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IST Project Sheet

AIM@SHAPE is a Network of Excellence project within EU's Sixth Framework Programme

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

Action Line: Semantic-based knowledge systems

Duration: 2004-2007 (48 months)

AIM@SHAPE Mission

The multimedia world can be classified into one-dimensional media like text and sound, and multi-dimensional media. Among the latter, those which are characterized by a visual appearance in a space of 2, 3, or more dimensions are called shapes. Examples of shapes are pictures, sketches, images, 3D models of solid objects, videos (disregarding the sound track), 4D animations, etc. As information is moving from textual to visual form, digital shapes are gaining more and more importance. They populate virtual environments in advanced scientific simulations as well as in emerging edutainment applications. The mission of AIM@SHAPE is to advance research in the direction of semantic-based shape representations and semantic-oriented tools to acquire, build, transmit, and process shapes with their associated knowledge. We foresee a generation of shapes in which knowledge is explicitly represented and, therefore, can be retrieved, processed, shared, and exploited to construct new knowledge.

The attainment of a new vision of shape knowledge is achieved by: the formalisation of shape knowledge and the definition of shape ontologies in specific contexts; the definition of shape behaviours which formalise the interoperability between shapes; the delineation of methods for knowledge-based design of shapes and the definition of tools for semantics-dependent mapping of shapes. The consortium of 14 excellent research institutions will pursue integration at the institutional level by founding a European Virtual Institute on Shape Modelling, at the foundational level by initiating a new Theory of Digital Shapes, and at the component level by developing a Digital Shape Workbench as a common platform for shape models and software tools. Integrating activities include the design of a common shape ontology and a program for human capital mobility and training. Spreading of excellence includes an international forum, an industrial users' group and regular conferences.

AIM@SHAPE WEB PORTAL: *http://www.aimatshape.net*

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Consortium

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ITALY
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Consortium Profile & Research Lines

Istituto di Matematica Applicata e Tecnologie Informatiche -Dept of Genova CNR- **IMATI**- GE

The Shape Modelling Group is a research team of the Institute of Applied Mathematics and Information Technology, Department of Genova (IMATI-Ge), of the Italian National Council of Research (CNR). Geometric modelling has been a key research topic at IMATI-Ge for several years. Geometric modelling is a set of mathematical and computer science techniques which relate to different fields, such as geometry, computational topology and computer graphics. The main aim is to describe the shape of an object or phenomenon, through the definition of geometric primitive entities and the classification of the reference context. Lately the Shape Modeling Group has been constituted with the aim of studying the issues related to the formalization, coding and processing of the knowledge embedded in digital shapes, considering geometry as a part of it but not as its whole. Digital shapes, indeed, have a meaning. They can be interpreted as a composition of perceptually relevant features, they may be designed with a specific intent, they can be classified by the human brain through abstraction and classification processes. The research strategy of the group is therefore to broaden the role of traditional modeling by the definition of new representations, able to highlight the semantic level at which the perception of a shape is encoded.

The main research lines contributing to this program concern:

- Methods to represent and process the geometry while preserving and enhancing the main features of a shape, (e.g. sharp features enhancement, shape based methods for geometry reconstruction, mesh compression, ...)
- Form Feature modelling tools to design shapes in CAD application fields, from the traditional mechanical engineering to the aesthetic design, including integration with downstream applications, such as FEA
- Shape characterizations through the analysis of its surface (e.g. curvature computation, feature extraction, computational topology, ..)
- Methods to automatically deduce structural information from geometric models (e.g. skeletons, topological graphs, ..)
- Knowledge management techniques for sharing data and tools in open and distributed systems (e.g. information visualization, data mining and ontology for semantic analysis of metadata)

Università di Genova -Diparimento di Informatica e Scienze dell'Informazione **DISI**

The team at the Department of Computer Science (DISI) of the University of Genova includes the Geometric Modeling and Computer Graphics (GMCG) group and the Computer Vision (CV) group. The GMCG group, funded in 1990, is active in the fields of geometric and solid modeling, computer graphics and computational geometry. The current research activity is focused on modeling computational issues related to the representation and manipulation of shapes and scalar fields. The expertise in the CV group includes motion analysis, interpretation of 3D scenes, object and pattern recognition, machine learning. The entire DISI team has been working on applications of shape representation and recognition techniques in Geographic Information Systems (GISs), in augmented virtual reality, in cultural heritage and biomedicine.

The research activity on shape representation and manipulation concerns the following topics:

- Multi-resolution representation of multi-dimensional scalar fields for applications to scientific data visualization and implicit surface modeling: in particular, our research focuses on Level-Of-Detail (LOD) models based on nested grids for regular volume data sets and time-varying scalar fields, and on LOD models for unstructured volume data sets.
- Multi-scale models for non-manifold shapes: in particular, our research focuses on data structures and algorithms for encoding and manipulating non-manifold shapes described through simplicial meshes, simplification of non-manifold shapes, part-based representations.
- Morphology-based representations of terrains (2D scalar fields) and volume data sets.
- Surface reconstruction for virtual reality applications: our research focuses on on-line mosaicing to reconstruct 3D objects from multiple acoustic/optical range images, and on techniques reconstructing surfaces from data with uncertainties coming also from multiple sensors.

The Computer Vision group performs research on the basic computational problems underlying the analysis and the understanding of digital images. The aim is designing, developing, and testing image processing methods for:

- extracting 3-D geometrical structure from stereo, active triangulation, or image sequences;
- dealing with several computer vision problems like image filtering, feature extraction and grouping, camera calibration, and motion analysis.

Further information can be found at the following URL:
http://www.disi.unige.it/index.php?research/ip and
http://slipguru.disi.unige.it

École Polytechnique Federale de Lausanne **EPFL**

VRlab – EPFL is currently involved in the following research lines: smart objects, object semantics for virtual interfaces and semantics for virtual humans.

