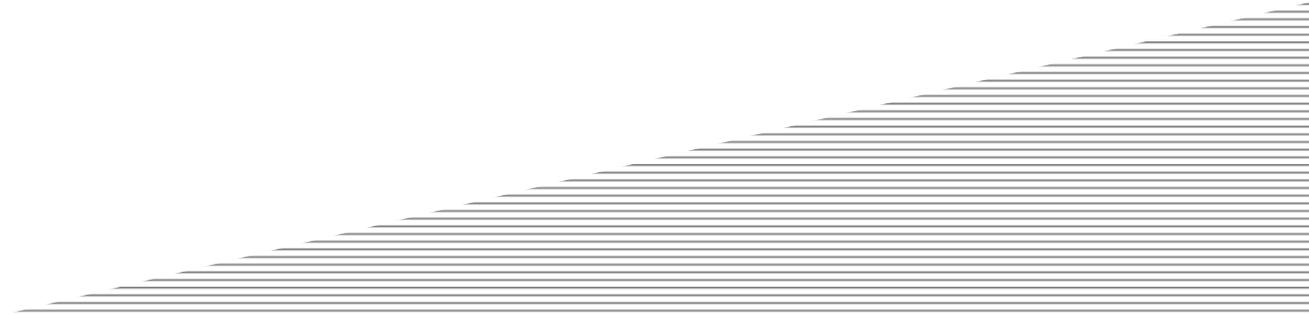


AIM@SHAPE

Advanced and Innovative Models And Tools for the
development of Semantic-based systems for
Handling, Acquiring, and Processing knowledge
Embedded in multidimensional digital objects

IST NoE No 506766

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Vers.	Issue Date	Stage	Content and changes
1	25 Aug. 2004	1 (40%) Draft	First contributions from the ontology clusters.
1	10 Sept. 2004	1 (70%) Draft	Contributions from the remaining ontology clusters and STAR leaders.
1	17 Sept. 2004	1 (100%) Draft	Web version of the glossary.
2	22 July 2005	2 (50%) Draft	Selection of significant terms
2	26 Sept. 2005	2 (100%) Final	2nd version of the glossary

Executive Summary

This document contains the second version of the deliverable **D1.3** of the IST NoE AIM@SHAPE. The deliverable D1.2.1 – Glossary – aims at the definition of a common vocabulary (glossary) which will be used by the Consortium to talk about digital shapes. It is an attempt to have a list of carefully selected terms that are used by the Consortium to deal with digital shapes. A new Glossary web interface has also been implemented that supports searching and browsing through the terms, as well as administration (insertion, deletion and editing of terms online).

The task leader is **ITI** and is actively supported by the Glossary Committee and all the AIM@SHAPE partners.

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1 INTRODUCTION

The objective of this activity is to create a common vocabulary (glossary) of terms concerning digital shapes, which will be used by the Consortium. To this end, a Glossary Steering Committee (composed by Chiara Catalano, Tor Dokken, Tal Hassner, Francesco Robbiano, Manolis Vavalis, and Remco Veltkamp) was set during the Managing Board meeting (which took place at Utrecht in November 2004) with the goal of coordinating and organizing all the activities related to the glossary.

The Glossary Steering Committee, as the experts of different domains, has agreed on a specific strategy for the development of the Glossary, and is in charge of collecting the glossary entries along with their definitions.

In the previous version of the Glossary, a great number of terms have been gathered from different activities of the AIM@SHAPE NoE (i.e. from the ontology design clusters, the state of the art reports, shape metadata, tool metadata and from the Digital Library). However, those terms were at a different level of detail, only a few of them had definitions and there was a lack of homogeneity.

The main decisions made in this phase were:

- to heavily reduce the number of terms collected in the previous version of the glossary, keeping only the most significant ones of each domain. In particular, a lot of terms were removed at this stage, which were irrelevant (e.g. "minimum") or not strictly distinctive of our field (e.g. basic mathematical terms like "eigenvalue").
- to provide the definitions of all the remaining terms in the glossary;

The selection process of the terms is presented in section 2. Section 3 provides a description of the new Glossary Web Interface implementation.

2 THE SELECTED TERMS

The selection of the reduced number of terms was not arbitrary but followed the criteria presented below:

- The term must be meaningful in the domain of digital shapes;
- The term must be distinctive in this domain;
- If the term is clear even without any knowledge of the domain, it should not be included;
- Basic mathematical terms should not be included;
- If a definition of a term cannot be provided at this stage, the term will be temporarily removed and inserted in a later stage.

The resulting list of terms from the above procedure, along with the definitions given and other related terms is presented in Appendix A. Around 300 terms were chosen and included in the Glossary.

3 GLOSSARY WEB INTERFACE

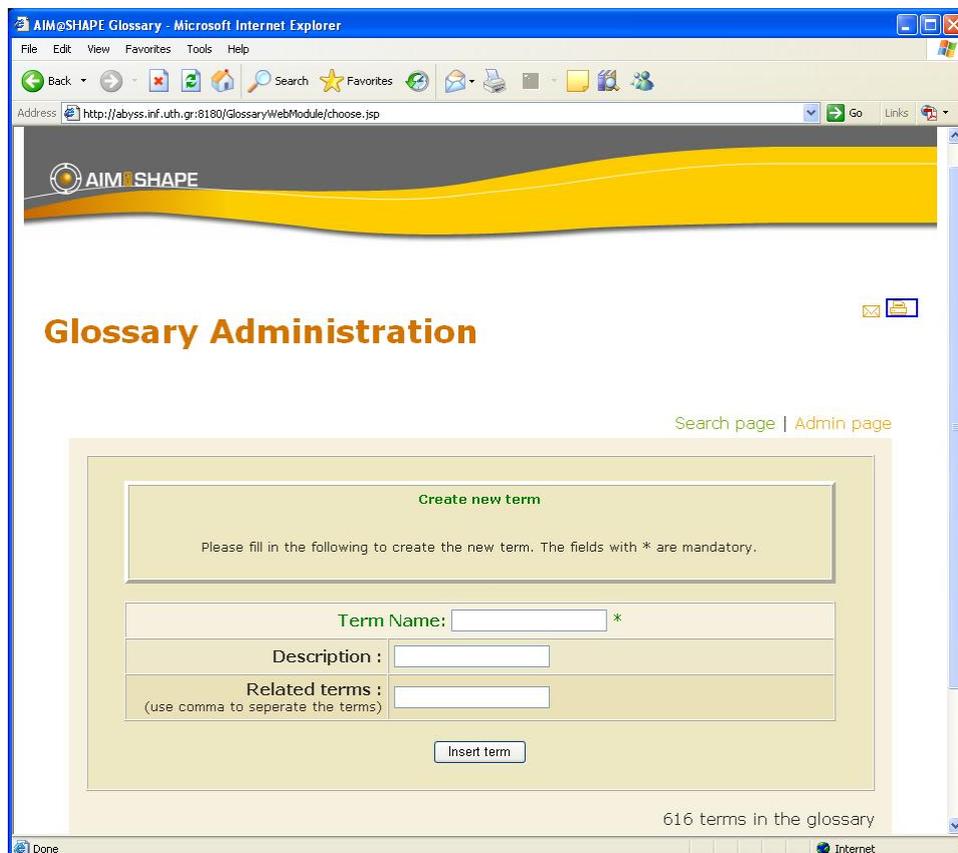
In order to have an easy way to access the Glossary and make it publicly available, a web interface is necessary. The web interface implementation of the previous version of the Glossary was based on TCS-8, which is an offline software tool that supports the development of complex controlled vocabularies (thesauri, taxonomies, hierarchies).

Basic administrative tasks were performed as follows:

- The insertion of new terms was made manually (by sending to the Glossary administrator any new terms) or semi automatically (after the addition of new terms, the user had to export the vocabulary in an ASCII format and send it to the Glossary administrator in order to merge it with the rest);
- The glossary publication was performed by using the HTML export utility of TCS-8. The produced HTML pages did not support keyword search and the terms could only be found alphabetically or by browsing different tree hierarchies.

The latest version of TCS (TCS-9) has no significant improvements that could help us inserting and publishing new terms. Since the consortium decided not to provide a thesaurus but only a glossary of terms, we implemented a simpler, more flexible web-based solution (without depending on expensive commercial software).

All the terms collected so far were exported in XML format and stored in a database (PostgreSQL). A web-based glossary administration interface was developed in order to insert (see Figure 1), delete and edit terms (using JSP technology). Selected members of the consortium (i.e. the Glossary Steering Committee) are authorized to update the glossary on-line, through an authentication mechanism.



