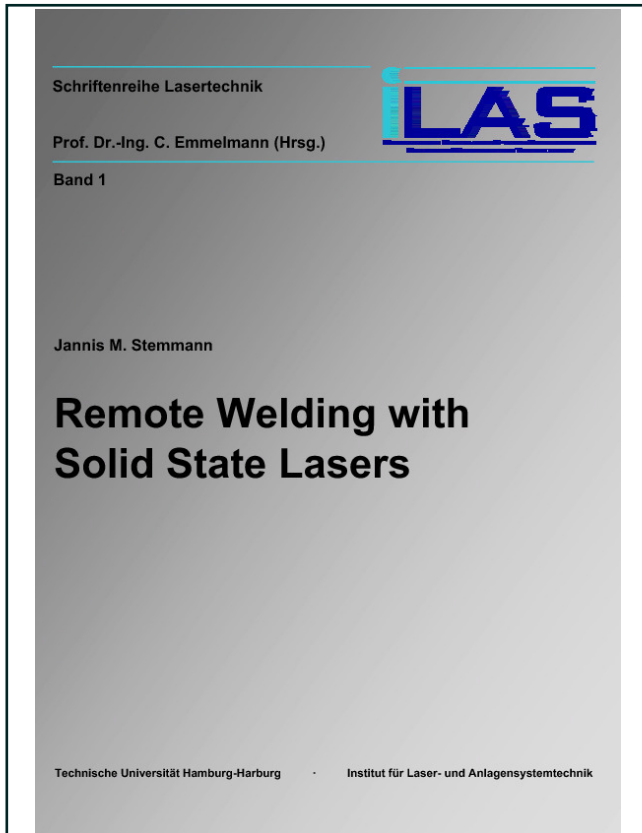




Jannis Martin Stemmann (Autor)
Remote Welding with Solid State Lasers



<https://cuvillier.de/de/shop/publications/2258>

Copyright:

Cuvillier Verlag, Inhaberin Annette Jentzsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen, Germany
Telefon: +49 (0)551 54724-0, E-Mail: info@cuvillier.de, Website: <https://cuvillier.de>

Contents

- List of Figures II
- List of Tables V
- Acronyms and Abbreviations VII
- Symbols IX

- 1 Introduction 1**

- 2 Laser Remote Welding 3**
 - 2.1 Laser Remote Welding Systems 4
 - 2.1.1 CO₂ Laser Remote Welding Systems 4
 - 2.1.2 Solid State Laser Remote Welding Systems 8
 - 2.2 Laser Remote Welding Process 11
 - 2.2.1 High Speed Beam Positioning 11
 - 2.2.2 Angular Beam Incidence 12
 - 2.2.3 Process Parameters 15

- 3 System Development 17**
 - 3.1 Optic Unit Design 18
 - 3.1.1 Laser Beam Propagation Analysis 19
 - 3.1.2 Fixed Process Tool Design 25
 - 3.1.3 Scanner Design 28
 - 3.2 Workpiece and Fixture Design 37
 - 3.3 Imprecision Assessment 42

- 4 Cycle Time Optimization 49**
 - 4.1 Robot Task Planning 50
 - 4.2 Task Planning System Layout 55
 - 4.3 Generalized Traveling Salesman Problem 60
 - 4.3.1 Mathematical Formulation 60

4.3.2	Complexity of GTSP	61
4.3.3	Literature Review	63
4.4	Scanning-feasible Workspaces	70
4.4.1	Constraints by Robot Kinematics	72
4.4.2	Constraints by Scanner Kinematics	76
4.4.3	Constraints by Process Parameters and Seam Length	77
4.4.4	Discretization of Scanning-feasible Workspaces	79
4.4.5	Overlapping of Scanning-feasible Workspaces	81
4.4.6	Ranking of Vertices	83
4.5	Calculation of Cost Matrices	85
4.6	Dependencies of GTSP Model Structure	91
4.7	Implementation of GTSP Approximation Approaches	95
4.7.1	Nearest Neighbour	96
4.7.2	Nearest Insertion	97
4.7.3	Generalized 2-Opt	98
4.7.4	Swap	101
4.7.5	Simulated Annealing	103
4.7.6	Genetic Algorithms	103
4.7.7	Tabu Search	106
4.7.8	Ant Colony System	108
4.7.9	Pilot	109
4.8	Runtime and Solution Quality of GTSP Approximation Approaches .	110
4.9	Validation	115
4.10	Conclusions of Task Planning Method	117
5	Summary and Outlook	121
A	Dynamic Robot Behaviour	123
A.1	Measurement Data for Motion Time Intervals	123
A.2	Coefficients for the Dynamic Robot Model	123
A.3	Plots of Axis Velocity Values	123
B	Robot Kinematics	133
C	Parameters of GTSP Metaheuristics	139
	Bibliography	141