A STUDY ON MEASUREMENT FOR LARGE SIZE OBJECTS WITH A NON-CONTACT TYPE CMM

Minseok Kim*[1], Dongeun Lee[1], Sookhan Kim[1], Jeongnak Lee[2], Junchul Kim[1] and Eungki Lee**[2]

[1]Department of Mechanical Engineering, Kongju National University
275 Budae-dong, Cheonan, Chungcheongnam, 330-717 Korea
[2]Division of Mechanical &Automotive Engineering, Kongju National University
275 Budae-dong, Cheonan, Chungcheongnam, 330-717 Korea
uranus1981@kongju.ac.kr*, eklee@kongju.ac.kr**

Abstract

Recently, efficient manufacturing of high precision is an important issue in modern industry as more variety of industrial products is being designed with compound surfaces. Rapid CAD data generation can be possible based on a non-contact type CMM of object through the use of reverse engineering. However, some registration to match the data measured from various directions into a common coordinate system is required. Also, the error can happen if it uses the conventional method to large product of thin thickness. So it is necessary to develop a new method, which was designed for the registration of large and thin products. Additionally, an algorithm to pick up coordinates for the newly designed method was proposed.

INTRODUCTION

Reverse Engineering is the technology that creates 3D CAD model to be approximated curved surface with a figure date of 3D body made by a 3D digitizing technique. Reverse Engineering is composed largely of four steps, that is, the collection of the point data about the curved surface of the body, the data preprocessing, segmentation of data and approximation of the curved surface, and the generation of the model.[1][2] The precision of the model to be produced last is under the great influence of the accuracy of the measurement of the curved surface and registration. Also, the body must be measured by changing the direction and location of it every time to get the curved surface of all body data, because 3D non-contact measuring instrument which is used to get the curved surface information of the body

can measure only one direction.[3] In addition, because the product is measured after the white spray is sprinkled on it to keep it from absorbing and reflecting the light, the surface of the product should not be touched by any objects and the setup of it not be changed while it is being measured.

The feature-based registration method is used many times to get the integrated data. This method is used by attaching the feature of a circle, a sphere, a column, or a cone on the product or connecting that it to fixing tools.[4] But it can't be used on thin, transparent and flexible products or the mother glass which is easy to be transformed by even little force. Therefore, new feature for transparent and flexible product is needed with considering the limit of direction measured with 3D non-contact measuring instrument and the accuracy of registration. In this study, when the product is measured with 3D non-contact measuring instrument, we intend to develop feature that can be applied effectively to transparent, large and thin products. Especially, we suggest the method that reduces error that can happen when the size of product is bigger than the work stage of 3D non-contact measuring instrument.

FLEXIBLE PRODUCT MEASURE

In this study, we experimented with big and thin glass, which is one of flexible products. The glass is divided into two parts and measured so that we compare the value of measuring the glass once with one of measuring the two parts of it.

Because the glass to be measured is 4G OLED mother glass and its size is 920×730×0.63t but work space of CMM, model name is Renishaw Cyclone series 2 and work space is 600×400×500, is smaller than the size of 4G OLED mother glass. The shape of true square, which is used as a standard shape for registration process, appears after sprinkling spray on the sticker which size is 15mm on the glass board and then removing the sticker.

