

Contents

1	Introduction	1
1.1	Hybrid Freeform Surfaces	2
1.2	Ultraprecision Machining of Hybrid Freeform Surfaces	5
1.3	Main Objectives of This Dissertation	6
1.4	Organization of This Dissertation	6
	References	7
2	Literature Review	9
2.1	Multiple-Axis Ultraprecision Diamond Machining Techniques	9
2.1.1	Fast Tool Servo (FTS)	10
2.1.2	Slow Slide Servo (SSS)	14
2.1.3	Other Multiple-Axis Ultraprecision Machining Techniques	16
2.2	State-of-Art CAD/CAM/CAE Technologies	18
2.2.1	CAD/CAM Technology for Surface Generation	18
2.2.2	Surface Accuracy and Error Compensation Approaches	19
2.3	Concluding Remarks	22
	References	23
3	Initial Development of CAD/CAM Technologies	27
3.1	CAD/CAM for Multiple-Axis Ultraprecision Machining Processes	28
3.1.1	Non-uniform Rational B-Spline Freeform Surfaces	28
3.1.2	CAD/CAM Interpolator for FTS/SSS Diamond Turning	29
3.2	API Methodology for CAD/CAM Software Development	31
3.2.1	Experimental Validation	34
3.3	Concluding Remarks	38
	References	38

4	Development of Hybrid FTS/SSS Diamond Turning	41
4.1	Principle of Layered Tool Trajectory	41
4.2	Layered Tool Trajectory Control	43
4.3	Experimental Validations	47
4.4	Concluding Remarks	50
	References.	51
5	Novel Surface Generation of Complex Hybrid Freeform Surfaces	53
5.1	Novel Surface Generation for Automated Guilloche Machining Technique.	53
5.2	Experimental Validations	55
5.2.1	Critical Machining Parameters	56
5.3	Concluding Remarks	62
	References.	64
6	Development of Surface Analytical Model for Accurate Hybrid Freeform Surfaces	65
6.1	Surface Generation for FTS/SSS Diamond Turning	66
6.1.1	Novel Surface Analytical Model	66
6.1.2	Cutting Linearization Error	68
6.2	Experimental Validation	70
6.2.1	Evaluation of Critical Machining Parameters	70
6.2.2	Cutting Experiments and Results.	77
6.3	Concluding Remarks	80
	References.	81
7	Integration and Implementation	83
7.1	Integrated CAD/CAM System	83
7.1.1	Integrated Sub-system for AGMT Process	84
7.1.2	Integrated Sub-system for Diamond Turning Process	84
7.1.3	Optimization of Tool Geometry	86
7.1.4	Geometrical Splitting of Hybrid Freeform Surface	88
7.2	Case Study 1: Hexagonal Fresnel Lens Array Using AGMT Process	89
7.2.1	Experimental Validations	89
7.3	Case Study 2: Multiple-Compound Eye Surface Design-B.	97
7.3.1	Experimental Validations	97
7.3.2	Cutting Experiments and Results.	102
7.4	Concluding Remarks	104
	References.	105
8	Conclusions and Recommended Future Works	107
8.1	Major Contributions	107
8.2	Recommended Future Works	108
	Curriculum Vitae	111

Ultraprecision Machining of Hybrid Freeform Surfaces
Using Multiple-Axis Diamond Turning

Neo, D.W.K.

2017, XVIII, 115 p. 97 illus., Hardcover

ISBN: 978-981-10-4082-5