The screenshot shows a web browser window titled "AIM@SHAPE Glossary - Microsoft Internet Explorer". The address bar shows the URL "http://abyss.inf.uth.gr:8180/glossaryWebModule/choose.jsp". The page features a yellow and black header with the AIM@SHAPE logo. Below the header, the title "Glossary Administration" is displayed in orange. There are two links: "Search page" and "Admin page". The main content area contains a form titled "Create new term" with the instruction "Please fill in the following to create the new term. The fields with * are mandatory." The form includes three input fields: "Term Name:" (with an asterisk), "Description:", and "Related terms:" (with a note "(use comma to separate the terms)"). An "Insert term" button is located below the form. At the bottom right of the form area, it says "616 terms in the glossary". The browser's status bar at the bottom shows "Done" and "Internet".

Figure 1. New term insertion form.

Searching the database for terms by using keywords has already been implemented (see Figure 2). Other methods of finding terms (e.g. alphabetically ordered terms) are also available.

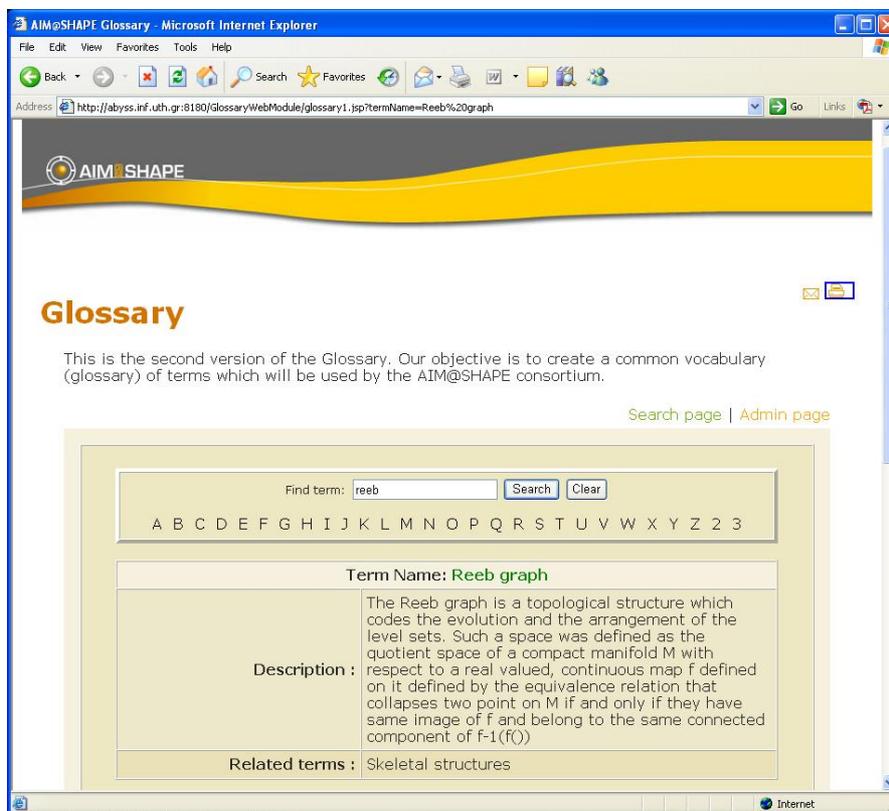


Figure 2. Select a term to edit.

This database solution will also facilitate the integration process with the Digital Shape Workbench and the Search Engine in particular.

The Glossary is temporarily hosted at <http://abyss.inf.uth.gr:8180/GlossaryWebModule/glossary.jsp> until it gets fully integrated into the AIM@SHAPE web portal.

APPENDIX A - GLOSSARY OF TERMS

Acquisition Device

A system of sensors connected to a storage device (usually a PC), designed for acquiring data.

Acquisition Planning

The design of the strategy for the data acquisition. For instance, it decides object/sensor position(s), number of acquisitions.

Aggregate

A part of an image segment.

Algebraic curve/surface

A curve or surface which can, in addition, be described as the zero locus of a polynomial system.

Alignment

See Registration.

Alpha shape

It formalizes the instinctive concept of "shape" for a set of spatial points. The alpha shape is uniquely defined for a specify point set.

When given a finite set of points S , and a real parameter α , the alpha shape of S is a polytope. This polytope neither have to be convex nor connected. When varying the number α over the real numbers, a family of shapes is generated displaying the intuitive concept of "rough versus "fine" shape. When α is sufficiently large, the alpha shape is identical to the convex hull. When decreasing α , the shape shrinks and progressively shows cavities. Such cavities may join to form holes. When α gets sufficiently small, the alpha shape is empty.

Animation Sequence

Pre-recorded animation sequences (key-frame animation, etc.). In general it contains the joint angle values and/or vertex displacements corresponding to the key animation frames. Different interpolation and codification methods can be used. Such sequences can be applied to one or many VH depending on the codification and technique being used.

Approximation

The process of generating a function, a curve, or surface, that is close to given spatial constraints (typically point samples).

Articulated character

3D animation object made of a geometric skin attached to an articulated skeleton. An articulated character animation is driven by skeleton animation and performed with Skeleton driven deformation.

Articulated skeleton

See Control skeleton.

Articulation

See skeleton joint.

Asymptotic curve

The asymptotic curve on a surface is that along which the normal curvature vanishes.

Behavioural Animation

Methods for animating characters by specifying their behaviour. For Virtual Humans behavioural animation is expected to exhibit an autonomous believable anthropomorphic behaviour, where Virtual Humans perform specific actions under pre-specified conditions.

Behaviour Controller

Algorithms used to produce behavioral animation. A BehaviorController specifies the inputs required for the algorithm to work, and the outputs (usually animation sequences or specific joint values) it is capable to produce. Behavior controllers can be used to make VHs react to stimuli on their virtual environments and select specific actions (e.g. animation sequences) to perform under pre-specified conditions.

Blending

Surface connecting smoothly two 3D curves, with prescribed tangent planes along these curves.

Blending Graph

It is used for skeleton-based (or structural) implicit modelling. The vertices of this graph are the skeleton primitives. Two primitives are connected by an edge if they can blend their field contributions. The field at a space point P is then computed as the sum of the field from the primitive that contributes the most at P and the contributions from all its neighbouring primitives in the graph. The use of such a graph prevents unwanted blending.

Body animation

Methods for animating the body of a Virtual Human. Body animation is usually performed with Skeleton Driven Deformations.

Body pose

See. Body posture.

Body posture

Specification of joint values describing a virtual human body posture. A body posture can be defined using forward/inverse kinematics, forward/inverse dynamics or even motion capture.

Boundary conditions

In a physical model simulation, they describe the physical conditions at the boundaries of the simulation region.

Boundary Representation (B-Rep)

Geometric representation of objects defined in terms of the faces, edges and vertices which make up its boundary. The boundary of a three dimensional solid is a two dimensional surface, that is usually represented as a collection of faces. Usually, the segmentation of the surface into faces is performed so that the shape of each face has a compact mathematical representation, e.g. that the face lies on a single geometric surface. Faces, again, are often represented in terms of their boundary being a one-dimensional curve. Hence boundary models may be viewed as a hierarchy of models.

Brand Identity

The set of features, attributes, benefits, performance, quality, service support, and the values that a brand possesses. The brand can be viewed as a product, a personality, a set of values, and a position it occupies in people's (customers') minds. Brand identity is everything the company wants the brand to be seen as.

B-Rep

See Boundary Representation.

B-Spline curve/surface

General form of piecewise rational or polynomial parametric curve/surface, which is represented by control points, basis functions, and possibly, weights.

Butterfly scheme

An interpolating subdivision scheme for triangle meshes.

CAD

See Computer Aided Design.

Calibration

Measuring the parameters appearing in the equations ruling the acquisition process of an acquisition device.

CAS

See Computer Aided Styling.

Case Based Reasoning (CBR)

The process of solving new problems based on the solutions of similar past problems. CBR starts with a set of cases or training examples; it forms generalizations of these examples, albeit implicit ones, by identifying commonalities between a retrieved case and the target problem.

Catchment Basin

The catchment basin of a minimum m on a surface described by a C^2 -differentiable function defined over a domain D in R^2 is the locus of the points in D which are closer to m than to any other minimum according to the topographic distance.

Catmull-Clark scheme

A subdivision scheme for quad meshes generalizing the bivariate cubic spline.

CBR

See Case Based Reasoning.

Center-line

See center-line skeleton.

Center-line skeleton

The concept of center-line is strictly related to that of skeleton. Complex objects can be seen as the arrangement of tubular-like components, and abstracted to a collection of center-lines which split and join, following the object topology, and which form, actually, a skeleton. A center-line should satisfy the following requirements: centricity, connectivity and singularity.