Virtual "smart objects" encapsulate information (semantics) about interaction plans for each possible actor-object interaction, detailing all primitive actions that need to be taken by both the object and the actor (virtual humans), in a synchronized way. New tools for assisting and automating the design and annotation of such objects are some of the research objectives we are currently pursuing. For example, we are interested on defining methods for automatic extraction of shape semantics that will let us annotate the objects with the required information for object grasping.

The second research line is related to the field of human-computer interaction. We have defined the concept of "mediators": virtual objects that act as interfaces to control virtual/real objects. Mediators are 3D objects that can be manipulated by the user and serve as interfaces to more complex objects (teleoperation), e.g. virtual joysticks with haptic feedback for controlling distant vehicles.

Finally, we are working on the definition of an ontology for Virtual Humans, this will provide us with a formal representation of the knowledge related to the animation and modeling of virtual characters and their virtual environments. For example, the semantic annotations will serve to define the "personality" of a Virtual Human and to make it react in different ways to other Virtual characters and objects in the environment. This will allow us to integrate in a common framework the research on behavioral animation, artificial emotions and perception.

Fraunhofer Institut für Graphische Datenverarbeitung FhG/**IGD**

The Fraunhofer-Institute for Computer Graphics in Darmstadt, Germany, is a research organization focusing on the development of product prototypes (hard- and software) and the realization of concepts, models, and solutions for computer graphics and its adaptation to specific application requirements. The work is rounded off by basic research projects and the realization of single devices and computer graphics systems with pilot character. Industry and public funded R&D projects at Fraunhofer-IGD are directly related to current problems in industry, trade, traffic, medicines, and service. Participating in AIM@SHAPE is the department for Industrial Applications, which is concentrating on applying innovations in computer graphics to engineering applications. Latest examples are, for instance, Virtual Reality, Augmented Reality, CSCW (Computer Support Cooperative Work) and Knowledge Management applied to Computer-aided Design and Styling as well as to FEM and CFD Analysis.

GraphiTech, Center for Advanced Computer Graphics Technologies, which in the project is associated to Fraunhofer-IGD, has been founded in July 2002 as joint venture between the INI-GraphicsNET Stiftung, the Cultural Institute of Trento (Istituto Trentino di Cultura) and the University of Trento (Università degli Studi di Trento).

GraphiTech has been established in order to conduct research and development activities in the broad technology area of advanced computer graphics, mixed reality, information and communication systems. The foundation contributes to the transfer of knowledge between the research sector and the industry through the promotion of world-class research in advanced computer graphics technologies and services, in particular, Augmented Engineering, Interactive Systems, E-business and E-commerce, Digital Technologies for media & streaming, Knowledge and Content Engineering, Secure Information Technology, Mixed Reality and Networked Audio, Collaborative Design.

Fraunhofer-IGD and GraphiTech are two of the core institutes of the INI-GraphicsNET (http://www.inigraphics.net/). Under the leadership of Prof. Dr.-Ing. Dr. h.c. mult., Dr. E.h., Hon. Prof. mult. José L. Encarnação, today this institutional network comprises one of the largest centres for information- and communication technology worldwide.

Major goal of Fraunhofer-IGD and GraphiTech is to promote the state-of-the-art in representing and handling shape semantics to improve the computer-aided support for product development and the product lifecycle as a whole. Their main research contributions to achieve this objective include the following:

- Feature-based and parametric modelling tools that support abstract and intuitive user-interfaces for shape generation based on shape and product semantics, for instance, to be used in virtual environments for design and styling
- Representation of shape semantics and mapping between different application-oriented shape interpretations in terms of shape features to support downstream applications like FEA and CFD, but also assembly, machining and maintenance
- Knowledge-based methods and tools for managing engineering data using shape semantics on different levels of abstraction for reasoning and retrieval

Institut National Polytechnique de Grenoble **INPG**

INPG (Institut National Polytechnique de Grenoble) is among the largest technical universities in France. It consists of nine engineering schools. INPG is a member of the CLUSTER consortium (Consortium Linking European Universities of Science and Technology for Education and Research). In the middle of a rich scientific and technological environment, INPG, with more than 30 laboratories and a graduate school in Engineering Sciences, has a first-rate research potential. The participants of INPG into the AIM@SHAPE network are members of four different research laboratories namely the laboratory Sols, Solides, Structures (3S), the Laboratoire des Images et des Signaux (LIS), the laboratoire de GRAphique, VIsion et Robotique (GRAVIR), and the Laboratoire de Modélisation et Calcul (LMC) (representing altogether 160 permanent staff researchers and 150 Ph.D students). The 3S is a research laboratory in Mechanical Engineering and is composed of three main themes. The Integrated Design project focuses on ontologies in the design process, design methodologies, CAD-FEM link, and shape design subjected to aesthetic and functional constraints. The LIS laboratory participates to the AIM@SHAPE project through the GOTA group. Research in this group focuses on 2D and 3D shapes, images and video, providing expertise on shape reconstruction, meshing and skeletonization. The Evasion group as part of GRAVIR contributes to AIM@SHAPE by its expertise on scientific visualisation of large data sets, interactive techniques for virtual sculpture and skeleton-based implicit surface modeling. The LMC is a research laboratory in Applied Mathematics and is composed of four departments. The department of geometric modelling and approximation that is involved in AIM@SHAPE concentrates on multi-resolution techniques for visualisation and geometric modelling, computational geometry, CAD models and classical curve and surface design. The INPG team combines expertise at high international scientific level across several disciplines, including geometric modelling, computational geometry, multi-resolution analysis, mechanical design and simulation, and has already developed strong international collaborations.

