

Dedicated to

My loving parents (Saraswathi. S and Srinivasan. R.)

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TABLE OF CONTENTS

ABSTRACT	xii
CHAPTER 1. INTRODUCTION.....	1
1.1 NEED FOR SELECTIVE DISASSEMBLY ANALYSIS	2
1.2 VIRTUAL SELECTIVE DISASSEMBLY ANALYSIS	4
1.3 RESEARCH GOAL AND OBJECTIVES	5
1.4 ASSUMPTIONS OF THE CURRENT RESEARCH.....	6
1.5 OVERVIEW AND ORGANIZATION OF THIS THESIS	7
CHAPTER 2. RELATED RESEARCH.....	10
2.1 ASSEMBLY/DISASSEMBLY SURVEY.....	10
2.2 ASSEMBLY/DISASSEMBLY SEQUENCING	10
2.3 ASSEMBLY/DISASSEMBLY PLANNERS.....	14
2.4 SUMMARY	14
CHAPTER 3. SINGLE SELECTIVE DISASSEMBLY.....	15
3.1 SINGLE WAVE PROPAGATION: AN OVERVIEW	15
3.2 SINGLE WAVE PROPAGATION ALGORITHM	17
3.2.1 <i>Geometric Attributes</i>	17
3.2.2 <i>Single Wave Propagation Algorithm</i>	19
3.3 DISCUSSION.....	22
CHAPTER 4. MULTIPLE SELECTIVE DISASSEMBLY.....	23
4.1 MOTIVATION	23
4.2 DISASSEMBLY WAVE PROPAGATION APPROACH: AN OVERVIEW	24
4.3 GEOMETRIC ATTRIBUTES FOR TOPOLOGICAL DISASSEMBLY ORDERING.....	27
4.4 DISASSEMBLY WAVES	28
4.5 INTERSECTION EVENT AND SEQUENCE DETERMINATION	30
4.6 MULTIPLE WAVE PROPAGATION ALGORITHM	32
4.7 PRIORITY INTERSECTION EVENT ALGORITHM	34
4.8 DISCUSSION.....	39
CHAPTER 5. GLOBAL SELECTIVE DISASSEMBLY.....	41
5.1 PROBLEM ANALYSIS: GEOMETRIC CONSTRAINTS AND AUTOMATION.....	41
5.2 GEOMETRIC ATTRIBUTES FOR GLOBAL SELECTIVE DISASSEMBLY.....	43
5.3 ALGORITHM.....	45
5.4 INCORPORATION OF USER-DEFINED CONSTRAINTS IN THE ANALYSIS	48

5.5	DISCUSSION.....	50
5.5.1	<i>Number of Removals.....</i>	50
5.5.2	<i>Computation Time</i>	51
CHAPTER 6. SELECTIVE DISASSEMBLY ANALYSIS		53
6.1	A3D SYSTEM : A SOFTWARE TOOL FOR SELECTIVE DISASSEMBLY ANALYSIS	54
6.1.1	<i>Functional Features</i>	55
6.1.2	<i>CAD Plugin</i>	56
6.1.3	<i>Disassemblability and Accessibility Computation</i>	57
6.1.4	<i>Sequence Generation, Editing and Validation</i>	57
6.1.5	<i>Path Generation, Editing and Validation</i>	59
6.1.6	<i>Overall Shape Editing and Validation.....</i>	60
6.1.7	<i>Component-Grouping and Directional Constraints.....</i>	61
6.1.8	<i>Selective Disassembly Cost and Time Evaluation.....</i>	62
6.1.9	<i>Design Rule Checking.....</i>	62
6.1.10	<i>Design Comparison.....</i>	63
6.2	A3D SYSTEM IMPLEMENTATION: VARIATIONS	64
6.2.1	<i>Virtual Reality Interface for A3D.....</i>	64
6.2.2	<i>Web-Interface for A3D.....</i>	66
CHAPTER 7. RESULTS AND DISCUSSION.....		67
7.1	CONTACT-GEOMETRIC CONSTRAINTS AND SELECTIVE DISASSEMBLY	67
7.2	CONTACT-BASED SELECTIVE DISASSEMBLY ALGORITHMS: ANALYSIS.....	72
7.2.1	<i>Comparison of SWP and MWP/PIE Algorithms</i>	74
7.2.2	<i>Comparison of MWP and PIE Algorithms</i>	75
7.3	SPATIAL-GEOMETRIC CONSTRAINTS AND SELECTIVE DISASSEMBLY	77
7.4	GLOBAL SELECTIVE DISASSEMBLY ALGORITHM : ANALYSIS.....	85
7.4.1	<i>Number of Removals.....</i>	87
7.4.2	<i>Computation Time</i>	91
7.5	USER-DEFINED CONSTRAINTS AND SELECTIVE DISASSEMBLY	95
7.5.1	<i>Grouping Components and Sequence Determination</i>	95
7.5.2	<i>Directional Constraints and Sequence Determination.....</i>	98
7.6	DISCUSSION: PERFORMANCE BOOSTING	100
7.6.1	<i>Computation</i>	100
7.6.2	<i>Graphics.....</i>	101