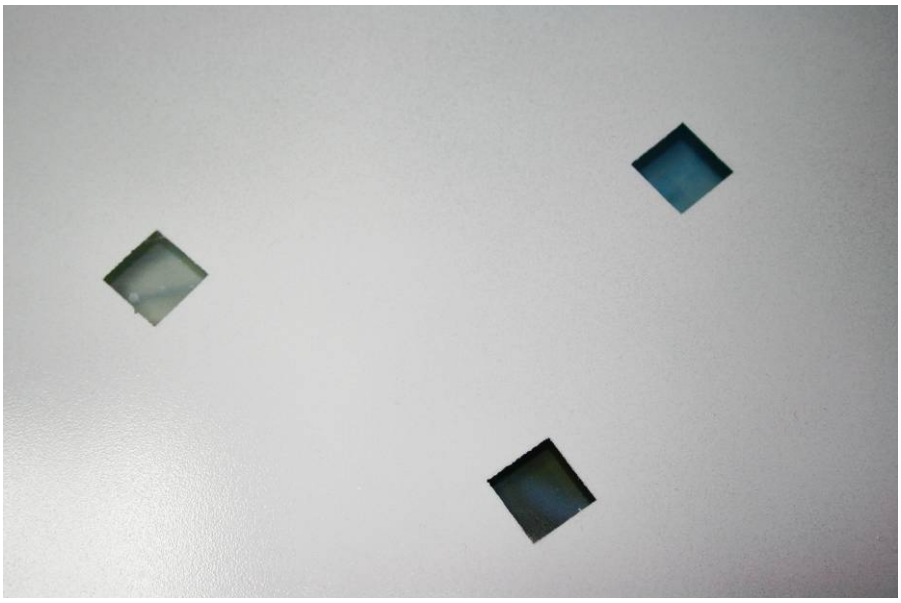
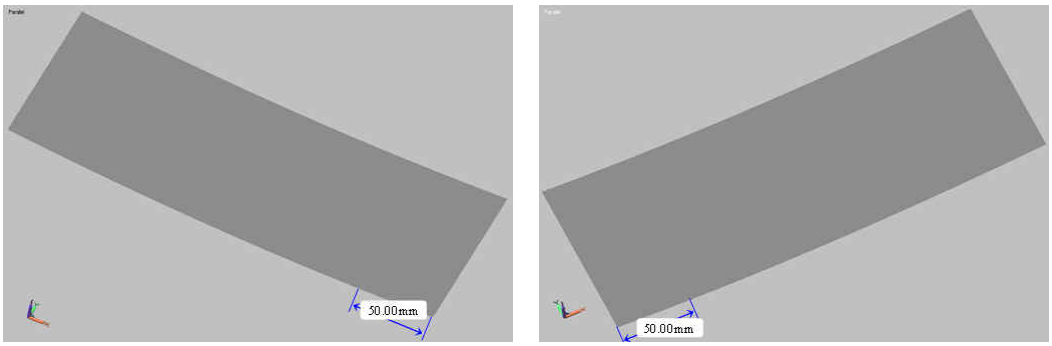


Figure 1 – True square feature on glass

The glass board was measured after it was divided into two areas and each of them included a true square shape. Nominal Pitch (point's interval to read on equal step) and Step over Distance (Scanning interval) were set up by 0.5mm. Figure 2 is measured data by points.



(a) Left part of the model (b) Right part of the model

Figure 2 – Measured data of glass

DATUM POINT DETECTION FOR REGISTRATION AND REGISTRATION

True square feature detection

To make Registration, the standard point from the feature should be detected. To do

that, the process of extracting the data of the feature from the measured data should be needed. The date of the feature is presented by sudden change of tilt in the entire data. The part in which the change of tilt is shown is defined as edge and then the data of the feature is extracted through edge detection. Figure 3 is result that was detected edge of the registration feature. [5][6][7]

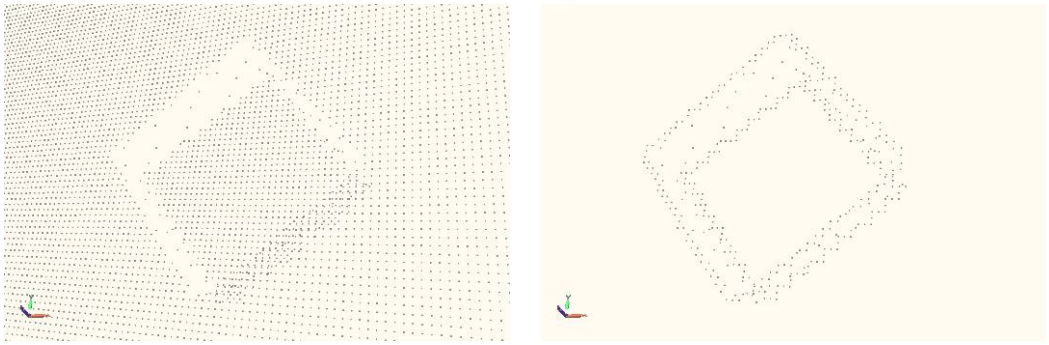


Figure 3 – Detected true square feature

Datum point detection and registration

The method of presuming values between the points with the given data points are curve fitting and both interpolation and least square method are included in it. Linear interpolation is to solve function that passes all given data points while least square method is to solve function that display general tendency of whole data. It is least square method that decides approximate expression of straight or curved line that passes data points most nearly when there are many data or error or noise are included in data. Therefore, to detect the point of the standard of registration, equation of straight line of each side was presumed from square feature data by using least square method.[8] Figure 4 is image that became registration using standard data by least square method.