Institut National de Recherche en Informatique et Automatique
INRIA

The GEOMETRICA group from INRIA is currently exploring theoretical and computational aspects of surface reconstruction, applied differential geometry (with theoretical guarantees, proofs of convergence), shape approximation with meshes (sampling, interpolation, meshing, isotropic/anisotropic surface remeshing), geometry compression, related data structures and analysis of algorithms.
We propose CGAL as a research development platform for training, research and integration of the results. CGAL (http://www.cgal.org/) is a C++ library of geometric algorithms designed to provide robust, efficient, flexible and easy to use implementations of geometric algorithms. CGAL aims to make most of the advanced solutions proposed in the field of computational geometry available to users in industry and application area. The library consists of three parts:

- The kernel includes basic geometric data types and operations,
- The basic library includes a large number of geometric data structures and algorithms, such as convex hull and (Delaunay) triangulation algorithms,
- The support library includes STL extensions, supports for different number types, and interfaces to other packages, e.g. for visualisation, and I/O.

The GALAAD (http://www-sop.inria.fr/galaad/) group is working on algebraic-geometric problems related to shape modeling. Its interest includes representations of shapes by parametric or implicit equations, conversion and approximation questions, in particular meshing algebraic surfaces and related problems for the treatment of these models such as intersection, topology, singularity analysis. These questions involve algebraic methods, for the resolution of polynomial equations, at the border between symbolic and numeric computation.
A special emphasis in our work is given on certified computation. We propose the library SYNAPS (http://www-sop.inria.fr/galaad/logiciels/synaps/) as a software support for training, research and integration of results on algebraic questions related to shape modeling.

Informatics and Telematics Institut – Center for Research and Technology Hellas
ITI- CERTH

The Centre for Research and Technology Hellas - CERTH is a legal, non-profit entity organized under private law, under the auspices of the General Secretariat for Research and Technology (GSRT), of the Greek Ministry of Development. CERTH's structure includes the Central Directorate and five Research Institutes; one of them is the Informatics and Telematics Institute – ITI (www.iti.gr). The main goal of the ITI is to achieve scientific and research excellence by developing the appropriate conditions that will motivate the conduct of basic, applied and technological research focusing on informatics, telematics and telecommunications. The majority of the Informatics and Telematics Institute's income derives from external R&D projects financially supported by the European Commission, National Research Programmes and Consulting Subcontracts with the Private Sector (I&T Industry). It is currently participating in more than 14 IST FP6 projects.
The newly established Distributed Systems Laboratory is located in the city of Volos and most of its personnel have been affiliated for almost a decade with the Computer Science Institute at FORTH. Distributed Systems Laboratory's main research areas of interest include: Advanced e-Services for the Knowledge Society, Grid computing, e-Science technologies, Global scientific metacomputing, Environmental informatics, e-Services and Digital Libraries, Semantic web, Scientific Computing & Parallel and Distributed Processing, Middleware technologies and Mobile Computing, Ubiquitous and pervasive computing, Wearable computers and mobile devices, Electronic commerce.
Concerning the AIM@SHAPE NoE, ITI is interested in the development of ontologies for modeling digital shapes and their semantics, and it promotes semantic interoperability by the use of Semantic Web technologies. Special attention will be given to semantic-enabled services that could effectively search, retrieve, share, exploit, and use shape models to construct new knowledge.

Université de Genève
UNIGE

The research activities dedicated to shape modeling at MIRALab, University of Geneva are mainly oriented towards human life virtual simulation. It involves a large range of modeling contexts such as modeling the outer shape of the human body and face for real-time virtual environments, modeling anatomical components for computer assisted surgical applications, modeling virtual clothes to dress virtual humans or modeling virtual decors to populate them with virtual humans.

Semantic-based modeling can drastically improve the shape modeling step and make it at the same time more accurate and more automatic. In the context of human virtual simulation, most of the modeled shapes are further deformed for animation, which implies heavy backward constraints to the modeling stage. The modeled shape only represents one static snapshot of the associated object but the shape structure needs also to be able to model the object in any other possible postures.To achieve this objective, the modeled shape must meet to the requirements imposed by the animation algorithms, either geometric based, physics based or hybrid. An efficient way to take these constraints into account consists in controlling the modeling process with prior-knowledge. One of the most appropriate approaches for incorporating prior knowledge in shape modeling consists in fitting a template model to a target shape using pre-defined features. Moreover, this approach is particularly suited for modeling directly animatable shapes by integrating the animation control structures into the template model and by fitting them to the target shape at the same time as the geometric shape. It results in a ready for animation shape. It is also possible to control the level of detail of the modeled shape by including level of details directly in the template model. We have successfully applied this approach to body and face cloning from 2 photos, body shape and clothes modeling from morphological parameters and bones articulation modeling from MRI stacks and anatomical landmarks.

MIRALab's recent research on human body modeling and simulation has been focused on parameterization techniques for modeling static shapes. A time-saving generation of realistic, controllable body model is the primary aim of this research. In order to gain insight into the variety of physical appearance, we base our modeling on the statistic analysis of the captured 3D body geometry of real humans, which arguably provides the best available resource to model and estimate correlations between control parameters and the full body shape. After finding the geometric correspondence among these example models, we construct a continuous range of the control-parameter space and the corresponding body space through multivariable interpolation. Given a specific location in the control parameter space, the resulting modeler will evaluate the most plausible model by efficiently blending the examples with known attributes. Subsequently, the user can generate a new model or modify an existing one almost instantly, simply by providing a few new parameters.