CHAPTER 8. APPLICATION, RESULTS AND DISCUSSION	103
8.1 APPLICATION: MAINTENANCE AND SERVICE.....	103
8.2 APPLICATION: ASSEMBLING.....	107
8.3 APPLICATION: RECYCLING AND REUSE.....	110
CHAPTER 9. DISCUSSION AND CONCLUSION	113
9.1 CONTRIBUTIONS.....	113
9.2 FUTURE WORK.....	114
9.2.1 <i>Limitations due to the Assumptions and Relaxation.....</i>	<i>114</i>
9.2.2 <i>Contact-Based Analysis and Global Disassembly</i>	<i>115</i>
9.2.3 <i>Knowledge-Assisted Selective Disassembly</i>	<i>117</i>
9.2.4 <i>Other Topics for Future Research</i>	<i>118</i>
9.3 CONCLUSION	119
REFERENCES.....	121
APPENDIX: SUPPLEMENTARY RESULTS.....	131

TABLE OF FIGURES

Figure 1. Test assembly to illustrate complete and selective disassembly	1
Figure 2. CD sequence is $\{C_1, C_2, C_6, C_3, C_4, C_5\}$ for A in Figure 1	1
Figure 3. SD Sequence $S = \{C_6, C_4, C_5\}$ for $C = \{C_4, C_5\}$ in Figure 1.....	2
Figure 4. Selective disassembly of the engine for maintenance	2
Figure 5. Selective disassembly of PVC and nylon components for recycling	3
Figure 6. Motivation to virtual SD analysis.....	4
Figure 7. Wave propagation approach.....	16
Figure 8. Disassembly ordering.....	16
Figure 9. Test assembly to illustrate single and multi-dependent components.....	17
Figure 10. Clamp Support assembly: To illustrate single SD	18
Figure 11. Mating faces and accessibility directions	18
Figure 12. RG: WP representation.....	20
Figure 13. RG for $C = \{C_{11}\}$: A in Figure 10.....	21
Figure 14. RG for $C = \{C_{11}\}$: A in Figure 10.....	21
Figure 15. Test assembly to illustrate multiple selective disassembly problem.....	23
Figure 16. $C = \{C_3, C_5\}$: t wave at $T=1$ and its representation.....	24
Figure 17. $C = \{C_3, C_5\}$: b waves and its representation.....	25
Figure 18. IE at C_4 : $S = \{C_1, C_4, C_3, C_5\}$ for A in Figure 15, $C = \{C_3, C_5\}$	26
Figure 19. Solid model of Machine Vice assembly: geometric attributes.....	27
Figure 20. t wave propagation and b wave propagation.....	29
Figure 21. RG showing the \mathbf{t}^5 wave for A in Figure 19.....	30
Figure 22. RG showing a part of \mathbf{b}_2 wave for A in Figure 19	30
Figure 23. IE at C_w and $S = \{C_b \rightsquigarrow C_w, C_w \rightsquigarrow C_x, C_w \rightsquigarrow C_y\}$ for $C = \{C_x, C_y\}$	31
Figure 24. RG for $C = \{C_4, C_5\}$: A in Figure 19	31
Figure 25. Wheel Support assembly	34
Figure 26. RG at $T = 1$ for $C = \{C_5, C_6, C_7\}$	34
Figure 27. RG at $T = 0$ for $C = \{C_5, C_6, C_7\}$: A in Figure 25.....	35
Figure 28. \mathbf{f}_2 event at C_w : S from \mathbf{f}_2 event is better than S from \mathbf{f}_1 events.....	36
Figure 29. RG at $T = 1$ for $C = \{C_3, C_5\}$ for A in Figure 15: \mathbf{f}_2 event $\mathbf{t}^3 \cap \mathbf{t}^5 \cap \mathbf{b}^2$ at C_4	37
Figure 30. Solid model of Toy Assembly (exploded view) to illustrate \mathbf{f}_3 event	38
Figure 31. RG at $T = 2$ for $C = \{C_3, C_4\}$: A in Figure 30.....	38
Figure 32. Engine sub-assembly to illustrate SD for spatial constraints.....	42

