Dedicated to

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

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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

$\mathbf{AC_i^j}$ Accessibility of the i^{th} component with respect to the j^{th} component

$\mathbf{C_i}$ The i^{th} component in the assembly

$\mathbf{C_b}$ Boundary component in the assembly

$\mathbf{C_x}$ Target component

$\mathbf{RI_i^j}$ Removal Influence of the j^{th} component on the i^{th} component

$\mathbf{MA_i}$ Mating Adjacent of the i^{th} component

$\mathbf{n_r}$ Number of components in the sequence

$\mathbf{n_s}$ Number of simultaneous component removals

$\mathbf{n_w}$ Number of waves

b Boundary wave

t Target wave

$\mathbf{D_i}$ 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.