Max-Planck-Institut für Informatik
MPII

The Computer Graphics Group, headed by Prof. Dr. Hans-Peter Seidel is a research division of the Max-Plank-Institut fuer Informatik (MPII) and one of the world's leading teams in the field of Visual Computing and Communication. Expertise and experience within the group include the following areas:

- Mesh Processing
- Free-Form Surfaces, Subdivision Surfaces, and Shape Analysis
- Implicit Surface Modeling
- Discrete Differential Geometry
- Learning-Based Modeling in Computer Graphics and Computer Vision
- Facial and Human Modeling and Animation
- Model Acquisition with Realistic Reflection Properties
- Image Based Rendering and Motion from Video
- Realistic Hardware-Supported Shading and Lighting
- Global Illumination
- Perception Issues in Rendering and Animation

The main research activities of the group within the AIM@SHAPE project are:

- Shape Reconstruction from Scattered Data
- Statistical Learning for 3D Shape Reconstruction and Manipulation
- Multiresolution Shape Analysis and Representation
- Curvature Feature Detection
- Mesh Filtering, Fairing, and Parameterization
- Modeling and Animation of Virtual Humans
- Topological Analysis and Modeling of Vector Fields
- Reconstruction and Visualization of Volume Data

Stiftelsen for industriell og teknisk forskning ved Norges Tekniske Høgskole **SINTEF**

SINTEF (www.sintef.no), the Norwegian Foundation for Industrial and Technical Research, is a multidisciplinary organization that finds intelligent, profitable solutions based on research and development in technology, the natural sciences, medicine and the social sciences. Technology for a better society is SINTEF's vision. SINTEF is Scandinavia's largest independent research organisation with about 1700 employees, of whom around 70% are researchers. Contracts for industry and the public sector generate more than 90% of the income. SINTEF collaborates closely with the Norwegian University of Science and Technology in Trondheim and the University of Oslo.
The about 40 employees of the Department of Applied Mathematics within SINTEF ICT (Institute of Information and Communication Technology) perform contract research, development and consultancy for industry and system vendors. The department is involved in numerous activities ranging from basic research to product and software development and commercialization.
The geometry group within the department concentrates on the modelling and representation of geometry as well as computations, enhancements and quality control of geometric objects. Areas of application are found in CAD/CAM, GIS (Geographical Information Systems), medicine, geology, animation, CAD to FEM integration, ocean wave modelling, and industrial quality control. Many industrial projects use the department's own commercially available software libraries that have extensive functionalities within their respective fields of curve and surface modelling and scattered data approximation, the pertinent know how having been gathered since the early 1980's. Some of the most recent research projects concern:

- visualization of medical data
- mathematical methods in mesh-based geometric modelling
- bridging the gap between algebraic geometry and computer-aided design
- use of graphics co-processors as high-end computational resources

The department is an active partner in the Centre of Excellence "Centre of Mathematics for Applications" at the University of Oslo (www.cma.uio.no). Within this centre, both geometry problems related to product development and manufacturing, as well as gridding for simulations and partial differential equation based simulations will be central topics. The department is also a main partner in the Oslo Graphics Lab (http://www.simula.no/ogl), a joint visualization research facility of the University of Oslo and the Simula Research Laboratory (www.simula.no).

A main goal of the AIM@SHAPE project is for SINTEF to make the research results in the consortium available to its customer base, thus initiating industrial projects or supporting existing ones. Of special importance is in our view the Digital Shape Workbench, allowing access to software that took years to develop. The main areas of our own research and industrial activity are CAD/CAM, where we feel new approaches are needed to overcome current inertia; medical applications for the visualization of data and the simulation of operations for training purposes; the combination of geometric modelling and numerical simulation, for example in shipbuilding; the handling of geological data from the oil and gas industry; animation for game and film production. For these applications (and others) there is special interest in new geometry representations and the conversion between different representations, in the scaling of shape information to different platforms (such as PDAs) and available hardware (such as graphics co-processors), as well as in multimodal approaches combining geometry and haptics (i.e. force and tactile feedback involving the sense of touch).

Technion –Israel Institute of Technology
TECHNION

The Technion is one of Israel's seven universities, and its only engineering school. Established in 1924, it has produced 70,000 graduates to date. Today the Technion has 700 faculties teaching 10,000 undergraduate students and 3,500 graduate students. The Computer Science department within the Technion has 54 faculties, teaching 1,300 undergraduates and 200 graduate students. The faculty offers 5 study tracks, and contains 14 research labs.
The Center for Graphics and Geometric Computing (CGGC -http://www.cs.technion.ac.il/cggc), based in the department is a research center studying computer graphics, solid modeling, visualization, discrete and computational geometry, image understanding and processing, geometric software and computing, computer-aided design and manufacturing, as well as related topics in discrete mathematics, computational biology and chemistry, and geographic information systems. The CGGC houses 3 faculties and approximately 25 research staff and students. It offers six undergraduate and graduate courses on computer graphics, geometric modeling and computational geometry.

Research in computer graphics and shape modeling is also performed in the Technion's Electrical Engineering department, which is comparable in size to the Computer Science department. This research is concentrated in the Vision and Image Sciences Laboratory (VISL -). Both the CGGC and the VISL are funded by the Israeli government and European grants. They are also funded by various bi-national funding agencies, such as the German-Israeli Fund (GIF), the US-Israel Binational Science Foundation (BSF), and others. The two centers have extensive ties with local Israeli industry, including RAFAEL, Elbit, the Israel Aircraft Industries, Optitex and Neomagic. Ties also exist with foreign companies, such as Dassault Systemes and Autodesk Inc.

The four PI's representing the Technion are:

Craig Gotsman (http://www.cs.technion.ac.il/~gotsman) specializing in geometry processing.

Gershon Elber (http://www.cs.technion.ac.il/~gershon) specializing in free-form geometrical modeling.

Gill Barequet (http://www.cs.technion.ac.il/~barequet) specializing in computational and combinatorial geometry.

Ayellet Tal (http://www.ee.technion.ac.il/~ayellet) specializing in geometry and shape analysis and recognition.