Figure 33. Test assembly to illustrate the GSD algorithm.....	43
Figure 34. RG for A in Figure 33: $C = \{C_3\}$	46
Figure 35. Global Selective Disassembly Algorithm.....	47
Figure 36. Illustration of Global selective disassembly algorithm for A in Fig. 33, $C = \{C_3\}$	47
Figure 37. 3D example to illustrate GSD algorithm and RG for $C = \{C_3\}$	48
Figure 38. RG for $C = \{C_3\}$	49
Figure 39. SD of the Engine assembly and the corresponding RG for $C = \{C_3\}$	49
Figure 40. SD of the Engine assembly and the corresponding RG with C_1 constrained.....	50
Figure 41. A3D system: A prototypical Software system for global SD analysis	54
Figure 42. UG-Plugin to load the assembly models from UniGraphics to the A3D system.....	56
Figure 43. SD of the Crankshaft sub-assembly for $C = \{4\}$	58
Figure 44. Sequence editing and validation in the A3D system.....	58
Figure 45. Path editing in the A3D system.....	59
Figure 46. Path editing and validation in the A3D system.....	60
Figure 47. Shape editing and validation in the A3D system	60
Figure 48. Interference checking in the A3D system.....	63
Figure 49. Alternate designs of Screw Jack assembly and design comparison.....	63
Figure 50. A3D implementation system with a virtual reality interface.....	65
Figure 51. A3D implementation system with a web interface	66
Figure 52. Exploded view of the Wheel Support assembly for SD analysis	67
Figure 53. RG at $T = 1$ by MWP for the Wheel Support assembly with $C = \{C_3, C_6\}$	68
Figure 54. SD of the Wheel Support assembly for $C = \{C_3, C_6\}$ from SWP	68
Figure 55. SD of the Wheel Support assembly for $C = \{C_3, C_6\}$ from MWP	68
Figure 56. SD of the Tail Stock assembly for $C = \{C_4, C_6\}$ from MWP and the RG at $T = 2$	69
Figure 57. Exploded view of the Gear Reducer assembly.....	70
Figure 58. RG at $T = 2$ by PIE for Gear Reducer	70
Figure 59. Bar chart-I comparing n and n_r for the contact-based SD results.....	73
Figure 60. Bar chart-II comparing n and n_r for the contact-based SD results.....	73
Figure 61. RG at $T = 1$, $C = \{C_3, C_4\}$ for A in Figure 30: from MWP algorithm.....	75
Figure 62. RG at $T = 1$, $C = \{C_3, C_4\}$ for A in Figure 30: from PIE algorithm	76
Figure 63. Selection of the target component $C = \{OL44\}$ for the Augmentor assembly I	77
Figure 64. SD of the Augmentor assembly (I) for $C = \{OL44\}$ from GSD and its RG	78
Figure 65. SD of the Augmentor assembly (II) from GSD for $C = \{s21\}$	79
Figure 66. RG for the Augmentor assembly (II) from GSD : $C = \{s21\}$	79