Characteristic map

An 1-1 local map between the subdivision surface around an extraordinary vertex and the tangent plane at that vertex. The existence of the characteristic map guarantees C^1 continuity of the subdivision surface at that vertex.

Character line

Basic drawing lines needed to define or characterize an object in the styling phase. They are used to give specific impression/feeling when looking at the object (e.g. the object appears sweet/aggressive), or to define a common peculiar aspect among set of products, as a signature of the designer (e.g. Pininfarina vs. Giugiaro) or the construction company (e.g. Alfa Romeo vs. Peugeot). Most of the character lines are virtual (i.e. only perceived) lines, such as light or curvature lines.

Clay Modelling

Modelling with clay to produce (scaled or full size) physical models of a product for evaluation purposes. Different material can be used to create the physical prototypes, but clay is especially used in the automotive industry.

Clustering

A process of dividing elements in a dataset into subgroups, by determining which of these elements are similar.

Colour mapping

A colour-coded map is an application which associates to a scalar function value a specific colour by using a colour table.

Compression

Compression aims at storing a data set in a more compact way than the original data file. Two main approaches for data compression exist:

- *Reversible* compression, where different packing and re-indexing techniques are used to represent the data with the fewest possible number of bytes without losing information.
- *Non-reversible* compression, techniques where information is lost and tolerances and other parameters describe which information is allowed to be lost.

Which compression techniques to use depend to a large extent of the later use of the information. Information that is only to be used for visual purposes often allow for high compression rates as the human eye most often do not detect small errors without a detailed scrutiny of the image. Information to be used in downstream computations can be degraded by compression, as compression algorithms tends to insert false structure in a data set, e.g., thinning a polyline description of a circle, will make the circle resemble a rough polygon.

Computational mechanics

Field of mechanics solving specific problems by simulation through numerical methods implemented on digital computers.

Computer Aided Design (CAD)

2D or 3D design software package or visualisation able to assist the product development process.

Computer Aided Styling (CAS)

3D surface design and evaluation software suitable for an accurate definition of the shape and aesthetics of a product.

Conceptual design

Starting phase of the product development in which designers clarify the requirements for a product and define its functions, structure, shape, materials, interfaces, behaviour and appearance.

Concurrent Engineering

Management/operational approach which aims at improving product design, production, operation, and maintenance by developing environments in which personnel from all disciplines (design, marketing, production engineering, process planning, and support) work together and share data throughout all phases of the product life cycle.

Conforming simplicial mesh

A conforming simplicial mesh is a simplicial mesh such that the intersection of any two simplices is either empty or is a simplex belonging to both simplices. A simplicial complex such that any k -simplex with $k < d$, bounds at least one d -simplex in the complex is a conforming simplicial mesh.

Conformity set up

Set of operators generating a conform model through healing treatments.

Connected component

Part of an object such that the path between any two point in that part lies within the same part.

Constraint

In geometric modelling, geometric condition that the model has to respect; for example, it can be a point, tangency or curvature constraint. More generally, any condition that a model has to respect according to some specific application purposes (from geometry, aesthetics, manufacturing, and so on).

Constructive Solid Geometry

Geometric representation in which the model is defined as combinations of primitive sets by Boolean operators (union, intersection, subtraction).

Continuous Levels-of-detail (LOD) Model

Both progressive and variable-resolution LOD model are continuous models. Often, in the literature, the term continuous LOD models is used to indicate only variable- resolution LOD models.

Continuum mechanics

Branch of computational mechanics studying bodies at the macroscopic level, using continuum models in which the microstructure is homogenized by phenomenological averages.

Contour

- (1) In CAD, one or a set of curves originated through intersection of a plane with the object.
- (2) See level set.

Contour curve

The contour curve of a surface is a intersection curve between the surface and a family of parallel planes.

Contour tree

The contour tree of a scalar field is the graph obtained by continuous contraction of each contour of (D, h) to a single point. It represents the relations between the connected components of the level sets of a scalar fields. Contour trees are special cases of the Reeb graphs.

Control Point

A point on a curve or surface that influence the shape in a region of the curve or surface. Control points are most frequently used for modelling of Bezier, B-spline and NURBS curves and surfaces, but the concept is not restricted to these. Sometimes control points are on the curve or surface they belong to, often control points are close to the curve or surface, but not close to the surface and influence the shape close to the point.

Control skeleton

A connected set of segments, corresponding to limbs, and joints, corresponding to articulations.

Convolution surface

It calculates the field value at P as the integral of the field contributions from each point of the skeleton. This results into smooth, bulge-free, surfaces for skeletons defined as graphs of branching curve and surfaces pieces.

Critical point

A point p in R^2 is a critical point of a C^2 -differentiable function defined over a domain D in R^2 if and only if the gradient of f vanishes at p .

Critical Point Configuration Graph (CPCG)

It is defined for a Morse function f defined on the closure of a simply-connected open set in R^2 . It is a graph G in which the nodes represent the critical points of f and two nodes in G are connected by an arc in G if there exists an integral line that emanates from one critical point (node) and reaches the other.

CSG

See Constructive Solid Geometry.

Culling

A concept from computer graphics used for the methods employed to sort not visible geometry sent to the graphics pipeline to avoid using computational resources on invisible parts of the objects displayed. Culling can both be performed on the CPU and by the graphics card.

Curvature

Let C be a curve and let P be a point on C . Let N be the normal at P and let O be the point on N which is the limit of where the normal to C at P intersects N as P tends to P . O is the *centre of curvature* at P and PO is the *radius of curvature* at that point.

Curve-surface intersection

Points of coincidence of a space curve and a surface. The points lie on both, the surface and the space curve, and thus, it is a way to compute points on a surface.

Decimation

Reduction of the number of triangles in a triangle mesh, maintaining the original topology of the mesh and preserving a good approximation to the original geometry.

Decision trees

A family of classification algorithms. The algorithm classifies data by hierarchical decomposition of conditions, which can be learned from a labeled set of training data.

Defocus/focus (shape from)

Estimating the 3D surface of a scene from a set of two or more images of that scene. The images are obtained by changing the camera parameters (typically the focal setting or the image plane axial position), and taken from the same point of view.

Degrees of freedom

- (1) The variables one can employ in manipulating geometry. Typically, these are the vertices of polygonal meshes and the control points and knots, in case of B-splines.
- (2) A particular axis of rotation within a skeleton joint.

Design for X

Philosophy suggesting that a design can be continually reviewed from the start to the end to find ways to guide the design process and improve production and other non-functional aspects. "Design for manufacture" and "design for assembly" methodologies remain the most important as they have a direct and recognisable impact on product costs.

Detail feature

Aesthetic features of the shape. In accordance with the stylists' activity, they are created in the second modelling phase and applied on a surface for adding aesthetic and functional details and for enforcing the visual effects of important shape elements. Detail features can be classified according to the type of action performed on the surface, i.e. an area deformation or elimination (*modelling classification*), to the position of the influence area (*topological*

classification), and to the morphological aspects of the resulting shape, i.e. the image of the deformed part (*morphological sub-classification*).

Digital Terrain Model (DTM)

A discrete model of a topographic surface built on the basis of a finite set of points sampled on the surface itself.

Direct kinematics

See Forward kinematics.

Direct Manipulation

A method that offers direct manipulation of geometry, typically in the context of multiresolution editing of freeform curves and surfaces, and possibly with constraints.

Discrete Levels-of-detail (LOD) Model

A collection of independent shape representations, each at a different level of detail.

Discretisation

In FE problems, conversion of a geometric model into a suitable discrete model with a finite number of degrees of freedom.

Distance surface

It calculates the field value at a point P as a decreasing function of the distance between P and the closest point on the skeleton.

Distributed design

Product design performed by actors but located in different places (even in the same company), working on different aspect of a product, but sharing its data.

Doo-Sabin scheme

A subdivision scheme for quadrilateral meshes generalizing the bivariate quadratic spline.

DTM

See Digital Terrain Modeling.

Edge collapse

It consists of contracting an edge e in a simplicial mesh to a vertex v , which can either be a new vertex (*full-edge collapse*) or one of its extreme vertices (*half-edge collapse*). In a triangle mesh, the simplices incident at e become simplices of one dimension lower. All simplices incident in one of the two extreme vertices of e become incident at v .

End-effector

The free extremity of an end segment in a control skeleton.

Equi-brightness curve

The equi-brightness curve of a surface is the locus of points where the brightness of an illuminated surface is constant.

Equi-gradient curve

The equi-gradient curve of a surface is formed by the points where the angle between the surface normal and a given vector is constant.