Technische Universität Darmstadt
TUD

The Discrete Modelling Group (DGM) at Darmstadt University of Technology (TUD) has been recently established inside the Department of Computer Science. Research focuses on several aspects of digital shapes:

- Establishing concepts and methods for linking discrete and continuous shape representations
- Creating adaptive (or scalable) discrete shape representations for efficient handling of complex shapes
- Developing tools for processing discrete representations or converting them to continuous surfaces

Research has been done in several projects funded by the German Ministries of Science and Business and has been documented at international conferences (e.g. SIGGRAPH, IEEE Visualisation, Eurographics, Shape Modelling International) and in journals (ACM Transactions on Graphics, IEEE Transactions on Visualisation and Computer Graphics, Computer Graphics Forum, The Visual Computer, and others). Besides the general tasks of harmonisation, integration, and spreading of excellence, TUD is mainly involved with the acquisition and processing of digital shapes. With a strong experience from specifying geometric animation within MPEG4, TUD will help in defining new standards and protocols for the exchange of smart shapes. For the acquisition of shapes, models will be developed that describe how many samples one has to acquire to make sure certain geometric features are preserved in the digital model. These shapes will be represented later in a multi-scale fashion, so that the shape is accessible at different levels of accuracy and complexity.

Utrecht University
UU

Although the human visual system is very good at the interpretation of images, the amount of digitally acquired and stored data is so large that we need computerized analysis and retrieval methods to handle it. Many applications exist in industry, company archives, internet, and hospital environments. Two examples are verification of misuse of a company logo among one of the millions of images on the Web, and examination and retrieval of the millions of digital medical scans made every year. Characteristic to our research is that fundamental research is followed by experimental verification. The approach we take is strongly algorithmic, and we put emphasis on the analysis of shape of patterns that are present in images, sound, video, and 3D scenes. The topics we work on are feature extraction, segmentation, matching of images, and organization of images in index structures for efficient retrieval, with a focus on medical imaging and shape-based multimedia. Our research in medical imaging is concerned with alignment of 3D scans (CT, MRI, etc.). Our research in multimedia is concerned with the algorithmic aspects of shape analysis. Some aspects involved are the representation, decomposition, approximation, and deformation of shape, the transformation of one shape into another, the measuring how similar two shapes are, and the organization of shapes in (index) search structures.

Research focuses on the following topics:

- Shape Matching: for shape-based image matching, features are extracted from images, such as edge and corner points, curves, and regions. The set of feature of one image is then translated, rotated, and scaled so as to minimize some similarity function with respect to the features from the other image. We develop similarity functions that are robust against noise, occlusion, blurring, and small deformations, as well as algorithms to compute them efficiently.

- Multimedia Indexing: we are primarily interested in multimedia retrieval based on the certain patterns that are present in the content. For example patterns of shape in images and video, or patterns of themes in music. Recognition and matching of the shape of such patterns is often a computationally expensive task. For large collections this makes it unrealistic to sequentially match all multimedia objects in the database with the query. Therefore we investigate indexing search structures that make it possible to use accurate but complex similarity measures and computationally expensive matching algorithms, while the search is still efficient.

- 3D Shape Recognition: in reverse engineering, robot vision, machine part database retrieval and many other applications, one of the primary tasks is to match and classify a given 3D object shape. Laser scanning devices, web repositories, and private industrial database provide a huge amount of 3D shapes in the form of point clouds or polyhedral surfaces. We perform research on the matching two point clouds, a point set with a polyhedral surface, and two polyhedral surfaces. Two research issues are how to do partial matching, and how to achieve an accurate match without a good initial estimate.

Weizmann Institute of Science
WEIZMANN

In the subject of shape modeling and semantics Weizmann participants currently peruse the following lines of research.
In recent years we have developed an advanced multi-scale segmentation algorithm (called "Segmentation by Weighted Aggregation"), which provides state-of-the-art segmentation results on both 2D and 3D data. This segmentation method combines local cues at multiple scales, including shape and texture properties of the object being segmented. Local measurements are combined hierarchically forming aggregates and salient segments at different scales, with a natural saliency measure defined for each aggregate. The complexity of the process is linear in the number of input pixels (or voxels), running significantly faster than other state of the art methods. The method was shown to produce high quality results when applied to complex images of natural scenes, in particular to camouflaged animals. We are currently extending this method to applications involving 3D data, including MRI images, video sequences and 3D meshes.
An object's silhouette representation extracted automatically and reliably, in conjunction with additional properties such as color and texture, provides a powerful cue for recognition. We are currently developing a novel approach that allows us to compute many useful properties of a shape, and then use these properties as shape descriptors for object recognition. We assign each pixel internal to a shape a value reflecting the mean time required for a random walk to hit the boundaries.

This function can be computed by solving a Poisson equation with the silhouette contours providing the boundary conditions. We use this function in order to extract various shape properties including part structure and rough skeleton, local orientation and aspect ratio of different parts, and convex and concave sections of the boundaries. So far we have shown this method to be effective in representing written numerals and silhouettes of natural shapes, allowing for accurate shape recognition. We are currently interested in extending this representation to handle silhouettes resulting from a segmentation algorithm (e.g., the one currently described above). This includes handling multi-scale information, and imperfect segmentation results.
Finally, our research addresses the problem of 3D object recognition and shape reconstruction from 2D images under complex, unknown illumination and viewpoint. It appears that the infinitely dimensional set of images of a shape obtained under different lighting lies very close to a low-dimensional linear subspace. Previous studies gave theoretical justification to this fact and presented a specific description of this subspace using spherical harmonics. The analysis assumes Lambertian reflectance and accounts for attached, but not for cast shadows. While the original formulation assumes light sources at infinity, our recent study indicates that spherical harmonics representations provide an accurate approximation also for fairly near light. We have shown this representation method to be useful for applications such as photometric stereo, dense shape reconstruction of a moving shape and shape indexing. Photometric stereo with unconstrained lighting was achieved by performing a simple optimization in a low-dimensional space. A new correspondence measure that enables point matching across views of a moving object was proposed and used for recovering of the 3D structure of a moving shape. By combining geometric properties of shapes together with a representation of lighting in terms of spherical harmonics, shape indexing leading to object recognition from single images was possible.

