Abstract

Design in CAD systems is often an interactive and iterative process It follows that the facility for redesign is an important aspect of CAD system Traditionally, support for redesign in CAD systems has been achieved using feature-based and constraint-based approaches However, these traditional CAD systems do not adequately support emerging manufacturing technologies like MEMS and layered manufacturing Voxel based sculpting offers a promising alternative, in which freeform and arbitrary topological changes can be made with ease However, voxel modelers at present do not have any means of supporting *resculpting* This is because of the *lack of feature information* in voxel models Other problems of voxel models are memory verbosity, aliasing etc This thesis focuses on the issue of **incorporating feature information without disturbing other virtues of voxel models to support resculpting**

A new modeling scheme for sculpting with emphasis on *shape operators* has been proposed This scheme is used to find the solution for the problem of *feature incorporation in voxel models* by introducing the notion of *regularised feature operators* Regularised feature operators are used to find and *selectively edit* features in voxel models instead of forcing them to store feature information as traditionally done Minkowski operators which are powerful shape operators have been, modified to *regularised Minkowski operators* for our demonstration, and different simple algorithms such as *reference count* and *stack-of-bits* have been developed for implementing these new operators Completeness and validity of these algorithms have been discussed

These ideas are demonstrated by extending an interactive sculpting system **Sirpi** (Sculpting Interface for Rapid Prototyping) This system is based on voxel representation and uses *Interactive Virtual Machining* (IVM) as an interface to sculpting

The usefulness of these ideas has been demonstrated by implementing a voxel-based frame by frame animation system which is perhaps the first of its kind The voxel models annotated with hierarchical feature information can be easily edited using regularised

Minkowski operators A volume keyframe can be sculpted either from scratch or by *selectively editing* the features in an already sculpted volume keyframe The power of selective editing leads to *parametric volume keyframe animation*, in which the features in a voxel model are parametrised These parameters are interpolated in each volume keyframe As an example, a jelly-fish has been sculpted and animated by selectively editing the legs of the fish

This thesis, we believe, opens up new avenues for volume modeling and volume animation Sculpting on "feature annotated voxel models" promises to be a powerful modeling paradigm in the coming years