Euclidean Cell complex

Let Γ be a connected finite set of cells of heterogeneous dimensions embedded in the Euclidean space R^n and d the i th maximum of the dimensions of the cells of Γ , such that the boundary of each cell in Γ is a collection of cells of lower dimensions belonging to Γ . Then, Γ is a d -

dimensional cell complex if and only if the interiors of any pair of d -dimensional cells of Γ are disjoint.

Extraordinary vertex

A non-regular vertex.

Facial animation

Methods for animating the face of a Virtual Human. Facial animation is usually performed with Skin Interpolation.

Fairing

Before computers the smooth curves describing the hulls of ships were faired by using an elastic thin wood ruler, the spline. Today the word *fairing* relates to designing and editing smooth curves and surface within CAD-type systems.

Feature

Very general term indicating any characteristic of a phenomenon or of an object, for example a surface patch of certain curvature characteristics. In CAD, it refers to a set of geometric elements with a special meaning and controllable by means of a limited number of significant parameters. The meaning depends on the context: for example, it can be related to functionality, geometry, assembly and manufacturing.

FE Element

Each parts in which the geometry is subdivided by a finite element mesh. For 2D analysis, or a 3D thin shell analysis, the elements are essentially 2D. For a 3D solid analysis, the elements have physical thickness in all three dimensions. (examples: solid linear brick , solid parabolic tetrahedral elements...).

FEM

See Finite Element Method.

Fillet

Surface joining and smoothing two other surfaces, defined as the envelop of spheres rolling along the intersection curve of these two surfaces.

Finite Element Method (FEM)

Numerical method able to solve a wide variety of mechanical problems (structural, mechanical, heat transfer, fluid dynamics, ...) through the discretization of the model in the 3D space.

Flexion

Rotation of the limb which is influenced by the joint and causes the motion of all limbs linked to this joint. This flexion is carried out relative to the joint point and a flexion axis has to be defined.

Focal Surface

The focal surface is formed by the centres of curvature of a given smooth surface. Thus, the focal surface consists of two sheets corresponding to the maximal and minimal principal curvatures.

Form Feature

In CAD, it is a geometric feature composed by parts of analytic surfaces (planes, cylinders and spheres).

Forward dynamics

In forward dynamics, a skeletal motion is determined from input torques and forces.

Forward kinematics

In forward kinematics, a skeletal posture is determined by assigning input joint angles individually for all the joints of a chain.

Fractal

A fractal is an object that exhibits self-similarity: the same form on all scales. A typical example is a snowflake. The boundary of the fractal object has a fractal (non-integer) dimension.

Free-form feature

In CAD, it is a geometric feature composed by free-form surfaces.

Free-form surface

Any 2 or 3 dimension shape that is not easily decomposable in regular, or analytic shapes.

Fusion

The combination of data from different sources.

Gaussian curvature

An intrinsic property of a space independent of the coordinate system used to describe it. The Gaussian curvature equals the product of the principal curvatures.

Generalised Focal Surface

The locus of all points of a normal congruence proportional to a curvature function value at these points. It is quite related to hedgehog diagram. Instead of drawing surface normals proportional to a function value, all the points on the surface normals proportional to the function value are drawn.

Genus

A topologically invariant property of a surface defined as the largest number of non-intersecting simple closed curves that can be drawn on the surface without separating it. Roughly speaking, it is the number of holes in a surface."

Geodesic path

It is a line which connect two points on a curved surface with minimum path length.

Geometric Continuity

Two C^k curves or surfaces join at a boundary with geometric continuity G^k if it is possible to reparametrise both the curves or surfaces with a unique map such that the derivatives of the component functions agree. For $k=0$, it coincides with C^0 , for $k=1$, it is a continuity of the tangent plane, for $k=2$, it is a continuity of curvature.

Gridded elevation model

A gridded elevation model is a DTM defined by a domain partition into a cell complex in which the 2-cells are squares.

Half-edge data structure

A data structure for encoding a mesh. For each edge of the mesh, the data structure stores two half-edges, and information about the edge is split between such two halves. Each half-edge stores the index of its origin, the index of the face on its left, two indices of its previous and next edges along the boundary of that face, and the index of its twin half-edge, which is oriented in the opposite direction. Information attached to vertices and faces are the same as in the winged-edge and in the DCEL data structures.

Hand Posture

Specification of joint values describing the hand posture required to grab or manipulate a Smart Object.

H-Anim Skeleton

The H-Anim skeleton is an animation-oriented structural descriptor. It is an efficient representation of an articulated skeleton for Virtual Humans. It was initially proposed by the Humanoid Animation Working Group (<http://www.h-anim.org>). Now it has been adopted by the MPEG-4 specification as one of the standard structural descriptors for animatable Humanoid Virtual Characters.

Healing

Technology to detect and repair connectivity problems (e.g. gaps) in order to have a conform geometric model.

Hedgehog Diagram

A hedgehog diagram (curvature profile) for planar curves visualizes the curve normals proportional to the curvature value at some curve points.

Hierarchical B-spline (H-Spline)

A scheme of defining surfaces using overlays of B-spline surfaces. A complex surface is defined as a single tensor product square patch with other tensor product patches laid on top of it at different orientations and sizes.

Hierarchical Model

Organisation of data records as a collection of trees, rather than arbitrary graphs. With respect to geometry a rough description of the geometry is located at the highest level, and more and more details are added descending the tree.

Related term: Graph

Highlight line

A highlight line is defined as the locus of all points on a surface where the orthogonal distance between the surface normal and the light line is zero.

Homotopy type

A class formed by sets in the Euclidean space which have essentially the same structure, regardless of size, shape and dimension. The essential structure is what a set keeps when it is transformed by compressing or dilating its parts, but without cutting or gluing.

Human joint

Joint node, basic building block of a Virtual Human skeleton, representing the actual joints on a human being: shoulders, wrists, vertebrae, etc. A joint can have different kinds of children: they can be segments (typically used to store the actual geometry of each limb), or other joints. Under certain cases (not H-Anim 1.0 compliant) a joint could directly store a geometry node.

Human segment

Node specialisation for H-Anim Segments, typically used as the container of a 3D shape representing a given human body part.

Image

A 2- or larger dimensional array of measurements. In common usage, images refer to digital recordings of intensities obtained with a camera.

Image Segmentation

A division of an image into a collection of (usually non-overlapping) segments.

Implicitisation

A process which consists in the conversion of a parameterised representation of an algebraic curve or surface into an implicit representation.

Implicit LOD representation

It refers to any implicit representation that provides different levels of detail for the implicit surface.

Implicit Surface

In contrast with parametric surfaces, an implicit surface is defined as the set of points P in space verifying an implicit equation ($f(P) - \text{constant} = 0$). f is called the "field function" (and sometimes the "implicit function", which is improper since this function is explicitly given by its parametric equation).

Impostor

An impostor is an image that represents a part of a complex object, and it is usually generated by capturing a rendered image of this object from the predefined camera position. It is mapped on the polygon that is best suited for the specific camera position.

Index of a critical point

Number of negative eigenvalues of the Hessian matrix of a C^2 -differentiable function defined over a domain D in R^2 .

Indexed data structure

A data structure for triangle and tetrahedral meshes. For each triangle (tetrahedron) in the mesh, the indices to its three (four) vertices are encoded.

Indexed data structure with adjacencies

Extension of the indexed data structure for both triangle and tetrahedral meshes. It encodes, for each triangle (tetrahedron) t , also the indices to the three triangles (four tetrahedra) edge-adjacent (face-adjacent) to t .

Industrial Design

The professional service of creating and developing concepts and specifications that optimise the function, value, and appearance of products and systems for the mutual benefit of both user and manufacturer.

Inflection Point

A point on a curve at which the curvature changes sign, passing from concave to convex or vice versa.

Influence Area

It usually refers to the area affected by applying a geometric operation to a surface (e.g. performing a modification).

Integral line

An integral line of a function f is a maximal path which is everywhere tangent to the gradient vector field of f . An integral line is emanating from a critical point or from the boundary of D , and it reaches another critical point or the boundary of the domain D .

Inverse dynamics

It consists in determining the forces and torques required to produce a prescribed motion.

Inverse kinematics

In inverse kinematics, a skeletal posture is defined by specifying target location to end-effectors. The joint angles of the control skeleton are defined so that the end-effectors reach their targets as close as possible.

Irregular mesh

A mesh which is not regular.

Irregular vertex

See extraordinary vertex.

Iso-level

See level set.

Isoline

It is a surface curve along which some function defined over the surface has a constant value.

Iterative Closest Point (ICP)

Class of algorithms for alignment of meshes or point clouds. They are based on the assumption that closest points correspond to each other. Iteratively, for closest points the best transformation is computed and applied to the data set.

Joint limits

Maximum and minimum values that restrict the angle range of a joint.