Figure 67. Tail Stock Assembly and the RG generated by the GSD algorithm for $C = \{C_9\}$	80
Figure 68. SD of the Tail Stock assembly for $C = \{C_9\}$ from GSD	80
Figure 69. SD of the Motor assembly for $C = \{C_3, C_4\}$ from GSD	81
Figure 70. RG of the Motor assembly for $C = \{C_3, C_4\}$	82
Figure 71. Cab assembly and the RG generated by the GSD algorithm for $C = \{C_2, C_3\}$	82
Figure 72. SD of the Cab assembly for $C = \{C_2, C_3\}$ from GSD	83
Figure 73. Cell Phone assembly and the RG generated by the GSD algorithm	83
Figure 74. SD of the Cell Phone assembly for $C = \{C_2, C_3\}$ from GSD	84
Figure 75. CD of the Cell Phone assembly from GSD	85
Figure 76. Bar chart-I comparing n, n_r, n_w and n_s for the global SD results.....	88
Figure 77. Bar chart-II comparing n, n_r, n_w and n_s for the global SD results.....	88
Figure 78. Bar chart-III comparing n, n_r, n_w and n_s for the global SD results	89
Figure 79. Bar chart-IV comparing n, n_r, n_w and n_s for the global SD results	89
Figure 80. Bar chart-V comparing n, n_r, n_w and n_s for the global SD results	90
Figure 81. Accessibility computation time plot (F vs Time) for GSD results.....	93
Figure 82. Sequence computation time plot (n vs Time) for GSD results.....	93
Figure 83. Log-Log plot for the accessibility computation time with trend line	94
Figure 84. Log-Log plot for sequence computation time with trend line.....	94
Figure 85. SD of the Aero-engine assembly for $C = \{rjf21\}$ from GSD	95
Figure 86. RG for the Aero-Engine assembly from GSD for $C = \{rjf21\}$	96
Figure 87. SD of the Aero-engine assembly from GSD for $C = \{S1\}$	97
Figure 88. RG for the Aero-engine assembly from GSD for $C = \{S1\}$	97
Figure 89. SD of the Aero-engine assembly from GSD for $C = \{rjf20\}$	98
Figure 90. RG for the Aero-engine assembly from GSD for $C = \{rjf20\}$	98
Figure 91. SD of the Aero-engine assembly from GSD for $C = \{rjf20\}$ with cy constrained.....	99
Figure 92. RG for the Aero-engine assembly from GSD for $C = \{rjf20\}$ with cy constrained.....	100
Figure 93. Aircraft sub-assembly: SD of the engine for in-place maintenance.....	103
Figure 94. SD of the rotor (C_5) from the Aircraft sub-assembly for in-place maintenance.....	104
Figure 95. Aircraft sub-assembly: SD of the engine for replacement maintenance.....	105
Figure 96. Dashboard sub-assembly: selection of the Instrument panel (C_{16}) for service.....	106
Figure 97. Dashboard sub-assembly: SD of the Instrument panel (C_{16}) for service	106
Figure 98. Dashboard assembly: disassembly yime graph for maintenance	107
Figure 99. A3D applet for visualization of assembly/disassembly.....	108
Figure 100. Augmentor: simultaneous assembling of components.....	109

Figure 101. Dashboard assembly: SD of PVC and nylon components for recycling	110
Figure 102. Dashboard assembly: value-sequence graph for recycling	111
Figure 103. Test assemblies to illustrate path-containment and component-containment	116
Figure 104. Disassembly constraints (precedence relation)	117
Figure 105. A Cube-Matrix assembly of 3x3 (= 9) components.....	131
Figure 106. Effect of \mathbf{n}_w on \mathbf{n}_s for a cube-matrix assembly by varying \mathbf{n} with $\mathbf{d} = 4$	132
Figure 107. Effect of changing \mathbf{n} on \mathbf{n}_s for a Cube-matrix assembly with $\mathbf{n}_w = 2$ and $\mathbf{d} = 4$	132
Figure 108. Effect of changing the position of \mathbf{C} on \mathbf{n}_s for a cube-matrix assembly.....	133
Figure 109. Effect of changing \mathbf{n} on \mathbf{n}_s for a cube-matrix assembly with $\mathbf{d} = 4$	133
Figure 110. Accessibility computation time plot (\mathbf{F} vs Time).....	134
Figure 111. Accessibility computation time plot (\mathbf{d} vs Time).....	135
Figure 112. RG computation time plot (\mathbf{n} vs Time).....	135
Figure 113. Sequence computation time from RG (Plot \mathbf{n} vs Time).....	136

