TIC 2001-2099-C03

A Platform to Support Advanced Parametric Modeling in CAD
1. Research Teams
2. Goals
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Research Teams
Research Teams

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    3 PhD researchers
    3 Junior researchers

• C02. Universidad de Granada
  Juan Carlos Torres, PhD
    4 Junior researchers

• C03. Universidad de Jaén
  Francisco Feito, PhD
    2 PhD researchers
    6 Junior researchers
Goals
General Goals

There are many functionalities in current CAD systems that should be improved to take full advantage of the potential they can offer.

In this context, the general goals of this project are:

- To explore efficient methods and techniques to transfer geometric models between sites,
- To develop new representation schemes for free form solid and volumes, and
- To optimize the underlying geometric engines to provide tools to deal with the complexity of emerging representation schemes.
Specific Goals

The general goals were divided into the following specific goals:

- To develop multi-view, parametric geometric constraint-based design techniques to allow each user to specify the object under design in a natural way according to the designer’s specific view.
- To develop new modeling schemes and paradigms to represent free form and sculptured solid models, as well as to capture volumetric properties.
- To develop multiresolution schemes to facilitate progressive transmission.
- To devise new geometric algorithms to improve the kernel throughput in basic geometric computations.
Teams Coordination
Teams Coordination I (II)

- Progressive Transmission
- New Representation Schemes
- Parametric Modelling
- Basic Geometric Algorithms
Teams Coordination II (II)

Teams Coordination has been conducted by

- e-mail
- Coordination meetings
  1. Project managers meeting
     Granada, 28 November 2002
  2. Project managers meeting
     Barcelona, 23 May 2003
  3. General Meeting
     Granada, 20-21 November 2003
Tasks
The developments were organized under fourteen different specific tasks.

These tasks can be categorized as belonging to

1. Coordination
2. Specific problems solving
3. Benchmarking

For a detailed list of tasks, see the Project Proposal and the Project Report.
Achievements
We present the project achievements according to the three main lines underlying our goals

- New Representation Schemes
- Basic Geometric Algorithms
- Progressive Transmission
- Parametric Modelling
New Representation Schemes
The Simplicial Chains is a new representation scheme based on decomposing the solid into a set of simplices: triangles (2D) and tetrahedra (3D).

Poligonal and polyhedral solids are represented by means of algebraic expressions.
Layer Decomposition

A new representation scheme based on *layers decomposition* has been developed.

Classic geometric algorithms (inclusion, localization, boolean operations, ...) performed on this scheme show an improved throughput.
The Simplicial Chains scheme has been extended to the ESC. The resulting scheme allows to represent solids bounded by free-form surfaces and to perform Boolean operations between them.
Basic Geometric Algorithms
The *point in solid* is a basic operation in geometric computations. This test as well as voxelization, octree conversion and rendering are performed with high efficiency on the new schemes.
New algorithms to perform Boolean operations between solids represented using the new schemes have been successfully developed. These algorithms are fast and robust.
Progressive Transmission
SP-Octrees combines Binary Space Partition (BSP) features and octree representations. It has been successfully applied to progressive transmission of polyhedral solids.
A new hierarchycal index method to represent volumes has been proposed. The scheme guarantees to generate sculptured surfaces free of crashes and holes. This structure has been succesfully used in progressive transmission of heterogeneous solids.
Progressive transmission of terrains

Terrain Visualization package. "Sierra Mágina" rendered using a 2D version of the Cell-octree representation.
Constraint-Based

Parametric Modelling
We use the term *completion* to refer to the process of adding new constraints (edges) to an under-constrained graph. The resulting graph will be called the *completed* graph or just a *completion*.

A graph and two different possible completions
Free Completion

Under-constrained graph, a tree decomposition and associated completion
Under-constrained geometric constraint graph, additional graph, and conditional completion.
Results Summary
Results Summary

PhD degrees

- Awarded 4
- Ongoing 8

The total number of international and national papers is summarized in the following table.

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<th>Category</th>
<th># of papers</th>
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<td>International journals</td>
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