K-dimensional Euclidean cell

A k -dimensional cell, or *k-cell* is a subset of the n -dimensional Euclidean space R^n homeomorphic to a closed k -dimensional ball, where $k \leq n$.

Key-frame Animation

Type of animation that is defined by a set of frames, where each frame contains a set of key frames which indicate the position and orientation of defined objects in the animation. Each key frame includes a key time which orders the set of key frames.

Landmark

A place holder to store information associated to a particular location on a 3D geometry. Landmarks can be anatomical structures used as a point of origin to locating other anatomical structures, or points from which measurements can be taken.

Level of Articulations

Term used in the H-Anim standard related to the degrees of freedom of a skeleton chain. LOA is also used relatively to LOD, with respect to multi-resolution for bone-based animation.

Level set (of a real function f)

The level set of a real function f is the pre-image through f of a constant value t in the domain of f . The level sets are also called contours or iso-levels. Level sets may be non-connected.

Levels-of-detail (LOD) Model

It is a compact description of several representations of a shape, from which representations of a shape at different levels of resolution can be obtained.

Linear axis

It is based on a linear wave-front propagation like the straight skeleton, but the discrepancy in the speed of the points in the propagating wave-front, though never zero, can decrease as much as wanted.

Linear static problem

Linear static analysis deals with continuum static problems in which the response is linear in the cause-and-effect sense.

Line of curvature

A surface curve whose tangent directions coincide with those of the principle directions. The lines of curvature form an orthogonal net everywhere on the surface except the umbilical points where the principal directions are not defined.

Line of Sight

The straight line between the observer and the target.

LOA

See Level of Articulations.

LOD

See Levels of Detail.

Loop scheme

A subdivision scheme for triangle meshes generalizing the three directional box spline.

L-system

Lindenmayer system. A string rewriting system which can be used to generate fractals with dimension between 1 and 2.

L-system surface

A surface built within a L-system.

Magnetic Resonance Imaging (MRI)

Three-dimensional images produced by a non-invasive diagnostic procedure that uses magnetic field resonance. MRI is commonly used to obtain 3D pictures of internal body structures.

Manifold

A (separable Hausdorff) k -dimensional topological space M in which each point has a neighbourhood which is homeomorphic either to the k -dimensional open ball, or to the half-ball.

Marching cubes

An algorithm that extracts an implicit surface represented by a 3D regular grid of data values. This grid is often referred to as a grid of voxels. The eight corners of a voxel give a total of alternative 256 different configurations for the corner status. By standard operations these can be group into 15 alternative configurations. Triangulations representing these 15 can be pre-computed, and thus efficiently used when tracing the implicit surface described by the grid of voxels.

Mask

The subdivision rule for calculating a new vertex on the refined mesh, usually described by diagrams. Several masks are required to describe a subdivision scheme, e.g. mask for new vertices corresponding to old vertices, edges, faces, or boundary vertices.

Mean curvature

Given the principal curvatures k_1 and k_2 , $H = (k_1 + k_2)/2$ is called the mean curvature.

Medial Axis

The medial axis of a bounded open subset X is the set of points that have at least two closest points in the complement of X .

Mesh

An Euclidean cell complex such that any k -cell of Γ , with $k < d$, bounds at least one d -cell of Γ .

Mesh merging

The combination of meshes resulting from different viewing directions into a single mesh.

Minkowski Sum

Set of point with integer coefficients that can be obtained as sum of two vectors with integer coefficients taken from two other sets of vectors with integer.

Model Composition

A process by which a new 3D model (e.g. a mesh) is constructed by the seamless composition of two or more existing models.

Morphing

The process of making a smooth transition between two shapes.

Morph Target

It defines a different version of an object over time. A morph target is built by deforming/morphing a base shape of an object into a different shape that represents the same object in a different configuration. Morph targets can be used to animate 3D objects with skin interpolation.

Morse function

A C^2 -differentiable function defined over a domain D in R^2 such all the critical points are non-degenerate.

Morse-Smale complex

The stable (unstable) manifolds are pair-wise disjoint and decompose the domain D of a Morse-Smale function f into open cells, whose closure form a complex, called a *Morse-Smale complex*.

Morse-Smale function

A Morse function f is called a Morse-Smale function if and only if the stable and unstable manifolds intersect only transversally.

Morse theory

A generalisation of calculus of variations which draws the relationship between the stationary points of a smooth real-valued function on a manifold and the global topology of the manifold.

Motion Capture

Methods for capturing movement data from a live source. The data are filtered and processed in order to replicate the same motion as the one performed by the live source on a control skeleton.

Multigrid algorithms

Algorithms designed to accelerate the convergence speed of basic relaxation iteration schemes (e.g. a Jacoby or Gauss-Seidel iteration) by computing corrections to the solution on coarser grids.

Multiresolution

An analysis and/or synthesis technique that allows manipulation of geometry at different resolutions, enabling both local and global modification, modulation of details at different frequencies.

Multi-Sensor Data Fusion

Study of the techniques for the integration of data from multiple sensors.

Non-photorealistic Rendering

It helps making comprehensible but simple pictures of complicated objects by employing different simplification techniques.

NURBS

NonUniform Rational B-splines is a standard way in CAD for describing piecewise rational univariate and tensor product functions. NURBS use the numerically very stable B-spline basis for representing both the numerator and denominator of the rational function. NURBS is a very central geometry representation format in the STEP Standard (ISO 10303).

Object joint

Analogous to the joint node (Human joint), but adapted to describe smart objects.

Object segment

Node specialization for Smart Objects' structural descriptors. It contains information about each object part, including the geometry and a pointer to additional smart object attributes.

Occlusion

A portion of a surface is occluded to a sensor when there is a closer object hiding it to the sensor. See also self-occlusion.

Offset surface

Coefficient set of points at a given distance of a given shape following the oriented normal to the input shape. It is a frequently used method for surface creation in CAD; if self-intersections occur, the offset has to be trimmed (see Trimming an offset).

Orthogonal projection

Projection P applied to x such that $P(x)-x$ is in normal direction of $P(x)$.

Orthotomic

The orthotomic of a given curve/surface) is the set of reflections of a given point around the tangents of a the curve/surface).

Out-of-core

When a problem is too large to fit into the primary memory (both physical and virtual) of the computer, it has to be processed using out of core techniques.

Parabolic line

A parabolic line on a surface consists of points where one of the principal curvature vanishes.

Parametric continuity

Two C^k function pieces join smoothly at a boundary to form a joint C^k function if, at all common points, their k^{th} derivatives agree for $k = 0,1,2, \dots, k$. For $k=0$, it is a point continuity, for $k=1$, it is a continuity of first derivative, for $k=2$, it is a continuity of second derivative. It cannot be inferred that curve or surface pieces join smoothly iff the derivatives of the component functions agree.

Parametric modelling

Method of supporting the generation of model variations in CAD systems, storing an object as a main shape description and parameters for the dimensions and/or topology. After the assignment of specific values to the parameters, the modelling system generates a model variant accordingly.

Pivot

The pivot makes the flexion axis rotate around the limb which is influenced by the joint.

Pixel

A picture element, one or more measurements at a particular integer coordinate of a 2-D image.

Point Cloud

A set of uncorrelated points, usually in 3D, that have to be further elaborated to obtain a 3D model.

Polyhedral terrain

A polyhedral terrain is the image of a piecewise-linear function f . The most commonly used polyhedral terrain models are triangulated irregular networks (TINs), in which the domain partition forms a triangle mesh.

Post-processing

In a FE context, phase of the finite element analysis in which the analyst checks the validity of the solution, examines the values of primary quantities (such as displacements and stresses), and derives and examines additional quantities (such as specialized stresses and error indicators).

Pre-processing

In a FE context, phase of the finite element analysis where the analyst develops a finite element mesh to divide the subject geometry into sub domains for mathematical analysis, and applies material properties and boundary conditions.

Principal curvatures

The maximum and minimum of the normal curvature k^1 and k^2 at a given point on a surface are called the principal curvatures. The principal curvatures measure the maximum and minimum bending of a regular surface at each point.

Product development process

A disciplined and defined set of tasks and steps which describe the normal means by which a company repetitively converts embryonic ideas into saleable products or services.

Product Modelling

The entire product information modelling which describes the product completely and unambiguously. It deals with two general types of information: physical product design information represented by the design model and process information, represented by the process and data model.

Progressive Levels-of-detail (LOD) Models

They consist of a coarse shape representation and of a sequence of small modifications, that, when applied to the coarse representation, produce shape representations at successively finer levels of detail.

Progressive transmission

An incremental transfer of geometry between two different sites to alleviate transmission delays due to the fact that geometry tends to be very large. This incremental transfer typically tries to capture most of the geometry, in as early as possible stages of the transmission.