Relevant Projects

Relevant EU Funded Projects

- **ARROV FP5 Growth**, Augmented Reality for Remotely Operated Vehicles based on 3D acoustical and optical sensors for underwater inspection and survey (*http://arrov.disi.unige.it*)
- **ECG FP5 IST FET**, Effective Computational Geometry for Curves and Surfaces (*http://www-sop.inria.fr/prisme/ECG/*) - finished
- **FANTASTIC FP5** Growth, Functional design and optimization of ship hull forms - finished
- **GAIA II FP5 IST FET**, Intersection algorithms for geometry based IT-applications using approximate algebraic methods (*http://www.sintef.no/static/am/gaiatwo/*)
- **HUMAINE FP6 IST NOE**, Human-machine Interaction Network on Emotion
- **KM FORUM FP5 IST**, European Knowledge Management Forum (*http://www.knowledgeboard.com*) - finished
- **LEADING EDGE FP5 Growth**, Prediction of leading edge and tip flow for the design of quiet and efficient screw propellers
- **MINGLE FP5 RTN**, Multiresolution in Geometric modeling (*http://www.cs.technion.ac.il/~vitus/mingle/*) - finished
- **MUVII FP5 IST**, Multi User Virtual Interactive Interface (*http://muvii.hpclab.ceid.upatras.gr/*) - finished
- **SMARTSKETCHES FP5 IST**, A Multimodal Approach to improve usability in the early stages of product design (*http://smartsketches.inesc-id.pt/*)
- **TELLMARIS FP5 IST**, Development of a 3D-map interface for tourist information on mobile computers (*http://www.tellmaris.com*) - finished
- **ViHAP3D**, Virtual Heritage: High-Quality 3D Acquisition and Presentation (*http://www.vihap3d.org*)
- **ViSiCADE FP5 IST**, Virtual Simulation Environment for a Seamless Integration of CAD/CAE into VR (*http://www.visicade.de/*)
- **WIDE FP5 IST**, Semantic Web-Based Information Management and Knowledge Sharing for Innovative Product Design and Engineering (*http://www.ist-wide.info/*)

Other Projects

- Compact Representation and Efficient Processing of Very Large Triangle Meshes, funded by the German-Israeli Founda tion for Scientific Research and Development (GIF), (*http://gifres.org.il/*), in progress
- Low-cost sensors and geometric techniques for scanning and modeling solid objects, funded by the Ministry of Education, University and Research (MIUR), Italy, (*http://www.ima.ge.cnr.it/*), in progress
- **GPGPU**, Graphics hardware as a high-end computational resource, funded by the Research Council of Norway, Norway, (*www.math.sintef.no/gpu*), in progress
- **InSide**, Intelligent Styling System for Industial Design, funded by the Provincia Autonoma of Trento (PAT), Italy, (*http://www.graphitech.it/projects/index.html*), in progress
- **MACROGeo**, Algorithmic and Computational Methods for Geometric Object Representation, funded by the Ministry of Education, University and Research (MIUR), Italy, (*http://www.isti.cnr.it/ResearchUnits/Labs/vc-lab/research-pro.html and http://www.ima.ge.cnr.it/*), in progress
- **MoSes**, Modeling Semantic Shapes, funded by the Provincia Autonoma of Trento (PAT), Italy, (*http://www.graphitech.it/projects/index.html*), in progress
- **SHAME**, Shape Matching Environment, funded by Technology Foundation (STW), The Netherlands, (*http://www.cs.uu.nl/centers/give/multimedia/matching/shame.html*),in progress
- **SIMI-Pro**, Semantic Information Management system for Innovative Product design, funded by the Provincia Autonoma of Trento (PAT), Italy, (*http://www.graphitech.it/projects/index.html*), in progress
- **Space Design PRO**, Space Design Product, funded by the Provincia Autonoma of Trento (PAT), Italy, (*http://www.graphitech.it/projects/index.html*), in progress
- **WEB-GIS**, Representation and management of spatial data on the WEB, funded by the Ministry of Education, University and Research (MIUR), Italy, (*http://www.ima.ge.cnr.it/*), in progress

Semantic-based Knowledge Systems

1. **ACEMEDIA:** Integrating knowledge, semantics and content for user-centred intelligent media services
2. **AGENTLINK III:** AgentLink III: A Co-ordination Network for Agent-Based Computing
3. **ALVIS:** Superpeer Semantic Search Engine
4. **ASPIC:** Argumentation Service Platform with Integrated Components
5. **DIP:** Data, Information, and Process Integration with Semantic Web Services
6. **DIRECT-INFO:** Media monitoring and multimodal analysis for time critical decisions
7. **KB20:** The European Knowledge Space
8. **KNOWLEDGE WEB:** Realizing the semantic web
9. **METOKIS:** Methodology and tools infrastructure for the creation of knowledge units
10. **MUSCLE:** Multimedia Understanding through Semantics, Computation and Learning
11. **REWERSE:** Reasoning on the Web with Rules and Semantics
12. **SEKT:** Semantically-Enable Knowledge Technologies
13. **SIMAC:** Semantic Interaction with Music Audio Contents

Knowledge Board *(www.knowledgeboard.com)*

The European KM Forum strives to build up a KM community in Europe and through the community to support and identify commonality in KM terminology, application and implementation. This is primarily done by providing infrastructure for networking and pushing KM information to a broad KM community of experts and laymen as well as pulling information and feedback from them. This infrastructure supports face-to-face communication as well as virtual meetings over the Internet. Besides this, there is one main focus on standardising KM application and implementation approaches and to create wide acceptance for these approaches by the community.

Objectives:
The objective of the European KM Forum is to bring together the available critical mass of KM experts in Europe in order to share and exchange the latest developments in the KM domain and to develop visions for the future. European KM Forum aims to establish and maintain a well co-ordinated and effective support infrastructure throughout Europe, enabling KM experts to co-ordinate their research activities and to network, both on formal and informal level. Different application and implementation approaches shall be converged to widely accepted standardised approaches and guidelines. The European KM Forum provides a means for individual organisations to find similarly oriented partners to build special interest groups in order to jointly discuss situations and seek for solutions without losing contact to other greater European view on KM, thus profiting from results achieved and experiences made in other European projects. Further the development and set-up of a WWW-portal has been a central objective of the European KM Forum.