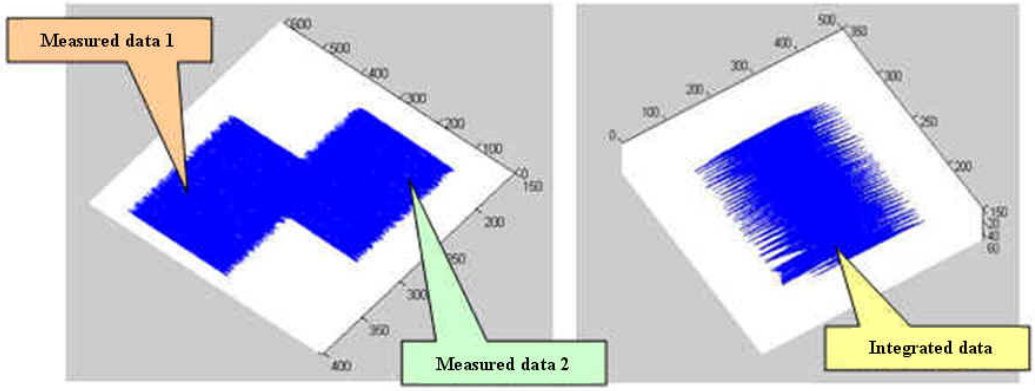


Figure 4 – Data integration

ANALYSIS OF REGISTRATION

Registration of measured board completed, but we can not know how to have error actually. So, we compared registration data to use true square feature with another data to measure whole board.

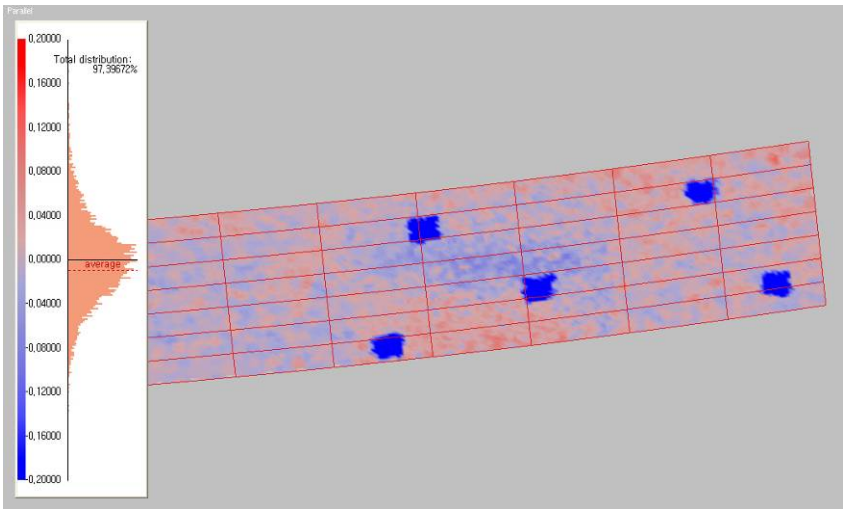


Figure 5 – Analysis registration

Figure 5 is graph that express distance between conversion data to standard data. The data had average error of 10㎛ and ranged more than 97% of the standard data. Also, the square feature used to registration was exposed dark blue.

CONCLUSION

The true square feature was developed to get efficiently body data, minimized error of registration when the product that is easy to be transformed by external force using was measured by 3D non-contact measuring instrument. Because the scanner' work space is smaller than product, it was measured in several parts to get the whole shape data. And standard coordinate system was set up by the standards points of true square shape to integrate each measured data to one coordinate system.

Also, algorithm was developed to detect the feature effectively using edge detecting means, one of image processing techniques. This algorithm can detect

various features effectively from polygon as well as square to circle. So far there is no way to measure flexible product and do registration with existing methods. Therefore, algorithm that can measure and detect the feature that was made directly on the product surface by spray will be used usefully in the limited environment.

ACKNOWLEDGEMENTS

This research was financially supported by the Ministry of Commerce, Industry and Energy (MOCIE) and Korea Industrial Technology Foundation (KOTEF) through the Human Resource Training Project for Regional Innovation

References

[1] Minyang Yang, Eungki Lee, “Segmentation of measured point data using a parametric quadric surface approximation”, Computer-Aided Design, Vol. 31, No. 6 (1999)

[2] Varady T. Martin R.R., and Cox J., “Reverse Engineering of Geometric Models”, Computer-Aided Design, Vol. 29, No. 4, pp. 255-268 (1997)

[3] K. H. Lee, S. K. Lee, and s. –M. Kim, “Design of a Universal Fixture for Laser Scanning”, Advance Manufacturing Technology, Vol 19, pp. 426-431 (2002)

[4] S. M. Kim, “Development of a universal fixture and the automation of registration for 3D laser scanning”, Department of Mechatronics, Prof Kwan Heng Lee (2001)

[5] William K. Pratt, “Digital Image Processing”, John Wiley & Sons, INC. (1991)

[6] Gregory A. Baxes, “Digital Image Processing”, John Wiley & Sons, INC. (1994)

[7] Marc E. Herniter, “Programming in Matlab”, BROOKS. (2005)

[8] Erwin Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, INC. (1983)