Projection operator

An operator that performs a projection. A projection P applied to x has the property that $P(x) = P(P(x))$, i.e. that projected points are stationary points of the projection operator. Commonly, the stationary points of a projection operator are a sub-manifold of the space they act on.

Range image

A grid of distances (range points) that describe a surface in Cartesian (height field) or cylindrical coordinates.

A range scanner senses 3D positions on an objects surface and returns an array of distance values.

Range scan

See Range image.

Rapid prototyping

The speedy fabrication of sample parts of a product for demonstration, evaluation, or testing. It typically utilizes advanced layer manufacturing technologies that can quickly generate complex 3D objects directly from digital models. This computer representation is sliced into two-dimensional layers, whose descriptions are sent to the fabrication equipment to build the part layer by layer. Rapid prototyping includes many different fabrication technologies: stereolithography (STL), selective laser sintering (SLS), laminated object manufacturing (LOM), and fused deposition modelling (FDM) are a few examples.

Ray Casting

A central method for making photorealistic rendering.

Ray-surface intersection

A specialization of Curve-surface intersection, where the space curve is an infinite straight line.

Reconstruction

The process of making a surface geometry or volume type description of a 3D object based on measured points coordinates on the outer and inner surfaces of the 3D object.

Automatic reconstruction is a very challenging process, as the point sets can have wrong points, can miss points or do not contain a sufficient amount of point to describe critical surface regions accurately. If a point set is produced by combining measurement from different camera positions, there is often drifting of the data between the measurements, Such drifting will often result in false surface features,

Recovery

The process of rebuilding a valid 3D model that existed at an earlier stage in the design process after a crash of the modelling system, erroneous use of modelling functionality, rejection of the used design approach, or other mishaps.

Reeb graph

A topological structure encoding the evolution and the arrangement of the level sets. It is defined as the quotient space of a compact manifold M with respect to a real valued, continuous map f defined on it defined by the equivalence relation that collapses two point on M if and only if they have same image of f and belong to the same connected component of $f^{-1}(f())$

Refinement operator

Operator to add primitives to a surface description. This typically increases the geometric fidelity of the representation.

Reflectance

The proportion of light aimed at an object that is reflected by it. An object's reflectance determines whether the object is perceived as light or dark.

Reflection line

A line consisting of all points p whose connection with some fixed point e , the eye, is reflected into a ray that meets a given fixed line L . Reflection lines, such as contour lines and isophotes, are very helpful to detect surface imperfections visually. They are very commonly in the automotive industry.

Registration

A rigid transformation that brings points of one range image into alignment with portions of a surface it shares with another range image.

Regular mesh

It is composed of simplices that are all similar (or belong to just few classes of congruent simplices) and have all vertices of the same degree (i.e. with the same number of incident simplices).

Regular square grid

See Gridded elevation model.

Regular vertex

A vertex of valence six for triangle meshes, valence four for quad meshes and valence three for hexagonal meshes. These valences correspond to the regular tessellations of the Euclidean plane. All major subdivision schemes refine the control mesh by inserting regular vertices, thus isolated the vertices with other valences.

Remeshing

There is no precise definition, since it often varies according to the targeted goal or application. Nonetheless, it is possible to say that, given a 3D mesh, remeshing consists in computing another mesh, whose elements satisfy some quality requirements, while approximating well the input. *Quality* has several meanings. It can be related to the sampling, grading, regularity, size and shape of elements. Often a combination of these criteria is desired in real applications. Some remeshing techniques proceed by altering the input, and some generate a new mesh from scratch.

Rendering

The process of creating an image on the screen from a mathematical model of a three-dimensional object or scene, including texture, lights and other graphical information.

Reparing

The process of removing (if possible) or reducing the gaps between the delimiting curves of different surface elements.

When repairing the surfaces to ensure that the bounding curves fit better, the interior of the surfaces also have to be modified. Such modification can, if care is not taken, easily destroy important properties imposed on the interior of the surface. Automatic repair of CAD-models is thus an extremely challenging task.

Resultant

A projection operator which is used to eliminate a set of variables in an over-constraint polynomial system.

Reverse Engineering

The process of recreating a design by analysing a final product, speeding up the design and the evaluation process. A point cloud typically acquired using scanning techniques is used as a basis for constructing 3D CAD surface data from a physical model.

RGB

An additive encoding of colors using the three primaries, red, green and blue. RGB is the common color model used in computer monitors and color images.

Ridge

A ridge consists of the surface points where one of the principal curvatures attains an extremal value along its corresponding line of curvature.

Sampling

The process of obtaining a sequence of point coordinates from a 3D model.

Scanning

To record or measure an object by sensing a systematically radiated beam of (laser) light. Sensing is typically done with a device such as a camera, from which color or depth information is acquired.

Scattered data

Point data not lying in a regular grid structure. Scattered data can have line structures, be clustered, be fairly evenly dispersed or have many other structures.

Segment

(1) Portion of an H-Anim figure (Virtual Human) or Smart Object that represents its geometry and appearance.

(2) A collection of pixels that have similar properties (e.g., similar intensity values or texture) which differ from their surrounding pixels.

Segmentation

To split a data set into smaller subsets based on given classifications or criteria. Frequently used in image processing to analyse pictures and for detection. When reconstructing geometry objects from sampled points, segmentation techniques can be used to detect subsets of points belonging to the same mathematical surface.

Selective Refinement

The extraction of shape representations from a LOD model in which the resolution varies continuously in different parts of the shape .

Self-intersection

It occurs when a curve, surface or higher dimensional manifold intersects itself. For surfaces used in CAD self-intersections represents a situation that cannot be reproduced physically in production, and thus should be avoided.

Self-occlusion

A surface is self-occluding when:

- Light cast from behind the surface does not illuminate it;
- The light source is in front of the surface but some closer portion of the surface blocks the incoming light;
- The light source is in front of the surface and the surface is illuminated, but some closer portion of the surface blocks the light coming from the surface.

Semi-algebraic curve/surface

A curve or surface which can, in addition, be described as the solution set of polynomial equalities and inequalities (e.g. B-Spline curves and surfaces).

Sensor

(1) An electronic device used to measure a physical quantity such as temperature, pressure or loudness and convert it into an electronic signal of some kind (e. g. a voltage).

Sensors can be classified in passive (not interacting with the scene) and active (interacting with the scene). Sensors are normally components of some larger electronic system such as a computer control and/or measurement system.

(2) Virtual entities that give to Virtual Humans the possibility to acquire information (stimuli) coming from their surrounding virtual environment. Virtual sensors let a VH see, hear and touch its virtual environment and react in consequence. The information acquired is then analyzed with different algorithms and/or Behavior Controllers that produce animation as output (the VH reacts to stimuli).

Separatrix line

An integral line which connects a minimum to a saddle, or a saddle to a maximum.

Shape Deformation

Each operation or technique aiming at modifying a shape.

Shape from Shading

A method for determining the shape of a surface from the pattern of lights and shades in an image.

Shape Grammar

A shape grammar defines a language of design, i.e. it is a set of precise generating rules, which in turn, can be used to produce a language of shapes, to generate infinitely many instances of shape arrangements starting from an initial basic set of shapes. For example, shape grammars are widely used in architecture to model houses starting from pre-defined primitives (e.g. walls, windows, doors) and rules (e.g. each room must have at least one door).

Shape Indexing

Classification algorithms that rely on a lookup table approach for fast object labelling.

Shape Interrogation

The process of extraction of information from a geometric model. Shape interrogation methods are used to analyse shapes with respect to different aspects like visual pleasantness, technical smoothness, geometric constraints, intrinsic surface properties or to highlight shape imperfections.

Shape Matching

The process of deciding if two shapes represent the same object within a given tolerance.

Shape Signature

Compact representation of the essence of the shape commonly used as a fast indexing mechanism for shape retrieval. Effective shape signatures capture some global geometric properties which are scale, translation and rotation invariant.

Shock graph

A directed, planar graph in which the shock sets are grouped and classified according to the number of contact points and the flow direction.

Shock set

Dynamic view of the medial axis, which associates a direction and a speed of flow to the fire front propagation.

Silhouette

The outline of an object when seen from a given position. Silhouette curves are frequently used to enhance the 3D display of a CAD-model and when making 2D drawings from 3D objects.

Simplex (k-dimensional)

A *k-dimensional simplex*, or *k-simplex*, in the Euclidean space R^n is the locus of the points in R^n that can be expressed as the convex combination of $k+1$ affinely independent points.

Simplicial complex

A *d-dimensional simplicial complex* is a collection of simplices of dimension at most d in R^n such that all simplices spanned by vertices of the complex belong to the complex and the intersection of any two simplices is either empty or is a simplex belonging to both simplices.

