PC with virtualized desktop and software would be great improvement in correcting CAD models on spot in the agreement with the ship developer and engineers.

Advantage of such improvement would be great, we would no more had to pay for license per annum for specialized programs as all will be in a cloud and that means that we pay only for what we will use. Also no more heavy equipment with specialized GPU processor for quicker CAD model building and adjustment to 2D and 3D CAD drawings will be needed. All scanned data would also be at hand to subcontractors which will always have newest CAD drawings and would develop parts without concern that they will not fit properly.

Conclusion

Cloud Computing combined with virtualization still expands to new areas of industries. Its use reduces costs, improve quality and accelerate the exchange of information. Implementation of the CC to reverse engineering, provides amazing opportunities, in particular, with 3D scanning where its main use is in Computer Aided Design (CAD), which then has its use in rapid prototyping (RP) and rapid tooling (RT). Adaptation CC in marine applications is next big step in fully virtualized measurement system, which will help in safer and unlimited data storage, less cost for software, more computing power and use of small and light devices as Tablet PC or Thin Clients.

Unfortunately, 3D scanning is not as widely used in marine applications as it should be. Also lack of highly accurate or even nonexistent CAD models of marine vessels and off-shore platforms may effects the ability of repair, repurpose or restore marine vessels. LADAR technology is not innovative technology but in marine applications is novelty which can help architects and marine engineers in redesigning, repairing or repurposing marine vessels, objects and systems.

References

1. MENNA F., NOCERINO E., SCAMARDELLA A.,: Reverse engineering and 3D modeling for digital documentation of maritime heritage. Int. Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 38 (5/W16), 2–5 March 2011, Trento, Italy.
2. NEWLING M., Tritan Survey: Surveying on a moving vessel. Position IT, Aug/Sept 2011.
3. 3D Laser Scanning for Marine Applications. Laser Design and GKS Services, 2009, http://www.laserdesign.com/project_news/349/.
4. JAWOR J., ŁUKASIK Z.: SaaS/DaaS application in reverse engineering 3D scanning. 2th International Conference ESAM 2012, Diagnostic of Electrical Machines and Materials, February 8–9, Papradno, Slovak Republic 2012, 10–12.
5. BUCKSCH A., KAGKARAS A.: 3D model generation with laser scanners. Approaches towards the improvement of CFD input data. Leonardo Times, June 2006.
6. CHANG M., PARK C.S.: Reverse Engineering a symmetric object, Computers & Industrial Engineering 55 (2008).
7. Mesfin Adane Dema: 3D Reconstruction for Ship-Hull Inspection, Seebyte Ltd, Scotland, UK 2009.
8. PÉREZ F.: Reconstruction of Lines in a Ship Hull with B-Splines. Computer-Aided Design & Applications, 5(1–4), 2008, 99–109.
9. JAWOR J, ŁUKASIK Z.: Cloud Computing and Possibility of use, Central European Doctoral School, Slovakia 2011.
10. BISKUP K., ARIAS P., LORENZO H., ARMESTO J.: Application of Terrestrial Laser Scanning For Shipbuilding, ISPRS Workshop on Laser Scanning 2007 and SilviLaser 2007, Espoo, September 12–14, 2007, Finland.
11. BOEHLER W., MARBS A.: 3d Scanning Instruments. Institute for Spatial Information and Surveying Technology.
12. INDRUSZEWSKI G., FARIN G., RAZDAN A., ARLEYN SIMON, VAN ALFEN D., ROWE J.: Application of 3D Modeling in Ship Reconstruction and Analysis: Tools and Techniques. College of Technology and Innovation, Computer Applications and Quantitative Methods in Archaeology, 2004.
13. WULF O., WAGNER B.: Fast 3D Scanning Methods for Laser Measurements System, Institute for Systems Engineering, University of Hannover, Germany.
14. BISKUP K., ARIAS P., LORENZO H., ARMESTO J.: Application of Terrestrial Laser Scanning for Shipbuilding. ISPRS Workshop on Laser Scanning 2007 and SilviLaser 2007, Espoo, September 12–14, 2007, Finland.