Comparative Study of Tool Path Strategies in CNC Machining for Part with B-spline Surfaces

Zainal Fahmi Zainol Abidin and Muhammed Nafis Osman Zahid

Faculty of Manufacturing, Universiti Malaysia Pahang, Malaysia.
nafis@ump.edu.my

Abstract. CNC machines are widely used in production of various machinery components including turbine blades, impellers, rotors, propellers etc. Most of these components are built-up from free form surfaces which considered complex shapes and required proper set up for machining. This paper presents optimization of toolpath pattern for cutting parts with B spline surfaces in 4 axis machining. Generally the operation is carried out by using 4 axis machining methods which employs variable streamline operations in the finishing process. The appropriate selection of a toolpath pattern can significantly improve productivity and lead to lower production times. Different toolpath scenarios are simulated in CADCAM prior to real cutting process. In order to execute the comparative study of tool path strategies, all common cutting parameters (spindle speed, feed rate, tool diameter, plunge-rate, and depth of cut) are set to be constant. The toolpath strategies employed in this study includes helical or spiral, zig, zigzag and zigzag with lift. Cutting operation built-up and validation are performed through NX10, VERICUT and CNC machining. The objective is to optimize the machining process for B-spline model by selecting the shortest toolpath with maximum volume removal based on using variable streamline operation. The result indicates different tool path strategies based on the level of B spline curvature exhibit in the component.

Keywords: Toolpath pattern, B-Spline, Free-form surface.

6 Acknowledgement

We acknowledge with gratitude to Ministry of Higher Education Malaysia for providing a financial support under Research Acculturation Grant Scheme (RDU160130), which realize this research project.

References

1. A. Lasemi, D. Xue, and P. Gu.: Computer-Aided Design Recent development in CNC machining of freeform surfaces : A state-of-the-art review. Comput. Des., 7(42), 641–654 (2010).
2. X. F. Zhang, J. Xie, H. F. Xie, and L. H. Li. : Experimental investigation on various tool path strategies influencing surface quality and form accuracy of CNC milled complex freeform surface. The International Journal of Advanced Manufacturing Technology 59(5-8), 647–654 (2012).
3. Li H, Dong Z., and Vickers G.W.: Optimal Tool Path Generation for 2½D Milling of Dies and Molds. In: International IFIP TC5/WG5.3 Conference SSM '98 Sculptured Surface Machining Conference. 9-11, (1998).
4. T. T. EL-Midany, A. Elkeran and H. Tawfik.: Toolpath Pattern Comparison: Contour-Parallel with Direction-Parallel. In: Geometric Modeling and Imaging. New Trends (GMAI'06), vol. 9098902, 77-82, IEEE, (2006).
5. Rakesh Prajapati, Avadhoot Rajurkar, Vijay Kumar Chaudhary.: Tool Path Optimization of Contouring Operation and Machining Strategies for Turbo Machinery Blades. International Journal of Engineering Trends and Technology (IJETT). 4(5) 1731-1737. (2013).
6. P. R. Panchal, S. J. Makwana, S. J. Makwana.: Comparative Study of Tool Path Strategies in NX for Pocket Machining. In: International Journal of Engineering Technology Science and Research (IJETSR). 4(10), 41-48 (2017).
7. K. K. Yana Mundra, Dr. R Karthikeyan, Dr. Vishal Naranjo.: Finite element simulation and Experimental verification of Incremental Sheet metal Forming. In: IOP Conference Series: Materials Science and Engineering. 346 (1), 1-12, (2018).
8. http://www2.me.rochester.edu/courses/ME204/nx_help/index.html#uid:drive_area_milling_dialog, last accessed 2019/05/21