Simplicial mesh

A *simplicial mesh* is a mesh in which all cells are simplices. A d -dimensional simplicial mesh is a simplicial mesh which contains simplices of dimension d or lower.

Simplification

Simplification can relate to a number of shape processing operations in CAD:

- Replace a boundary structure CAD model consisting of many surface elements by a CAD-model with significantly fewer surface elements, without changing the shape or design intent behind the model. Such simplification can be important to ensure simple meshing and remeshing of CAD-models when preparing for simulation of the CAD-model, or just to clean up the CAD-model.
- Remove unnecessary details before a CAD-model is meshed. Details not important for the simulation are removed, and regions where the actual geometry does not play any role for the outcome the simulation are given a simpler description.

Simplified incidence graph

For a tetrahedral mesh, it encodes the following information: for each vertex v , a pointer to one edge incident at $t v$; for each edge e , the indices of the two extreme vertices of e and of one of the triangles sharing e ; for each triangle t , the indices of the three edges bounding t , and the indices of the two tetrahedra sharing it; for each tetrahedron σ the indices of the four triangles bounding σ .

For a triangle mesh, it encodes the following information: for each vertex v , a pointer to one edge incident at v ; for each edge e , the indices of the two extreme vertices of e , and of the two triangles sharing e ; for each triangle t , the indices of the three edges bounding t .

Skeletal linear structure

One-dimensional representation which encodes the decomposition of a shape into its relevant parts, or features, which may have either a geometric or an application dependent meaning.

Skeleton

- (1) In algebraic topology, a p -skeleton is a simplicial sub-complex of a simplicial complex K that is the collection of all simplices of K of dimension at most p .
- (2) Related with the notion of medial axis, the skeleton of a bounded open subset X is the set of centres of maximal balls, where an open ball B is maximal if every ball that contains B and is contained in X equals B .
- (3) The skeleton of a shape is the reduced object representation that conforms to human visual perception and preserve the salient shape features.
- (4) Implicit skeleton: in the field of implicit modelling, it is used for a set of geometric primitives to which a distance can be computed. These primitives are used for generating the field function that defines the surface. Skeleton-based implicit modelling can also be referred to as "Structural Implicit Modelling", since the skeleton defines an internal structure for the model.

Skeleton animation

Methods to animate an articulated skeleton by changing the values of the skeleton joints angles over time. The main methods are inverse and forward kinematics and Motion Capture. The result of a skeleton animation is stored as an animation sequence.

Skeleton articulation

An articulation is the intersection of two limbs, which means it is a skeleton point where the limb which is linked to the point may move.

Skeleton-based implicit surface

An implicit surface whose field function is generated by a set of geometric primitives called *skeleton*.

Skeleton-driven deformation

It consists of deforming the skin to match the current posture of the control skeleton for articulated object animation or deformation. The basic approach consists in assigning a set of joints with weights to each vertex in the skin. The location of a vertex is then calculated by a

weighted combination of the transformation of the influencing joints. Various extensions and enhanced complex methods have been proposed.

Skeletonisation

The operation of extracting a skeleton.

Skeleton joint

A joint is the intersection of two segments, which means it is a skeleton point where the limb which is linked to the point may move. Skeleton joints are usually 3D Degrees of Freedom (DoF) rotational joints: flexion, pivot and twist.

Skeleton joint angle

The angle between two segments (limbs) connected by a joint is called the joint angle.

Skeleton pose

See Skeleton posture.

Skeleton posing

It consists in specifying all joints angles values to define a skeleton pose or posture.

Skeleton posture

Specification of joint values describing a posture for an articulated character. A skeleton posture can be defined using forward/inverse kinematics, forward/inverse dynamics or even motion capture.

Skeleton skin

A geometric shape that represents the outer shape of an articulated object. This shape is attached to the articulated skeleton and animated with skeleton driven deformations according to the skeleton animation.

Skeleton skinning

(1) Applying skeleton driven deformation to the skeleton skin of an articulated character in order to adjust it to the current skeleton pose.

(2) Attaching geometric primitives or volumes to the joints and limbs of a control skeleton in order to define and control the shape of the skin. This information is further used in animation to control the skin deformation with respect to the control skeleton motion.

Sketch

Drawing or other composition that is not intended as a finished work, but captures the basic elements and structure.

Skin Interpolation

It consists in deforming a geometric surface (the skin) according to the animation of an underlying associated animation structure (skeleton, muscles) or to morph targets.

Skin mapping

It consists of mapping a geometric surface called *skin* to a control skeleton in order to establish a direct correspondence between the control skeleton and the skin. This information is further used in animation to control the skin deformation with respect to the control skeleton motion.

Skinning file

It describes a particular type of data used for animating deformable VH. A skinning file contains weights assigned to each vertex of the VH geometry. Such weights indicate the amount of deformation to apply when changing the posture. Deformations can be considered as vertex displacements driven by a function of rotation angles belonging to one or more joints. This allows for more aesthetical visual results when animating VH. Skinning algorithms

can be used to obtain anatomically correct skin deformation by simulating the interaction between bones, muscles and skin.

Skin rigging

See Skin mapping.

Smart Object

Virtual object with which virtual humans are capable of manipulations. To implement this, the environment should be extended with some form of knowledge on how interactions between virtual humans and objects are to be carried out. Typical interactions are grasping and manipulation operations. A Smart Object is constituted by a hierarchical collection of nodes. The hierarchical organization specifies the relations between different Geometry and Attribute Sets composing an object.

Smart Object skeleton

Hierarchical structure of object joints and/or object segments used to describe a smart object which usually including mobile parts.

Solid mechanics

Area of application of the continuum mechanics. It includes *structures* which are fabricated with solids. The computational structural mechanics emphasises technological applications to the analysis and design of structures.

Solution

In a FE context, phase of the finite element analysis in which the program derives the governing matrix equations from the model and solves for the primary quantities.

Space-time constraints dynamics

It consists in attempting to meet specified constraints while minimising energy functions in order to add more control over the motion produced by dynamics.

Spline space

Multiresolution manipulation of geometry draws from the ability to project geometry G_i in space S_i onto another subspace $S_{i+1} \subset S_i$. A Spline space is solely defined by the knot sequences τ and orders o . Both uniform and non-uniform knot sequences are considered. The use of uniform knot sequences allows the removal of every second knot, preserving the uniformity of the knot sequences and hence the pre-computation of the wavelet analysis.

Stable/unstable manifold of a critical point

Integral lines that converge to (originate from) a critical point of index l form an l -dimensional cell ($(2-l)$ -dimensional cell).

Static problem

Continuum mechanics problem where the time dependence is not considered.

Stereo Vision

Vision is the act of perceiving and interpreting visual information. The word "stereo" comes from the Greek word "stereos" which means firm or solid. With stereo vision the objects are perceived as solid in 3D. In human beings the stereo vision is achieved by the presence of two eyes and the elaboration of the brain; in the digital world it is achieved by the presence of two sensors and the techniques to combine the measurements coming from them.

Straight-line skeleton

It is a type of skeleton for polygons which is defined as the union of pieces of angular bisectors traced out by the wave-front vertices during the propagation process from the polygon boundary.

Strain

Change per unit of length in a linear dimension of a part or specimen, usually expressed in %. Strain, as used with most mechanical tests, is based on original length of the specimen. *True* or *natural strain* is based on instantaneous length.

Strain Energy

Measure of energy absorption characteristics of a material under load up to fracture. It is equal to the area under the stress-strain curve, and is a measure of the toughness of a material.

Stress

Load on a specimen divided by the area through which it acts. As used with most mechanical tests, stress is based on original cross-sectional area without taking into account changes in area due to applied load. This is sometimes called conventional or engineering stress. *True stress* is equal to the load divided by the instantaneous cross-sectional area through which it acts.

Structural feature

Aesthetic features of the shape. In accordance with the stylists' activity, they represent the basic entities created in the preliminary phase of design, which are used for defining the surfaces constituting the product, thus having an important aesthetic impact. Structural features consist of the so called *contours* and *character lines*.

Structured light

Structured light is the projection of a light pattern (plane, grid, or more complex shape) at a known angle onto an object. This technique can be very useful for imaging and acquiring dimensional information. The most often used light pattern is generated by fanning out a light beam into a sheet-of-light. When a sheet-of-light intersects with an object, a bright line of light can be seen on the surface of the object. By viewing this line of light from an angle, the observed distortions in the line can be translated into height variations.

Styling process

The set of tasks necessary to convert an idea of a product in a final aesthetic shape.

Subdivision

The strategy often used in CAGD is to divide the geometric elements describing the problem into pieces. The idea behind subdivision is that the problem gets simpler when addressing sub pieces of the original geometry. In many cases this is true. However, if care is not taken and the subdivision is not performed in the proper location, the sub-problems can get more complicated than the original problem.