TABLE OF TABLES

Table 1. Illustration of the MWP algorithm for A in Figure 15 with $C = \{C_3, C_5\}$	33
Table 2. PIE algorithm for A in Figure 25 with $C = \{C_5, C_6, C_7\}$; f events at $T = 0, 1$	38
Table 3. Details about the A3D Virtual reality system.....	65
Table 4. Summary of results for contact-based SD algorithms.....	71
Table 5. Comparison of SD results from SWP and MWP/PIE algorithms.....	74
Table 6. Comparison of SD results from MWP and PIE algorithms.....	76
Table 7. Summary of results for the Global SD algorithm: SD Sequence.....	86
Table 8. Summary of results for Global SD algorithm: Computation Time	90
Table 9. Incremental approach and the computation time for sequence generation.....	101

NOMENCLATURE

A3D	Assembly Disassembly in Three Dimensions
CD	Complete Disassembly
DWP	Disassembly Wave Propagation
GSD	Global Selective Disassembly
IE	Intersection Event
MWP	Multiple Wave Propagation
PIE	Priority Intersection Event
RG	Removal-Influence Graph
SD	Selective Disassembly
SWP	Single Wave Propagation
WP	Wave Propagation
A	Assembly
C	Target components
d	Number of disassembly directions
F	Number of faces
m	Number of target components
n	Number of components in the assembly
S	Sequence
T	Time step
AC_i^j	Accessibility of the i^{th} component with respect to the j^{th} component
C_i	The i^{th} component in the assembly
C_b	Boundary component in the assembly
C_x	Target component
RI_i^j	Removal Influence of the j^{th} component on the i^{th} component
MA_i	Mating Adjacent of the i^{th} component
n_r	Number of components in the sequence
n_s	Number of simultaneous component removals
n_w	Number of waves
b	Boundary wave
t	Target wave
D_i	Disassemblability of the i^{th} component
f	Priority event

ABSTRACT

Selective disassembly (**SD**) involves disassembly (or removal) of one or more selected components from a multi-component assembly. Applications of **SD** include maintenance, recycling and assembling. Despite the advances in assembly/disassembly analysis that focus on disassembling all the components in the assembly, there has been little investigation of the techniques for **SD** analysis. The current research analyzes the problem of **SD** and presents methods for automated **SD** analysis of geometric assembly models, at the product design stage.

A new concept called disassembly wave is proposed which arranges the components in the assembly denoting the disassembly order for component removals. Utilizing the disassembly wave (represented in a graphical form) several geometric algorithms analyzing the contact and spatial constraints of the assemblies are proposed to determine **SD** sequence and paths.

First, the problem of disassembling a single target component from the assembly is analyzed and an algorithm called *Single Wave Propagation* is proposed. The motivation is that the disassembly analysis can be localized with respect to the target component and the analysis of all the components in the assembly may not be required. The proposed algorithm analyzes the contact-geometry of the assembly recursively from the target component until a removable component is reached in determining a **SD** sequence.

Secondly, the problem of disassembling multiple target components is analyzed and an algorithm called *Multiple Wave Propagation* is proposed. The motivation is that a better solution may be obtained if two or more components are disassembled along a common sequence. The proposed algorithm analyzes the contact-geometry of the assembly recursively from the target

components and also from the removable components in determining a common sequence to disassemble the target components.

Thirdly, the problem of global disassembly of components is analyzed and an algorithm called *Global Selective Disassembly* is proposed. The proposed algorithm analyzes both the spatial geometric constraints of the assembly and the user-defined constraints for **SD**. The global disassembly of each of the components is recursively analyzed starting from the target component, utilizing the disassembly wave in determining a non-interfering (collision-free) **SD** sequence.

The proposed **SD** methods are implemented in a new prototypical software system (*Assembly and Disassembly in Three Dimensions, A3D*) which has been developed to assist the designer in performing an automated and interactive **SD** analysis. Results from the **A3D** system for the 30 test assemblies analyzed, show that the proposed **SD** algorithms enable determining an efficient **SD** solution with fewer number of removals computed in a feasible time. Moreover, the ability allowing the designer to generate, edit, validate, evaluate and animate the **SD** sequences of components by the developed **A3D** system demonstrate its applicability for virtual **SD** analysis and its usefulness for maintenance, assembling and recycling applications.