Conferences and Events _04

June 2-4	Symposium on Point-Based Graphics, ETH Zurich (**Switzerland**) *http://graphics.ethz.ch/PGB/*
June 6-12	SMI & SM '04, International Convention on Shapes and Solids, Genova, (**Italy**) *http://smism04.ge.imati.cnr.it*
June 6-9	CGGM'2004, International Workshop on Computer Graphics and Geometric Modeling ,Krakow, (**Poland**) *http://personales.unican.es/iglesias/CGGM20*
June 8-9	EGVE'2004, Eurographics Symposium on Virtual Environments, Grenoble, (**France**) *http://www.inrialpes.fr/egve04/*
June 8-11	Tutorial on Computer Vision for Immersive Communications, E. Trucco, Università di Verona, (**Italy**)
June 9-11	20th Annual ACM Symposium on Computational Geometry, New York, (**USA**) *http://socg.poly.edu/home.htm*
June 12	2nd CGAL User Workshop, New York, (**USA**) *http://www.cgal.org/UserWorkshop/index.html*
June 16-18	VRCAI'2004, ACM SIGGRAPH International Conference on Virtual-Reality Continuum & Its Applications in Industry, Nanyang, (**Singapore**) *http://www.ntu.edu.sg/mpe/Research/Programmes/VirtualReality_SoftComputing/VRCAI2004/page2.htm*
June 16-19	CGI'2004, Computer Graphics International, Crete, (**Greece**) http://www.ics.forth.gr/cgi2004/
June 21-25	Minisymposium on "The CAD-FEM Link" at European Conference on Mathematics for Industry 2004, Eindhoven, (**The Netherlands**) *http://www.ecmi2004.tue.nl/*
June 27-2 July	IEEE Computer Vision and Pattern Recognition Conference, Washington DC, (**USA**) http://cvl.umiacs.umd.edu/conferences/cvpr2004/
July 1-6	The Sixth International Conference on Mathematical Methods for Curves and Surfaces, Tromsø, (**Norway**) *http://www.ifi.uio.no/~cagd/*
July 7-9	CASA'2004, Conference on Computer Animation and Social Agents, Geneva (**Switzerland**) *http://casa2004.miralab.unige.ch*
July 12-13	SGP, Symposium on Geometry Processing, Nice, (**France**) *http://www.geometryprocessing.org/*
July 19-23	AAMAS'2004, International Conference on Autonomous Agents and Multi-Agent Systems, New-York, (**USA**) *http://satchmo.cs.columbia.edu/aamas04/*
August 8-12	SIGGRAPH2004, Los Angeles, (**USA**) *http://www.siggraph.org/s2004/*
August 15	Call for papers for a Special Issue on Geometric Mesh Processing of the CAGD Computer Aided Geometric Design journal. Deadline August 15, 2004, *http://www.cs.technion.ac.il/~gotsman/CFP.pdf*
August 23-26	17th International Conference on Pattern Recognition, Cambridge, (**UK**) *http://www.ee.surrey.ac.uk/icpr2004/*
August 27-29	SCA'2004, ACM SIGGRAPH / Eurographics Symposium on Computer Animation, Grenoble, (**France**) *http://hms.upenn.edu/sca04/*
August 30-3 Sept	EG'2004, Eurographics 2004: The annual conference of the European Association for Computer Graphics, Grenoble (**France**) *http://eg04.inrialpes.fr/index.html.*

September 6-9	3DPVT, The Second International Symposium on 3D Data Processing, Visualization, and Transmission, Tessalonaki, (**Greece**) *http://www.umiacs.umd.edu/conferences/3dpvt04/*
September 27-29	Algebraic Geometry and Geometric Modeling, Nice, (**France**) *http://www-sop.inria.fr/galaad/conf/04aggm/index.html*
November 2-5	IEEE and ACM International Symposium on Mixed and Augmented Reality ISMAR'04, Arlington, VA, (**USA**), *http/www.ismar04.org/*
November 22-24	KSCE 2004, IASTED Int'l Conf. on Knowledge Sharing & Collaborative Eng., St. Thomas, (**US Virgin Islands**), *www.iasted.org/conferences/2004/vi/ksce.htm*
December 1-3	CIS 2004, IEEE Conf. on Cybernetics & Intelligent Systems, (**Singapore**) *http://cis-ram.nus.edu.sg*
December 19-22	KBCS 2004, 5th Int'l Conf. on Knowledge-Based Computer Systems, Hyderabad, (**India**) *http://, www.ncst.ernet.in/kbcs2004/*

International Convention on Shapes and Solids

From June 6 to 12, the city of Genoa (Italy) will host the International Convention on Shapes and Solids. The Convention is chaired by our coordinator Bianca Falcidieno and is organized by the Shape Modelling Group of CNR IMATI-Ge. It joins together two of the most important annual events dealing with the theoretical and algorithmic foundations for modeling and visualizing real or virtual shapes in a variety of applications: the Shape Modeling International Conference (SMI) and the ACM Symposium on Solid Modeling and Applications (SM). To stimulate the interaction between these two communities, the two events have been scheduled one after the other: the SMI Conference on June 7-9 and the SM Symposium on June 9-11, 2004. Each event retains its own Chairs, program committee, paper selection process, and proceedings. However, the two share tutorials and keynote lectures, and a social program on Wednesday June 9, culminating in a dinner in the Shark and Dolphin Halls of the Genoa Aquarium. This will be also a good opportunity to present our network to the scientific community. For this reason a special session has been organized during the common day immediately after the invited talk to be given by Aristides Requicha, the father of one of the first and most used representations for solid objects, the Constructive Solid Geometry (CSG).