Subdivision algorithms play a central role in a number of algorithms in CAD:

- Visualization algorithms to produce an accurate triangulation of surfaces for display;
- Intersection algorithms for potentially simplifying the intersection problem.

Subdivision curve

A curve described by an initial control polygon and a refinement rule. The subdivision curve is the limit of the progressively refined control polygon.

Subdivision matrix

A matrix describing the transformation of a part of the control mesh under one subdivision step. The spectral analysis of subdivision matrices is the main tool for studying a subdivision scheme.

Subdivision surface

A surface described by an initial control mesh and a mesh refinement rule. The subdivision surface is the limit of the progressively refined control mesh.

Sub-parabolic line

It is formed by the surface points where one of the principal curvatures takes an extremal value along the opposite line of curvature.

Support

The part of the subdivision surface affected by the change in position of a single point of the initial control mesh.

Support plane

Frame used to compute surface properties in a parametric setting. The support plane is used as the parameter domain for a piece of surface, where the mapping between surface and support plane is established by orthogonal projection.

Support Vector Machines (SVMs)

A family of algorithms that seek to divide a dataset using hyperplanes by margin maximisation. SVMs are often used as a supervised learning methods, applicable to both classification and regression.

Surface network

Being f a Morse function defined over a domain D in R^2 , it is a graph in which the nodes represent the critical points of f and the arcs the integral lines connecting the critical points.

Surface patch

A selected part of a larger surface. In B-Spline modelling, any of the sub-surfaces which the global shape is decomposed in.

Terrain

See Topographic surface.

Tessellation

Process forming or arranging continuous curves or surfaces in a piecewise, checked or mosaic pattern. In case of surfaces it is usually a triangulation.

Tetrahedral mesh

A 3-dimensional simplicial mesh.

Tetrahedron bisection

The action of replacing a tetrahedron σ in a tetrahedral mesh with the two tetrahedra obtained by splitting σ at the middle point of its longest edge through the plane passing through such point and the opposite edge of σ . This rule is applied recursively to an initial decomposition of the cubic domain obtained by splitting it into six tetrahedra all sharing one diagonal.

Texture

In computer graphics, the digital representation of the characteristic appearance of a surface having a tactile quality.

Thinning

Process of removing pixels or voxels from a discretised pixel-based or voxel-based representation of an object for generating a representation consisting of connected, unit-wide paths of pixels or voxels.

TIN

See Triangulated Irregular Network.

Topographic distance

The topographic distance between two points p and q on a surface described by a C^2 -differentiable function defined over a domain D in R^2 is the length of the path of steepest slope joining p and q .

Topographic surface

The image of a real bivariate function f defined over a subset of points D in the Euclidean plane.

Topological graph

A simple unlabeled graph whose connectivity is considered purely on the basis of topological equivalence, so that two edges (v^1, v^2) and (v^2, v^3) joined by a node v^2 of degree two are considered equivalent to the single edge (v^1, v^3) . This entity acts as a placeholder for a variety of structural descriptors. Topological graphs are different from the H-Anim or Smart Object skeletons, which are animation-oriented structures not suitable for other applications.

Triangle bisection

The action of replacing a triangle t in a triangle mesh with the two triangles obtained by splitting t at the middle point of its longest edge through the segment passing through such point and the opposite vertex of t . This rule is applied recursively to an initial decomposition of a square obtained by splitting it into two triangles by one of its diagonals.

Triangle mesh

A 2-dimensional simplicial mesh.

Triangulated Irregular Network (TIN)

A DTM based on the decomposition of the domain of a two-dimensional scalar field into a triangle mesh.

Triangulation

Denoting $|S|$ the topological space underlying a simplicial complex S , ($|S| = \cup_{\sigma \in S} \sigma$), then a triangulation of the topological space M is a case of simplicial complex S such that $|S| = M$. Improperly, the term triangulation is also used to denote the geometric realisation of a bi-dimensional simplicial complex (also known as *triangle mesh*); while tetrahedralisations are a subclass of three-dimensional simplicial complexes.

Trimming an offset

The operation of removing self-intersecting parts of offset surfaces. In fact, when the offset distance is larger than the minimal radius of curvature of the existing surface in some points and smaller in some others, some corresponding normals of the two surfaces will point in opposite directions causing self-intersections in the offset.

Trimming line

Line creating a restriction of the parametric space, i.e. of the definition domain of a parametric surface (Bezier, B-Spline, NURBS...).

Twist

A torsion of the limb which is influenced by the joint.

Two-dimensional scalar field

A real bivariate function f defined over a subset of points D in the Euclidean plane.

Umbilical point

Surface point where the principal curvatures are equal. All the points in planar and spherical surface regions are umbilical.

Uniform knot sequence

A knot sequence where all knots are equally spaced. One clear advantage of using uniform knot sequences can be found in the fact that the wavelet decomposition could be performed a-priori as the decomposition depends solely on the subspaces of the splines and is completely independent of the control points of the shapes.

Variable-Resolution Levels-of-detail (LOD) Model

It consists of a coarse shape representation and of a set of small modifications, organised into a partial order that allow performing selective refinement in such a way that the resolution be changed on a virtually continuous scale.

Variational Modelling

A paradigm used to find the "best" curve or surface among all solutions that meet a set of prescribed constraints. The constraints may result from the particular modelling technique used, for example, sample point approximation, or direct curve manipulation. It is typically formulated by minimising some energy functional.

Vertex insertion

Vertex insertion in a simplicial mesh Σ consists of deleting a connected set of d -simplices from Σ , called the *region of influence* of the vertex insertion, and replacing them with a set of new d -simplices all incident at v . The region of influence is defined by the specific triangulation criterion used.

Vertex removal

Removal of a vertex v from a simplicial together with all the d -simplices incident at v from a d -dimensional simplicial mesh and re-triangulating the resulting star-shaped region formed by the union of the removed simplices. It is the inverse operation with respect to vertex insertion.

Vertex split

Expansion of a vertex v in a simplicial mesh into an edge e .

A vertex split is the inverse operation with respect to an edge collapse. There are two cases: vertex v is an extreme vertex of e (inverse of half-edge collapse) or not (inverse of a full-edge collapse). In the latter case, any simplex incident in v either expands of one dimension and becomes incident in e , or becomes incident in one of the extreme vertices of e . In the former case, only a subset of simplices incident at v are affected by the vertex split, forming the so-called region of influence (specified in the split operation).

View

In a 3D modeller, a view indicates a projection of an object according to some planes, typically the main planes of the coordinate reference system.

In the product development process, a view is the product information required by a development phase. Since the various phases of the development process have different goals, they require proper digital model and information of the product itself together with proper tools to treat them. It is therefore necessary to transform the model from one point of view to another one.

Virtual Human

Specialized instance of an articulated character. The model can be synthesised in a variety of ways and can represent a real or a virtual person. VHs are characterized by a set of general attributes (sex, nationality, race, ...), and structural descriptors (skeleton, geometry, landmarks, etc..).

Vision

The investigation of how the human visual perception works, and how simulating it artificially.

Voxel

An abbreviation for "volume element" or "volume cell." It is the 3D conceptual counterpart of the 2D pixel. Each voxel is a quantum unit of volume and has a numeric value (or values) associated with it that represents some measurable properties or independent variables of the real objects or phenomena.

Watermarking

Adding a hidden pattern in an image, surface, or sound, that can be checked algorithmically, but is not perceived by the human observer.

Watershed

The watershed of a C^2 -differentiable function f defined over a domain D is the set of points of D which do not belong to any catchment basin.

Water tightness

In general there are small gaps between the surface elements describing the shells (inner and outer) in a CAD-model. In a simulation model such small gaps are not allowed, the elements constituting the simulation model has to have an exact match, or in other words be water tight.

Wavelet

Multiresolution representation based on wavelets have been developed for parametric curves and surfaces, meshes and surfaces of arbitrary topology and even for volume data. Wavelets provide a framework to decompose a complex function into a "coarser" low resolution part, together with a collection of detail coefficients and different resolution levels, all necessary in order to recover the original function

Winged-edge data structure

It explicitly encodes all entities forming a mesh. For each edge e , the data structure maintains the indices of the two extreme vertices of e of the two faces bounded by e , and of the four edges that are both adjacent to e and are on the boundary of the two faces bounded by e . Vertices and faces are also encoded: for each vertex v , a pointer to any edge incident in v , and for each face f , a pointer to an edge bounding f is maintained.

Zippering

The process of merging polygonal meshes generated from different 3D scans of an object into one mesh. Multiple scans are often necessary because the objects measured are self-occluding.