Some words about the two conferences:
Shape Modelling International was inaugurated in Japan in 1997 with the aim of drawing together a rather multi-disciplinary community with common interests about shape modelling, but looking at the problem from a side view with respect to other specialized conferences. SMI is now an annual and circular event with the venue changing circularly from Asia to Europe, and to America. Previous conferences were organized in Japan (1997, 1999), Italy (2001), Canada (2002), and South Korea (2003). Some years it includes the Eurographics/ACM SIGGRAPH Workshop on Implicit Surfaces as a specific session. This year, in response to the call for papers, 79 papers were submitted out of which 29 papers were selected for presentation. The accepted contributions mainly focus on modeling implicit surfaces, surface meshes, point sets and subdivision surfaces, shape retrieval, feature-based modeling and deformations, and interactive modeling. To highlight topics of particular importance, three additional contributions were invited. One of these will be given by our Network partner Nadia Magnenat-Thalmann. She will give a talk on semantic human body reconstruction. The other invited talks deal with shape theory and shape issues in highly-distributed robotics systems at the nanoscale. In addition, 11 short papers have been selected from among the submitted short and full papers. Finally, a full day tutorial on Freeform Shape Representations for Efficient Geometry Processing has been organized for June 6th. The ACM Solid Modeling Symposium is an international forum for the exchange of recent results of research and applications of solid modeling, geometric modeling, and geometric computation in design, analysis and manufacturing, as well as in biomedical, geophysical and other application areas. Since 1991 this highly successful event has been bringing together prominent researchers, key practitioners, and students in the field. The symposium has been held annually since 2002, alternating its location between the USA and other countries. This year, from among the 60 paper submitted, 19 have been retained for publication in the conference proceedings as full papers and 20 will appear as short papers. The accepted contributions deal with CAD related applications, such as data exchange, engineering drawing, surface parametrization and approximation, constraint based design, and Boolean operations, or different types of representations, such medial axis, geological and volumetric, simplicial geometric and subdivision schemes. Among the papers presented at the convention, best papers will be selected for publications in Special Issues of different journals: ASME Journal of Computing and Information Science in Engineering on Shapes (JCISE), Graphical Models (GMOD) and International Journal on Shape Modelling (IJSM). To encourage colleagues from the same institutions to participate in both the conferences and to bring their students, a multi-participant discount scheme has been introduced. Discounts for the AIM@SHAPE partners are offered as well. Since Genoa is the European capital of Culture for this year, the program organized for the summer season is packed with events. Therefore, we strongly recommend proceeding with hotel booking as soon as possible.

For further details, please visit our conference site at http://smism04.ge.imati.cnr.it/
Looking forward to meeting you at the conference

Franca Giannini, Michela Spagnuolo

AIM@SHAPE Consortium Life

Important Dates

March 17-18, 2004: **Darmstadt, Germany -** Harmonization workshop
April 21-23, 2004: **Santorini, Greece -** Ontology workshop
May 24-25, 2004: **Geneva, Switzerland -** Standards workshop
July 12-13, 2004: **Nice, France -** Digital Shape Workbench workshop

Seminars and Training

- **Ontology workshop, Santorini, April 21-23 2004**

  See the e-Room for material and presentations in Aim@Shape > 2_Meetings > Harmonization WorkShop at Santorini>Material

- **Training on Standards, Geneva, May 24-25 2004**

  This training covered MPEG(1), WEB3D(2), W3C(3) and STEP(4).
  Related web sites for further information:
  http://www.chiariglione.org/mpeg/
  http://www.web3d.org/,
  http://www.h-anim.org(3)
  http://www.w3.org/
  http://www.mel.nist.gov/sc5/soap

  See the e-Room for further material and presentations in
  Aim@Shape > 1_Deliverables > WP_8 > Task 8.5 > Training on Standards

- **Annual Seminars on Computer Vision and Graphics at the Weizmann Institute**

  Every year (usually during the fall semester) a graduate introductory class is taught in which basic computer vision problems and algorithms are introduced. In addition, we hold an annual reading group (usually during the spring semester), aimed at discussing recent advances in computer vision and graphics. Also, throughout the year we run a weekly seminar in which invited speakers present their work in both vision and graphics. All courses and seminars are open to the public and do not require pre-registration.
  Please see the Weizmann Institute web page at www.weizmann.ac.il for course time and location information, or the computer vision group's homepage at www.cs.weizmann.ac.il/~vision.

AIM@SHAPE Dissemination Activities

Knowledge and content technology research - The past and the future, EUROPEAN COMMISSION, Luxembourg, December 2-3, 2003. Presentation of AIM@SHAPE at the poster session (See eRoom)

Workshop on Mathematical Foundations of Scientific Visualization, Computer Graphics, and Massive Data Exploration, Banff International Research Station for Mathematical Innovation and Discovery (BIRS), Canada, May 22 - 27, 2004, http://www.pims.math.ca/birs/workshops/2004/04w5043/ Presentation of the AIM@SHAPE project and its objectives by Ewald Quak (SINTEF)

Minisymposium on "The CAD-FEM Link" at European Conference on Mathematics for Industry 2004, Eindhoven, The Netherlands, June 21-25, 2004, http://www.ecmi2004.tue.nl/. Minisymposium organized by Ewald Quak (SINTEF) on research by AIM@SHAPE partners presented by Vibeke Skytt (SINTEF), Franca Giannini (IMATI), Jean-Claude Léon (INPG) and Holger Graf (IGD)

Jobs

Check out for Post Doc openings at GraphiTech (www.graphitech.it). Please send your applications at raffaele.de.amicis@graphitech.it

The Department of computer science and Applied Mathematics at the Weizmann Institute is accepting applications for M.Sc., Ph.D., and Post-Doctoral positions. In addition, it offers a program for summer students at the undergraduate level. Please check the Weizmann web page at www.weizmann.ac.il for application information.

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